Report on Market & System Operations IRC Emerging Technologies Task Force Public Report Overview

Presentation to IESO Board of Directors

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June 14, 2017

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Key Messages

- The recent public report of the ISO/RTO Council's Emerging Technologies Task Force (IRC ETTF) has a strong connection with the IESO's DER strategy formulation.
- The report helps frame a policy-level discussion that all system operators in North America now agree must happen.
- **Economic efficiency** and **reliability** are the two common responsibilities of all system operators that underlie their interest in DERs.

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Key Messages (cont'd)

- The report sets the stage for a policy discussion regarding the coherent management of DER growth:
  - Obtaining situational awareness data for system operators.
  - Clarifying roles, responsibilities and accountabilities at the distribution level.
  - Ensuring that the transmission/distribution interface allows both levels of the system to mutually benefit each other as DER numbers continue to grow.

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…

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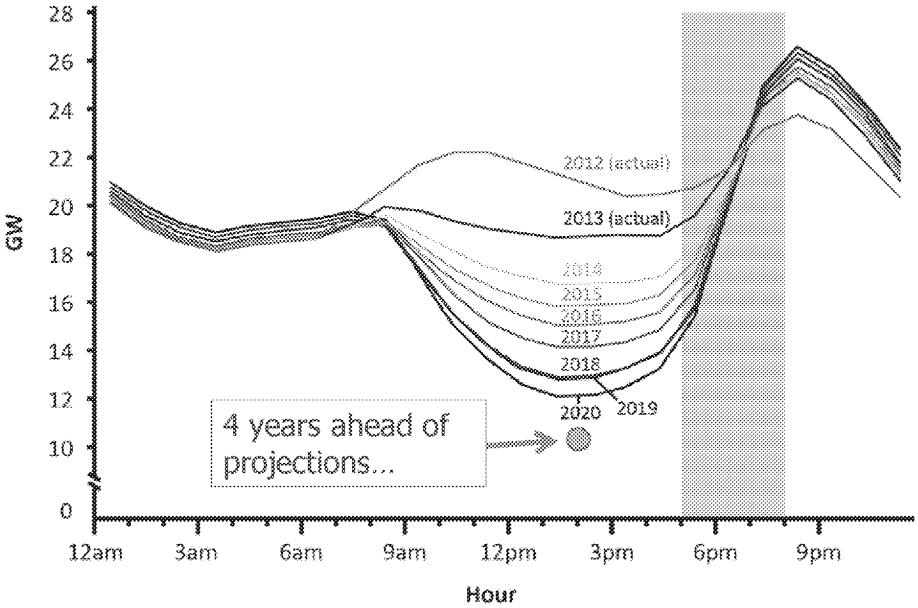
How fast is our system changing?

Example: California Independent System Operator "duck curve"



2016 Net Load: 11,663 MW (5/15/2016)

2020 Projected 3-Hour Ramp: 13,000 MW
2016 Actual 3-Hour Ramp: 10,892 MW (2/1/2016)

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.

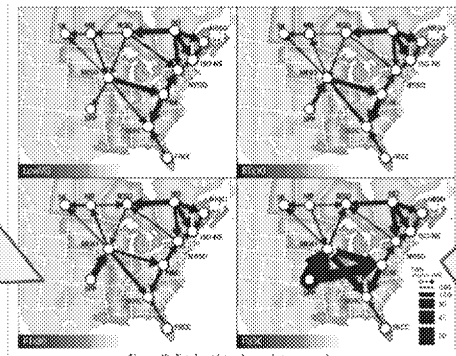


Figure 40. Total net interchange between regions.

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

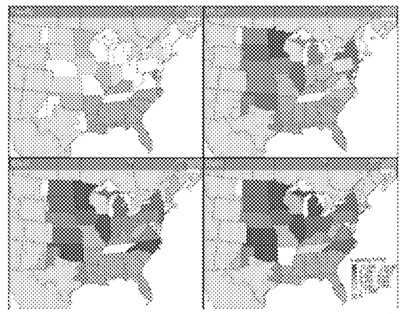
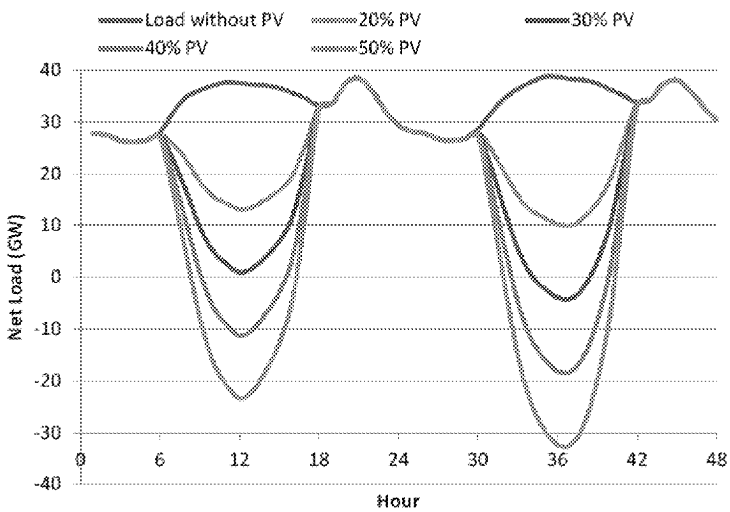


Figure 16. Installed wind capacity by state for each of the ERGIS scenarios: Low (first), RTx10 (second), RTx30 (third), ITx30 (fourth)

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

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.

"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"

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

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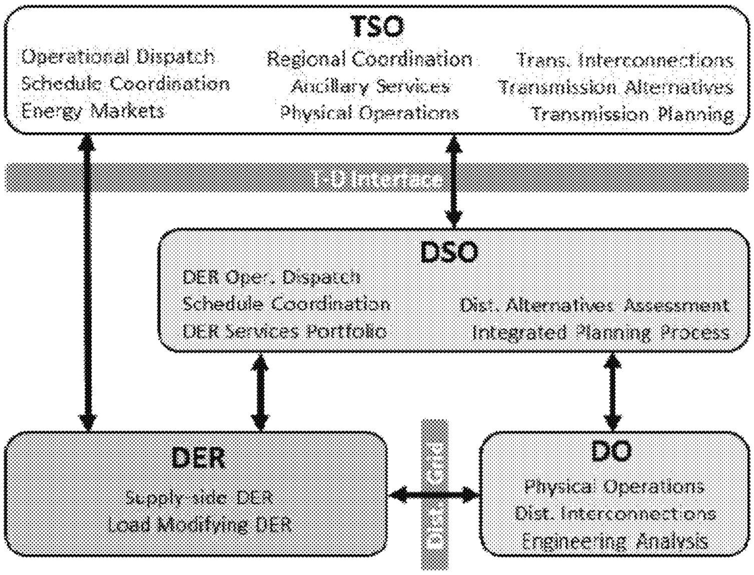
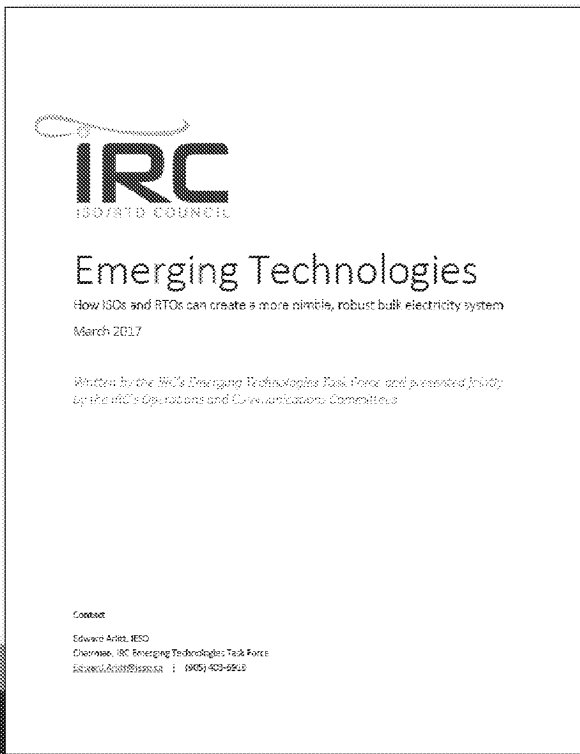
How will we manage an increasingly distributed system?

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



IRC ETTF public report, published March, 2017



IRC
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

Contact

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

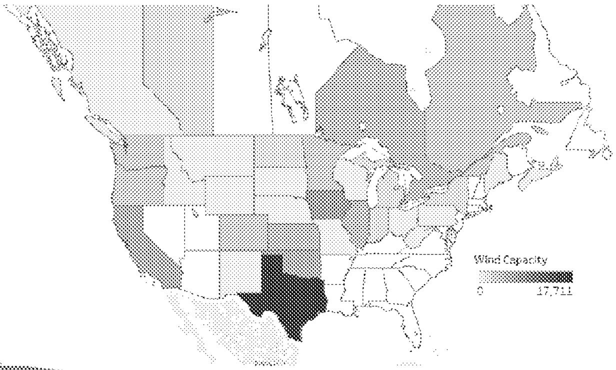
Emerging Technologies: How ISOs and RTOs can create a more nimble, robust bulk electricity system

Available at: www.isorto.org

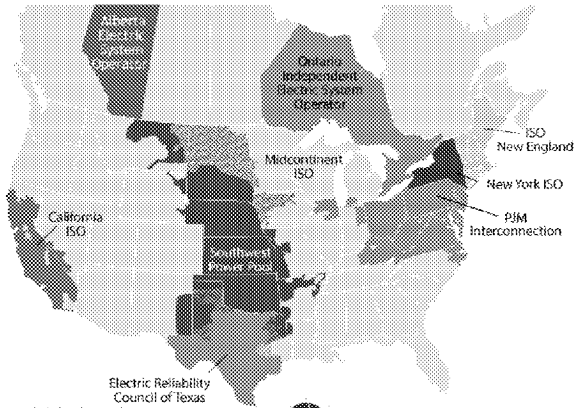
IRC members are on the forefront of North America's changing supply mix

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

Wind Capacity



ISO/RTO regions



Data sources: IEA, U.S. Energ
of Energy National Renewable Energy

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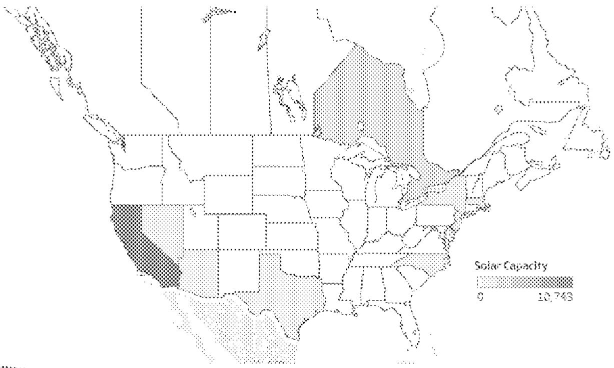
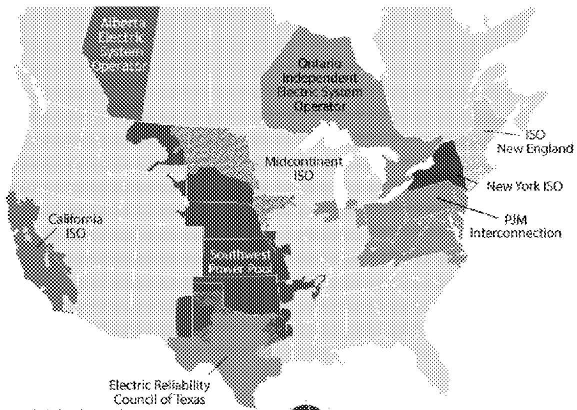
IRC members are on the forefront of North America’s changing supply mix

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

Solar Capacity



ISO/RTO regions



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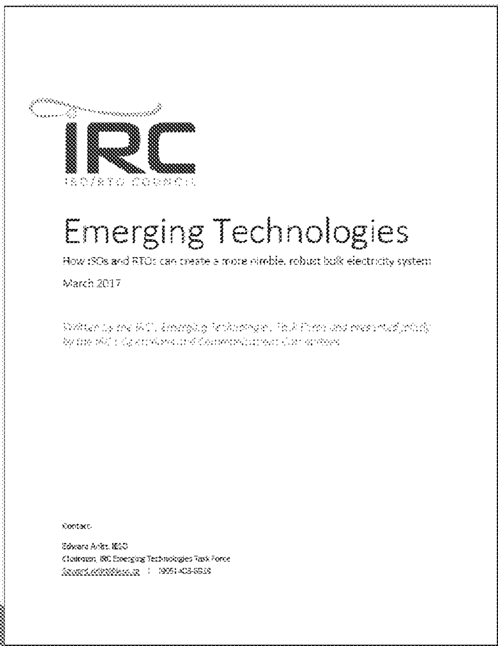
The IRC is taking **public positions** in three priority issues heavily impacted by Emerging Technologies….



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. **Level of control over an increasingly distributed electricity system** (e.g. microgrid controllers, connection requirements)

IRC PUBLIC POSITIONS

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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

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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**. Location, size and technological capabilities are just a few examples of critical and reliable data that IRC members need to formulate a comprehensive strategy for managing an increasingly distributed electricity system.
- **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.** This framework should be flexible enough to accommodate local differences in policy, roles and structural arrangements across North America.

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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.

APPENDIX SLIDES

IRC-ETTF member organizations and representatives:

Alberta Electricity System Operator
AESO
Arman Kiani, Cam Bush

California Independent System Operator
CAISO
Brad Bouillon, Bob Kott, Ali Miremadi

Electric Reliability Council of Texas
ERCOT
Bill Blevins, Pengwei Du, Clayton Stice

Independent Electricity System Operator
IESO
Edward Arlitt, ETTF Chair
Karen Backman

Independent System Operator of New England
ISONE
David Bertagnolli (ret.), Michael Gilmore

Midcontinent Independent System Operator
MISO
Kevin Frankeny, Beibei Li

New York Independent System Operator
NYISO
Brad Garrison

PJM Interconnection
Chantal Hendrzak

Southwest Power Pool
SPP
Casey Cathey, Derek Hawkins

IRC Emerging Technologies Task Force (ETTF)

ETTF Objectives:

1. *"Share experiences regarding development of PMU and other system wide monitoring;*
2. *Monitor, review, share and recommend practices related to grid operations driven by continued evolution of micro-grids and distributed resources, and*
3. *Evaluate member efforts to incorporate other emerging technologies such as flywheels, batteries, dynamic ratings, topological control, and smart grid devices for example."*

(from the *ETTF Terms of Reference*)

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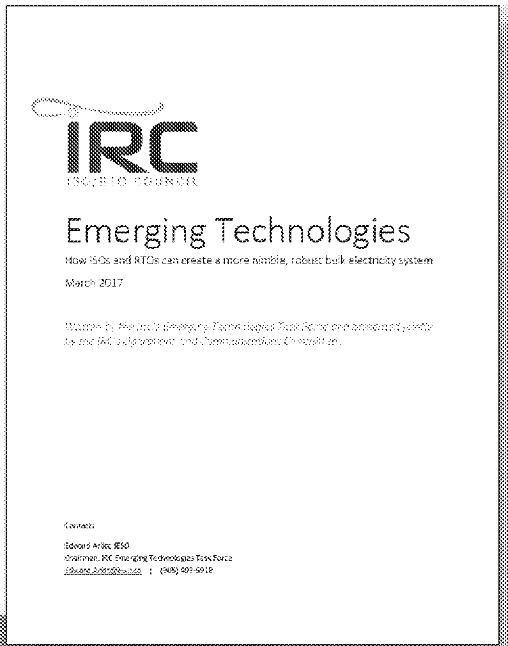
Development of the Report


IRC

Emerging Technologies

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

March 2017

- Began in the fall of 2015 as a summarization of the current state of emerging technology deployment across the IRC member organizations
- Interim report shared with the IRC Operations Committee in Feb 2016.
- Interim report prompted the IRC CEO's to call for the development of a public-facing report.
- Final version of public report includes commentary on the prospects of emerging technologies and the policy questions they raise

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DERs in North America: Deployment of distributed solar

- On the North American continent, Ontario is second only to California when it comes to distributed solar capacity.
- Distributed solar is one of **several** forms of Distributed Energy Resources, and provides a useful benchmark for the DER growth phenomena due to the presence of comparable data series.

Data sources: IESO, "A Progress Report on Contracted Electricity Supply
U.S. Energy Information Administration – 860-M data as of Feb. 2017

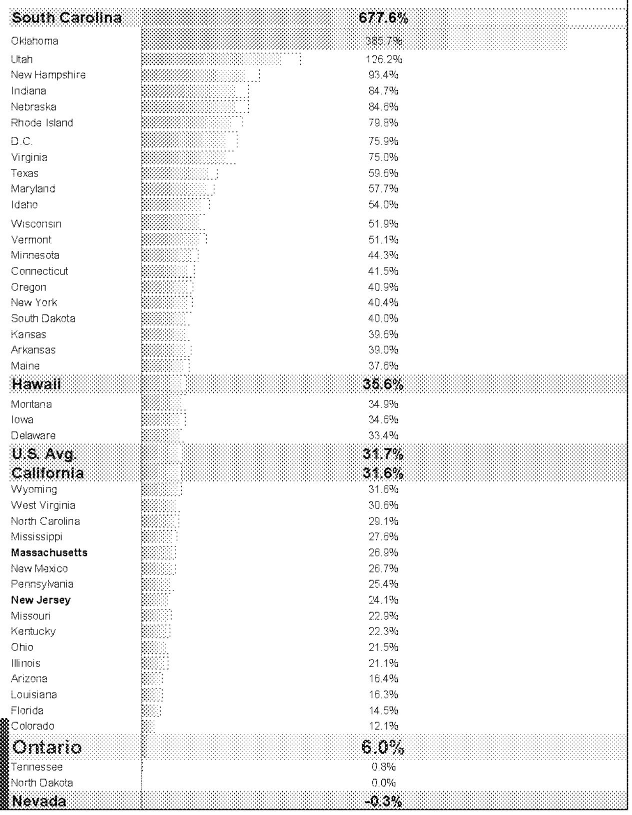
2017 Installed distributed solar CAPACITY (MW) as of February 2017

California	**5506.10**
Ontario	**1947.00**
New Jersey	1327.80
Massachusetts	1010.20
Arizona	921.10
New York	794.70
Maryland	599.90
Hawaii	**529.10**
Colorado	295.50
Connecticut	274.00
Texas	270.50
Pennsylvania	240.50
Nevada	**171.60**
Florida	145.50
Utah	132.80
Louisiana	125.70
Missouri	120.20
North Carolina	114.80
Oregon	103.00
New Mexico	98.30
Ohio	87.10
Delaware	86.20
Vermont	79.20
South Carolina	**66.10**
New Hampshire	58.80
Iowa	47.80
D.C.	43.10
Virginia	41.30
Tennessee	39.80
Wisconsin	32.50
Minnesota	31.90
Illinois	27.50
Maine	24.50
Rhode Island	21.40
Indiana	15.70
Oklahoma	13.60
Kentucky	12.60
Montana	8.50
Idaho	7.70
Kansas	7.40
Arkansas	5.70
West Virginia	4.70
Mississippi	3.70
Wyoming	2.50
Nebraska	2.40
Alaska	1.60
South Dakota	0.70
North Dakota	0.20

DERs in North America: Comparative growth rates

- Despite being second in North America for capacity, Ontario's solar growth rates have recently fallen to among the slowest on the continent as Feed-in-Tariff rates have diminished.
- Over 40 U.S. states have net metering policies in place

2016 annual GROWTH RATES - distributed solar



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