North America's System Operators: a public perspective on a changing electricity system

Presentation to IESO Stakeholder Summit

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ISO/RTO Council – www.isorto.org

"By sharing innovative ideas and real-world best practices, IRC members work together to build a smarter and more efficient electric grid that's well prepared to serve the North American power market and its consumers, today and tomorrow."

Further information:
www.isorto.org

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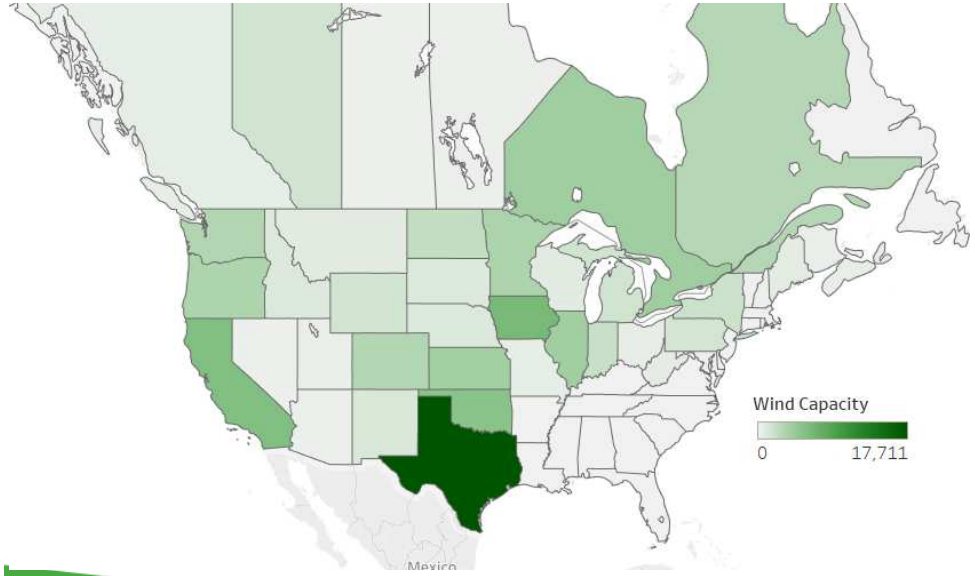
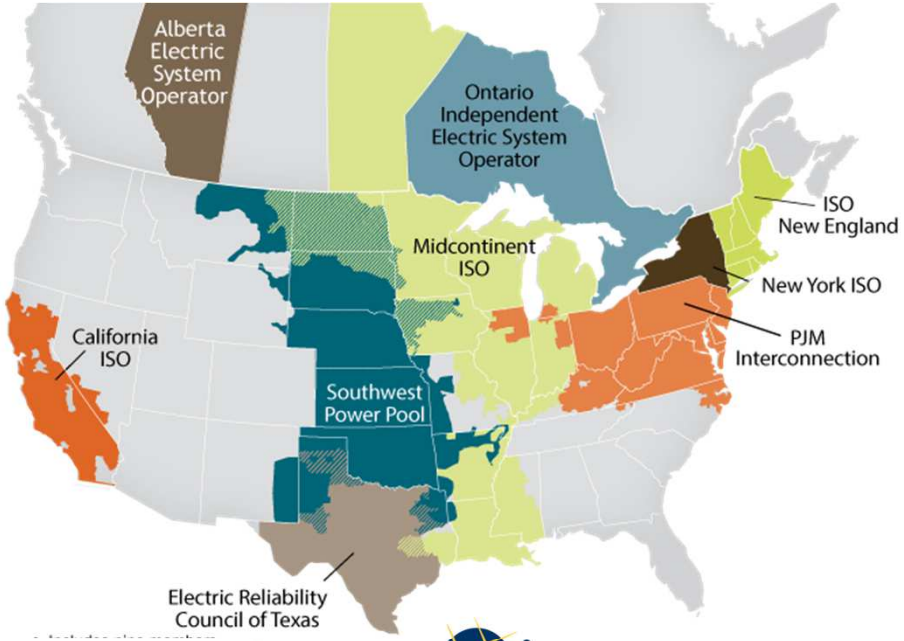
IRC members are at the forefront of North America's changing supply mix

80.3 percent of all **wind capacity** on the continent is now located in IRC regions.

Wind Capacity



ISO/RTO regions



Data sources: Government of Alberta, International Energy Agency, IESO, United States Department of Energy, "Wind Technologies Market Report, 2015", Aug. 2016, U.S Department of Energy, "WINDExchage" website: http://apps2.eere.energy.gov/wind/windexchange/wind_installed_capacity.asp accessed, October, 2016
Data sources: U.S. Energy Information Administration, EIA - Electric Power Monthly, July, 2016, Government of Canada – Natural Resources Canada, "Photovoltaic Technology Status and Prospects - Canadian Annual Report", 2015, IESO

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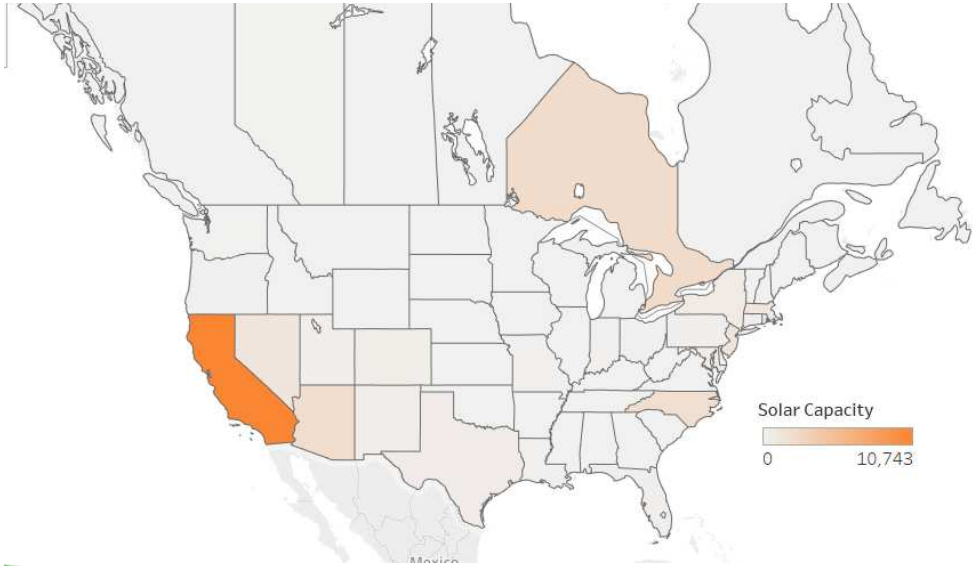
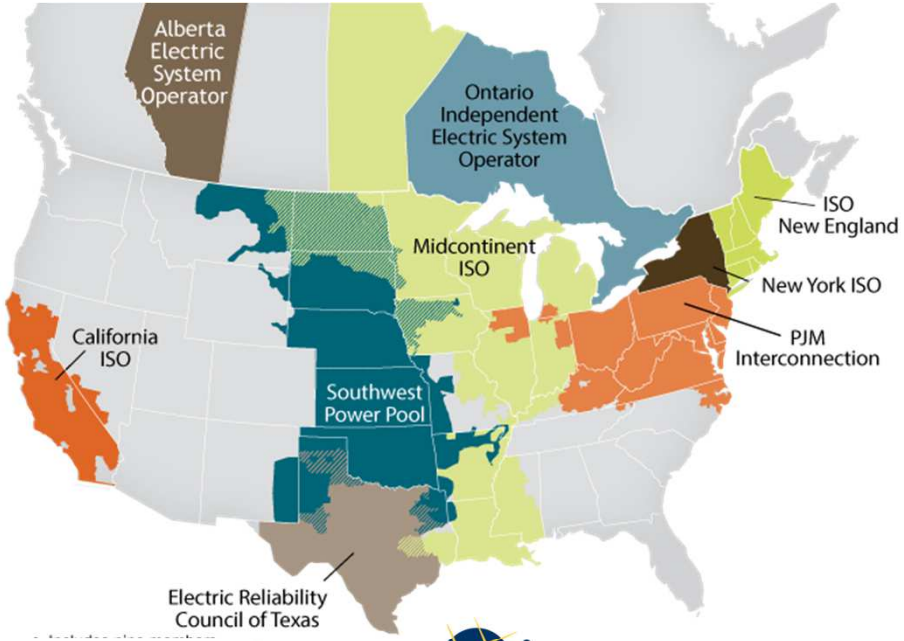
IRC members are at the forefront of North America's changing supply mix

81.1 percent of **solar capacity** is situated within regions served by IRC members

Solar Capacity



ISO/RTO regions



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Looming questions for System Operators

- In 2015, the ISO/RTO Council's Emerging Technologies Task Force (IRC ETTF) initially set out to conduct a preliminary assessment of the use of emerging technologies in each member organization.
- Over the course of 2016, it became clear that the this effort intersected with several looming questions of common importance across the North American continent…

Is renewable integration a local problem, or a regional problem?

NREL Scenario RTx30:
30% renewable solutions with regional-based solutions:
- Renewable targets met within each region.
- Local solutions dominate: storage, load control, demand response, DER participation in markets, etc.

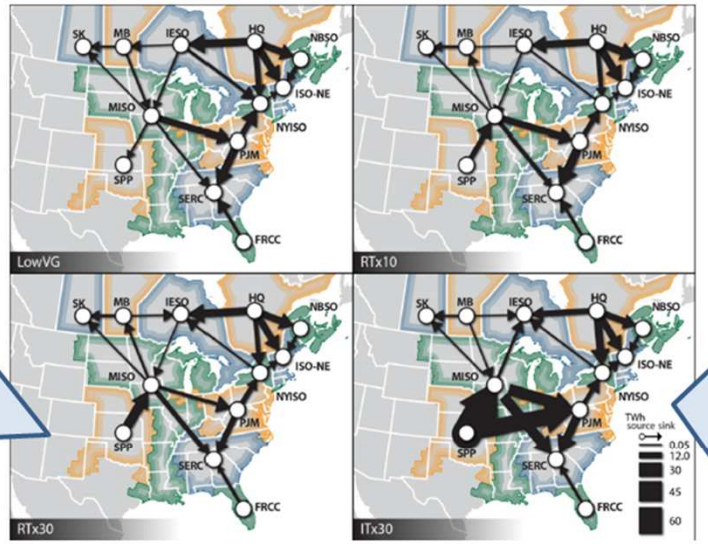

Figure 49. Total net interchange between regions

NREL Scenario ITx30:
30% renewable solutions with interregional solutions:
- Renewable targets met in each region
- Shared solutions potentially dominate: Greater use of HVDC technologies, Regional network models, dynamic trading at interties, shared capacity, shared reserves, etc.

Implications: Solar concentrations

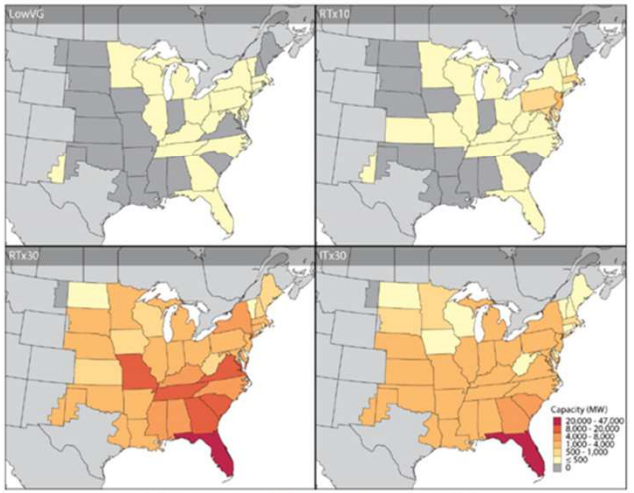

Figure 17. Maps of the installed PV capacity in the four ERGIS scenarios

Implications: Wind concentrations

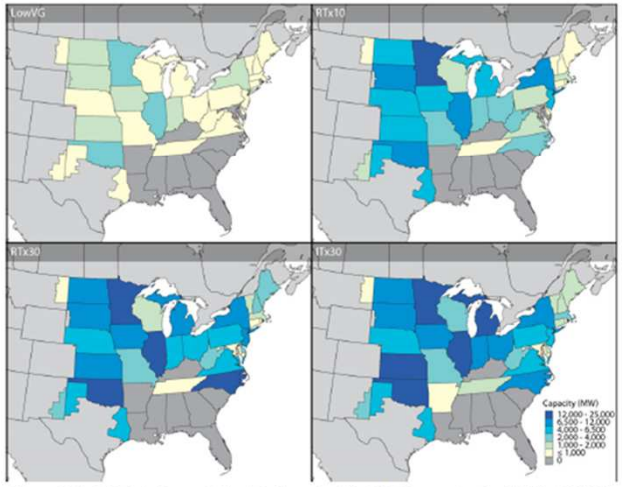

Figure 16. Installed wind capacity by state for each of the ERGIS scenarios: LowVG (first), RTx10 (second), RTx30 (third), ITx30 (fourth)

Image sources from: National Renewable Energy Laboratory (NREL) "*Eastern Renewable Integration Study*," August, 2016

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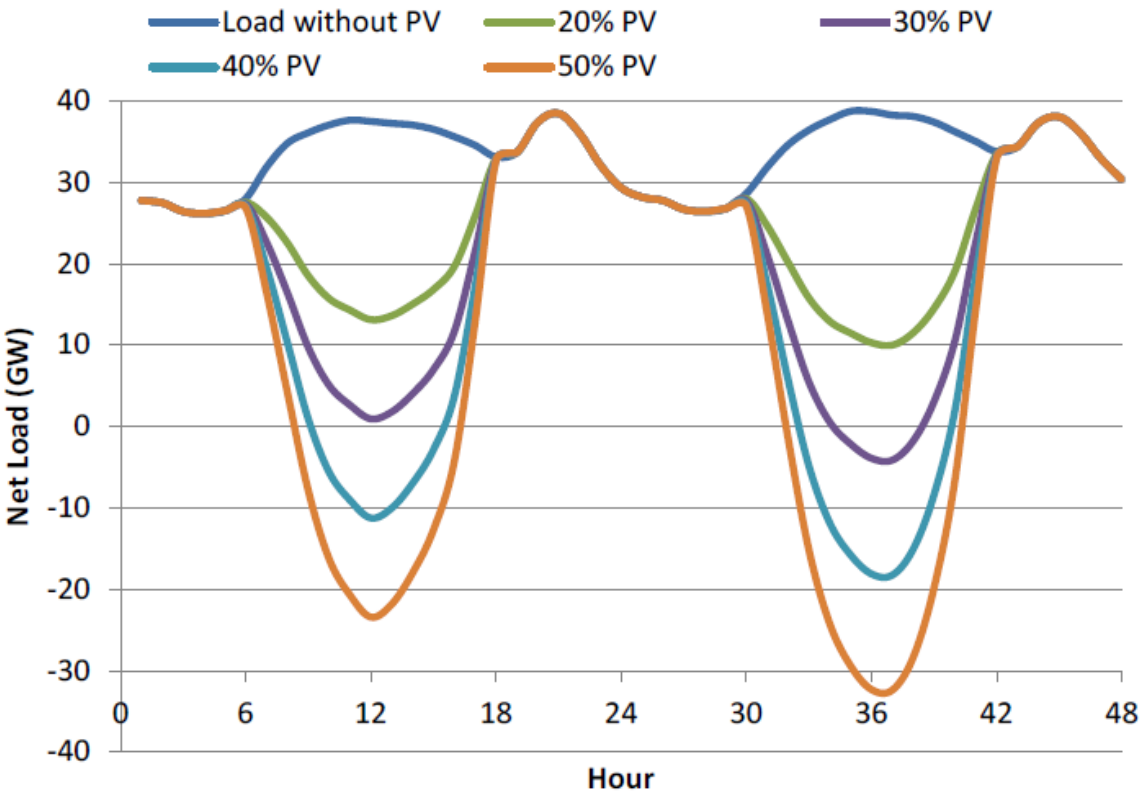
Will system operators have enough visibility to ensure reliability?



Example: Projections of large-scale DER growth show the potential to fundamentally change the nature of a distribution/transmission interface in CAISO's territory.

Source: NREL, *"Energy Storage Requirements for Achieving 50% Solar Photovoltaic Energy Penetration in California"*, Aug. 2016

"As the deployment of PV increases, it is possible that during some sunny midday periods due to limited flexibility of conventional generators, system operators would need to reduce (curtail) PV output in order to maintain the crucial balance between electric supply and demand. As a result, PV's value and cost competitiveness would degrade."

U.S. Department of Energy, "ON THE PATH TO SUNSHOT: EXECUTIVE SUMMARY"

How will we manage an increasingly distributed system?

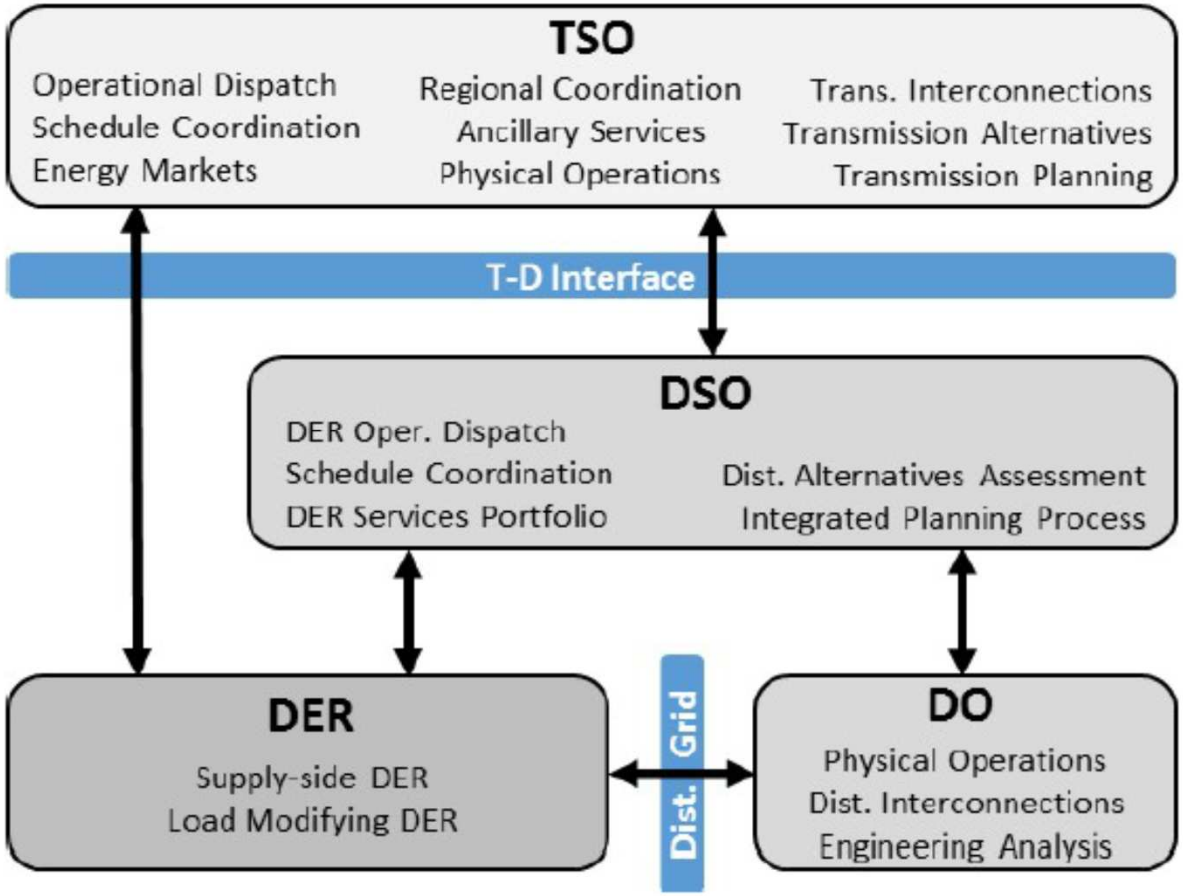
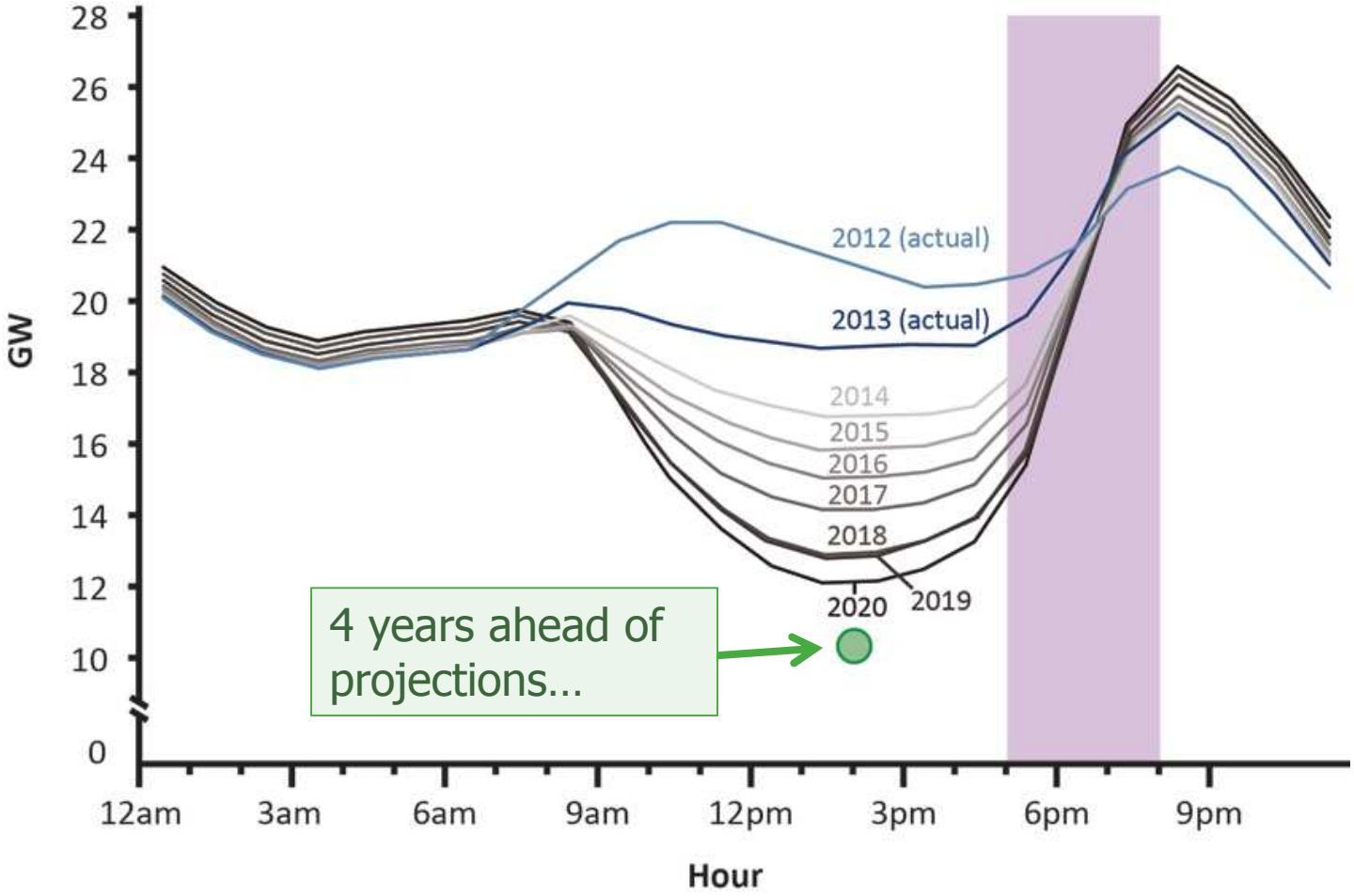


Image Source: Lawrence Berkeley National Labs, Kristov, L. (CAISIO), et. al., "*Distribution Systems in a High Distributed Energy Resources Future*." December, 2015

How fast is our system changing?

Example: California Independent System Operator “duck curve”



How fast is our system changing?

Surprisingly, there are other projections of a rapidly changing electricity system - that don't involve a picture of the CAISO "duck curve"…

How fast is our system changing?

Future projection scenarios of the U.S. Energy Information Administration:

- **Reference case**
- **Without the U.S. clean power plan**
- **High Oil Prices**
- **Low Oil Prices**
- **High Economic Growth**
- **Low Economic Growth**

Many scenarios…

…and a few common themes...

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How fast is our system changing?

Reference case

Without the U.S. clean power plan

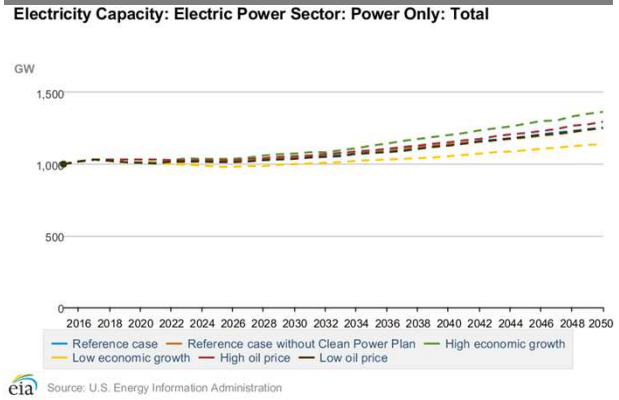
High Oil Prices

Low Oil Prices

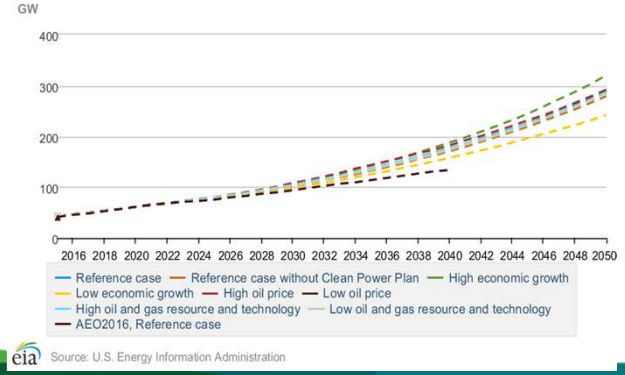
High Economic Growth

Low Economic Growth

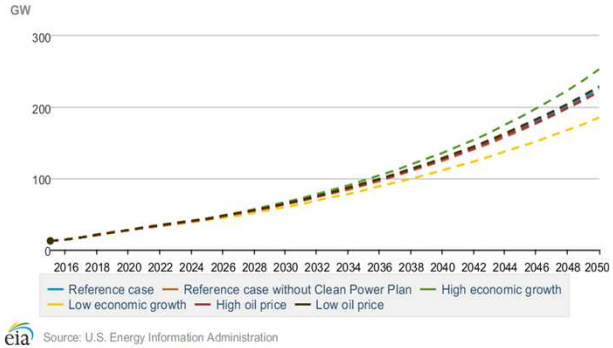
All U.S. generation capacity to the year 2050



U.S. end-use generation, summer capacity to the year 2050



U.S. end-use solar PV capacity to the year 2050



Data sources: U.S. Energy Information Administration, *"Annual Energy Outlook, 2017"*

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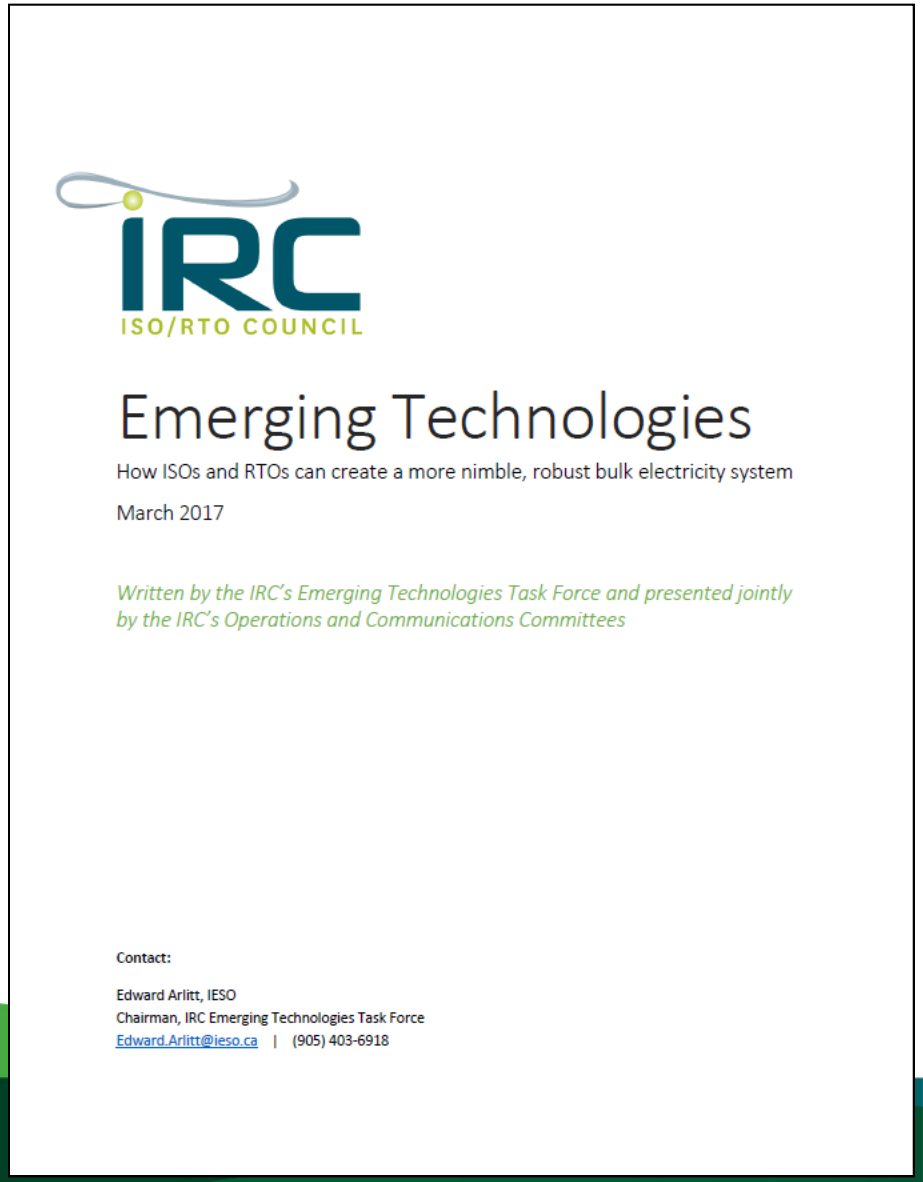
IRC ETTF public report, published March, 2017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ISO/RTO COUNCIL

Emerging Technologies

How ISOs and RTOs can create a more nimble, robust bulk electricity system

March 2017

Written by the IRC's Emerging Technologies Task Force and presented jointly by the IRC's Operations and Communications Committees

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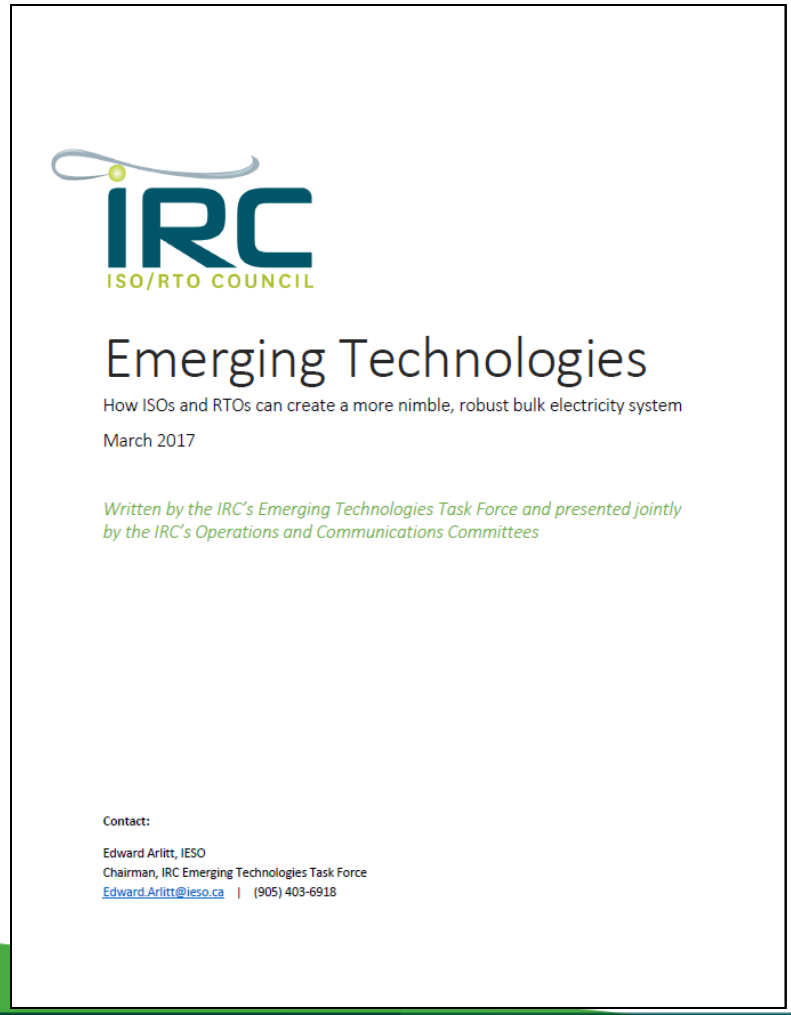
ISO/RTO Council (IRC) Emerging Technologies Task Force (ETTF) report:

Emerging Technologies: How ISOs and RTOs can create a more nimble, robust bulk electricity system

Available at: www.isorto.org

The IRC is taking **public positions** in three priority issues heavily impacted by Emerging Technologies....



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Emerging Technologies

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1. **Variability of Supply and Integration** (e.g. energy storage, microgrids)
2. **Leveraging emerging technologies for greater situational awareness** (e.g. PMU's, transactive energy)
3. **Manging an increasingly distributed electricity system** (e.g. microgrid controllers, connection requirements)

IRC PUBLIC POSITIONS

IRC Positions: Variability of Supply and Integration

IRC Positions: Renewable Supply and Integration:

The IRC….

- Generally supports policies and positions that recognize the electricity system's ability to reliably and efficiently accommodate large-scale amounts of renewables and realize their growing technological potential.
- Is agnostic to specific technologies.
- Recommends approaches that avoid early technological lock-in.
- Supports discussions to achieve a continent-wide consensus of the extent to which renewable integration will be achieved through regional or interregional trade.

"Wind power represented the largest source of U.S. electric-generating capacity additions in 2015. Wind power constituted 41 percent of all U.S. generation capacity additions in 2015, up sharply from its 24 percent market share the year before and close to its all-time high."

U.S. Department of Energy

"2015 Wind Technologies Report"

August 2016

IRC Positions: situational awareness

IRC Positions: Situational Awareness

The IRC believes…

- Data should no longer be treated as the constraining factor with respect to situational awareness arrangements across the transmission/distribution interface – particularly in regard to data transfers
- At a minimum, North American ISOs and RTOs should have access to basic static data series about DERs in their respective service territories
- A general operational data framework should be developed, where increasingly comprehensive operational data from the distribution system is provided as DER penetrations reach different thresholds.

"Data and information exchange across the transmission and distribution interface is a crucial aspect of power system planning, forecasting, and DER modeling."

NERC "Long-Term Reliability Assessment"
December 2016

IRC Positions: A distributed electricity system

IRC Positions: A distributed electricity system

The IRC…

- Recognizes that there must be some form of **coordinating influence** in a high-DER future to help ensure reliability.
- Will continue to facilitate a continent-wide dialogue on the appropriate means by which mass DERs and the bulk electricity system can mutually benefit each other. This **dialogue should focus on effective transfer of data across the transmission/distribution system interface** while allowing maximum flexibility for suitable local policies and market mechanisms to develop.
- Believes due consideration should be given by jurisdictions in which Distribution **System Operators (DSO)** are implemented and require such entities to conform to a sufficiently rigorous set of standards that allows for the safe interaction between DSOs, non-utility actors and the bulk electricity system.
- Supports policies to ensure that if variability at the distribution level results in a risk to system reliability **ISO/RTOs have appropriate authority over DERs** — or otherwise isolate their impact from the bulk electricity system.

In conclusion

1. It's not just about the IRC.
2. It's not just about North America.
3. The 'next steps' have already started.

"As the capabilities of DER evolve to include advanced controls (e.g. active power control) and monitoring, the transmission and distribution utilities will need to expand their coordination activities in order to maintain BPS reliability."

NERC, *"Distributed Energy Resources - Connection Modeling and Reliability Considerations"*
February, 2017

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