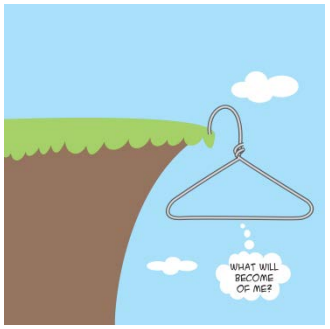


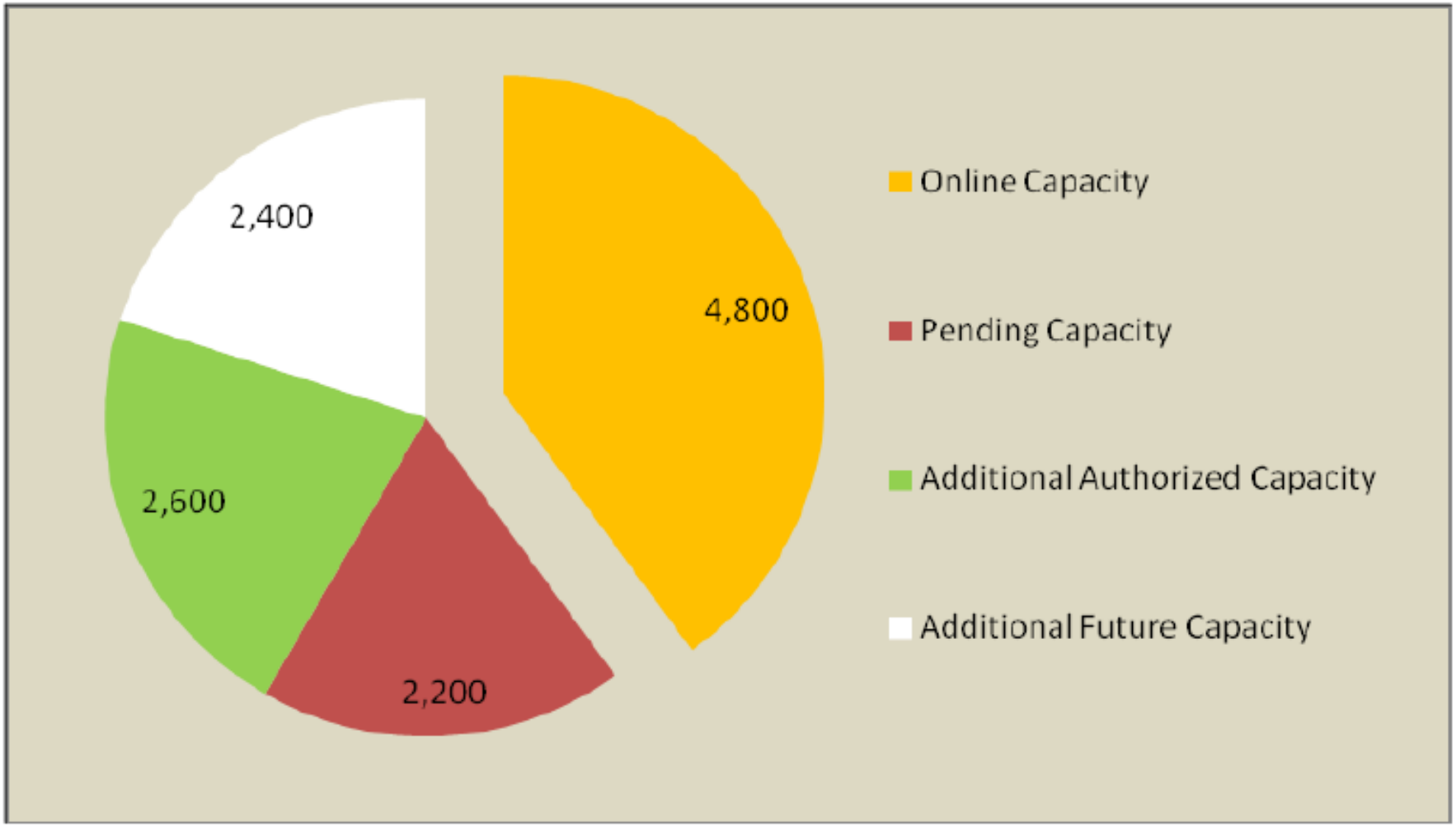
Cliffs and Ducks, Inverted Blocks and Spirals: Where Does Distributed Solar Go From Here?

Steve Weissman

Lecturer in Residence and Director of the Energy Program

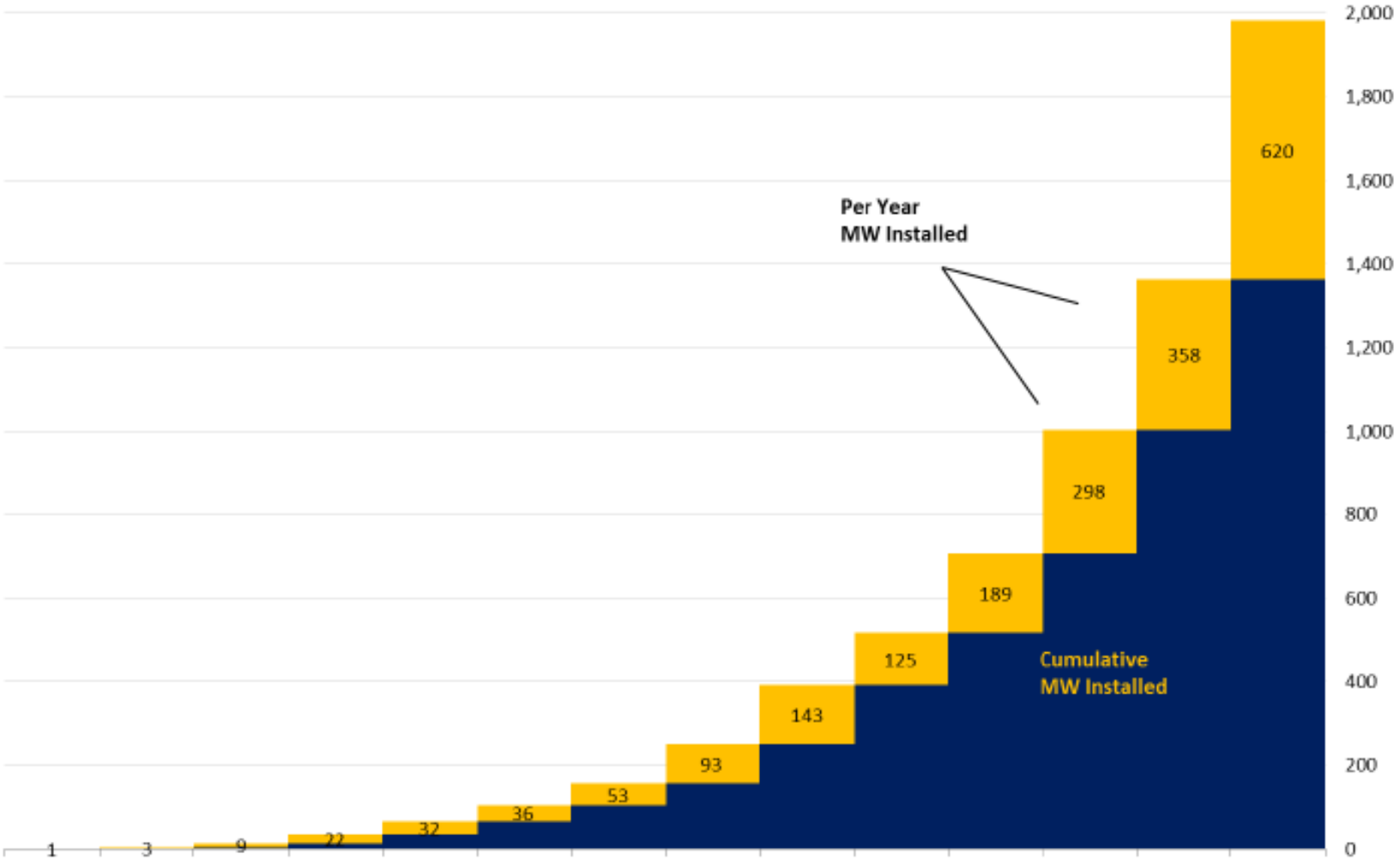
Berkeley Law

Figure 1: Renewable Distributed Generation in California
(20 MW or Smaller, Includes Wholesale and Self-Generation)



Source: California Energy Commission, based on sources [D1] through [D14]. Updated July 2014.

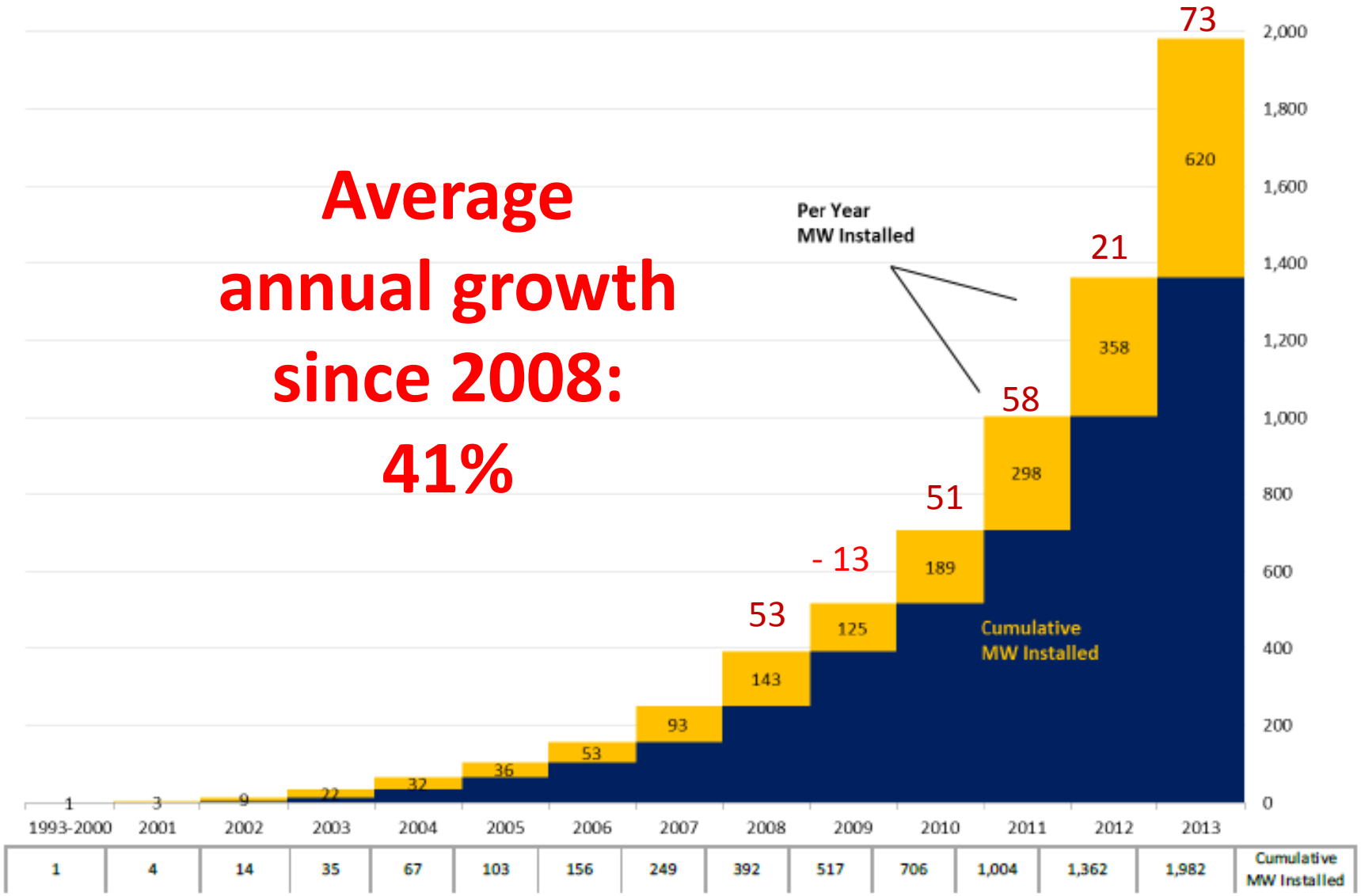
Figure 1: Customer-Sited Solar Capacity Installed in CA's IOU Territories, 1993-2013



1	4	14	35	67	103	156	249	392	517	706	1,004	1,362	1,982	Cumulative MW Installed

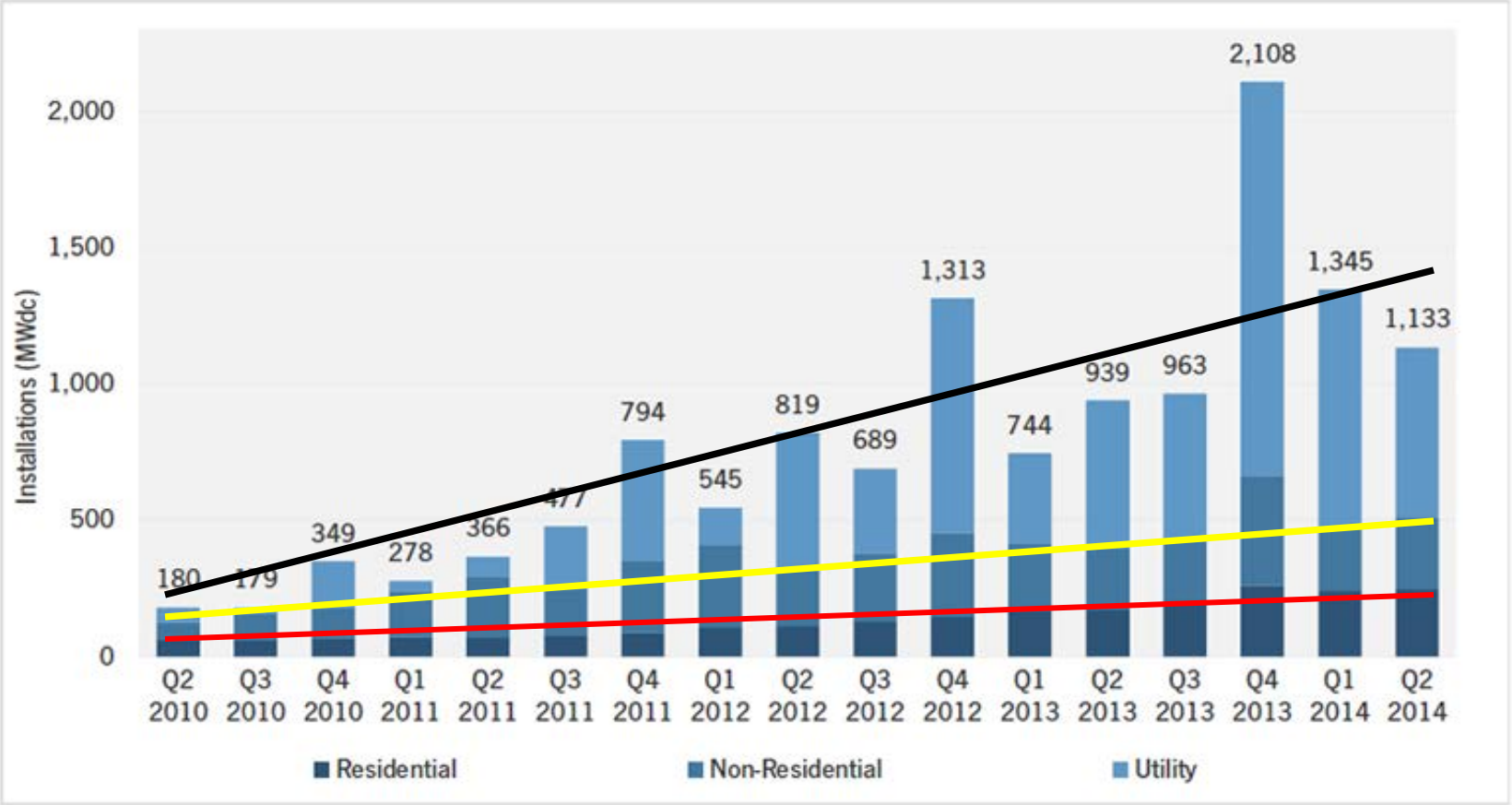
Data is through December 31, 2013. It Includes CSI, NSHP, ERP and SGIP data, but not POU or RPS data.

Figure 1: Customer-Sited Solar Capacity Installed in CA's IOU Territories, 1993-2013



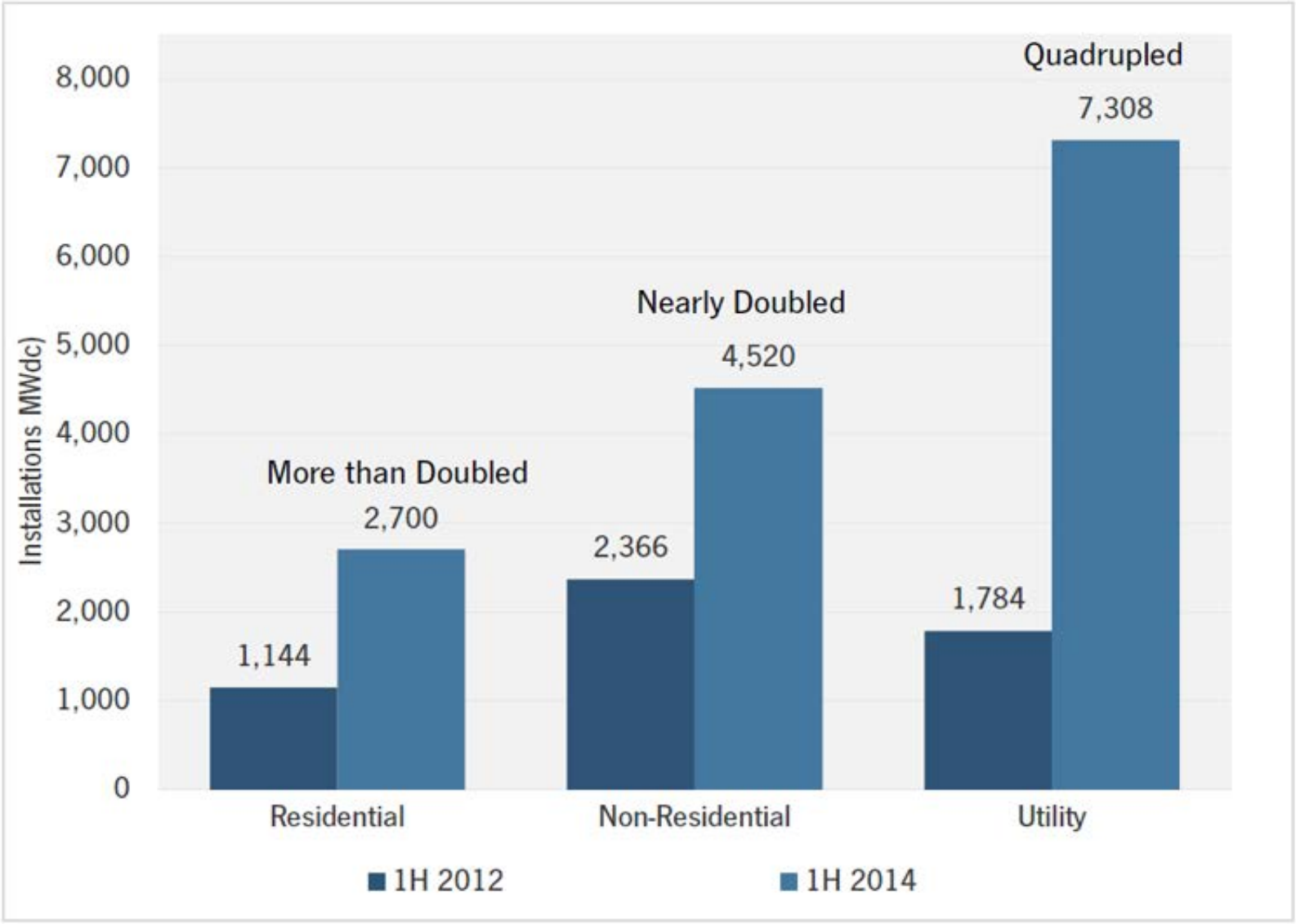
Data is through December 31, 2013. It Includes CSI, NSHP, ERP and SGIP data, but not POU or RPS data.

Figure 2.1 U.S. PV Installations, Q2 2010-Q2 2014



Although the DG market has grown by impressive strides, the primary backbone of U.S. demand continues to be utility PV. More than 10 gigawatts of utility PV earned PPAs between 2010 and 2012, thanks to a wave of aggressive procurement driven by RPS standards. This contracted pipeline is finally becoming realized, and the outlook for utility PV remains stronger than ever as contracted capacity continues to outpace capacity brought on-line in primary markets (California and North Carolina) and secondary markets as well (Georgia, Minnesota, Texas, and Utah).

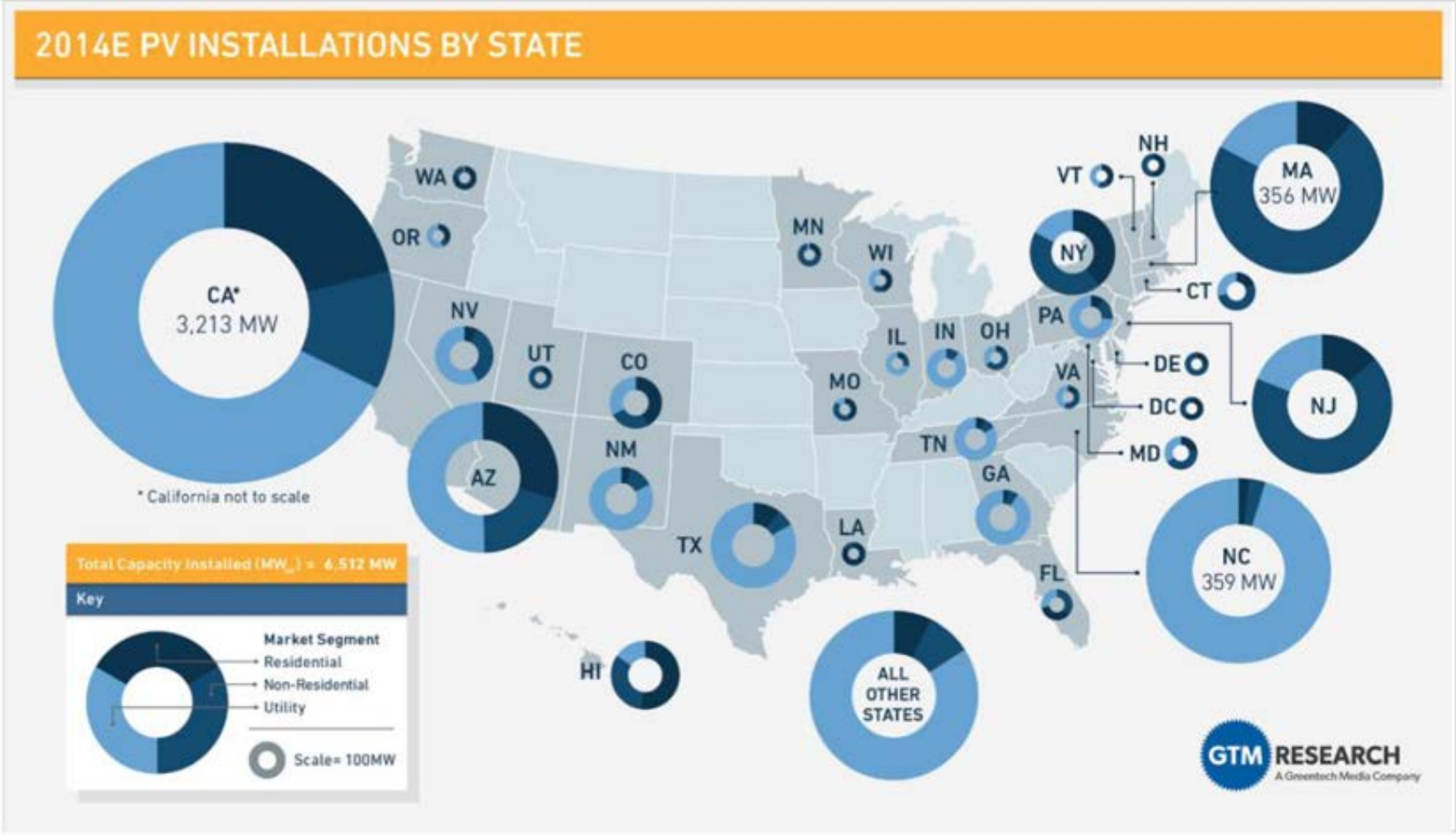
Figure 2.5 Cumulative U.S. Solar PV Installations by Market Segment, 1H 2012 vs. 1H 2014



GTM RESEARCH

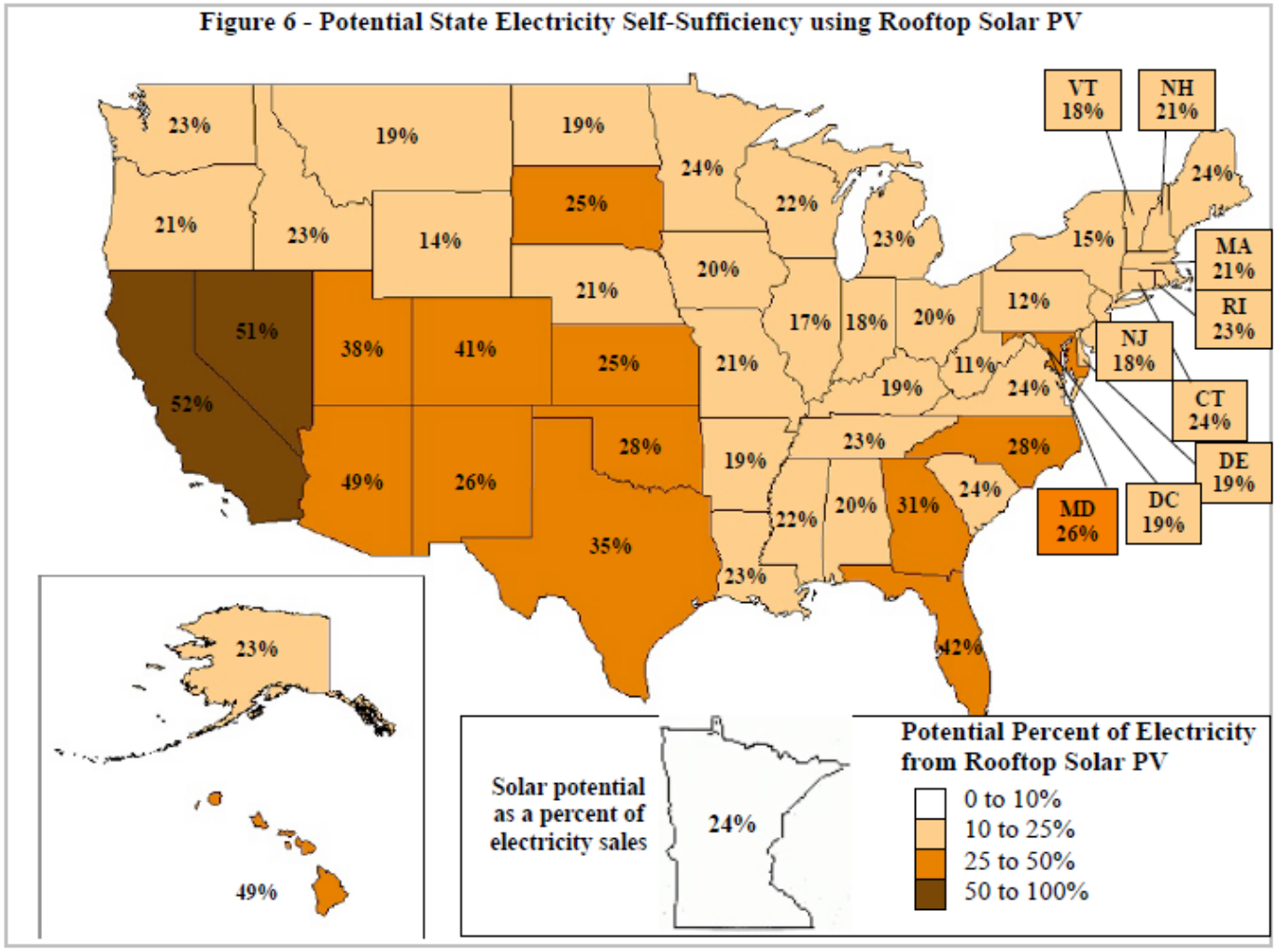
40 YEARS SEIA Solar Energy Industries Association®

Figure 2.12 PV Installation Forecast Map, 2014E



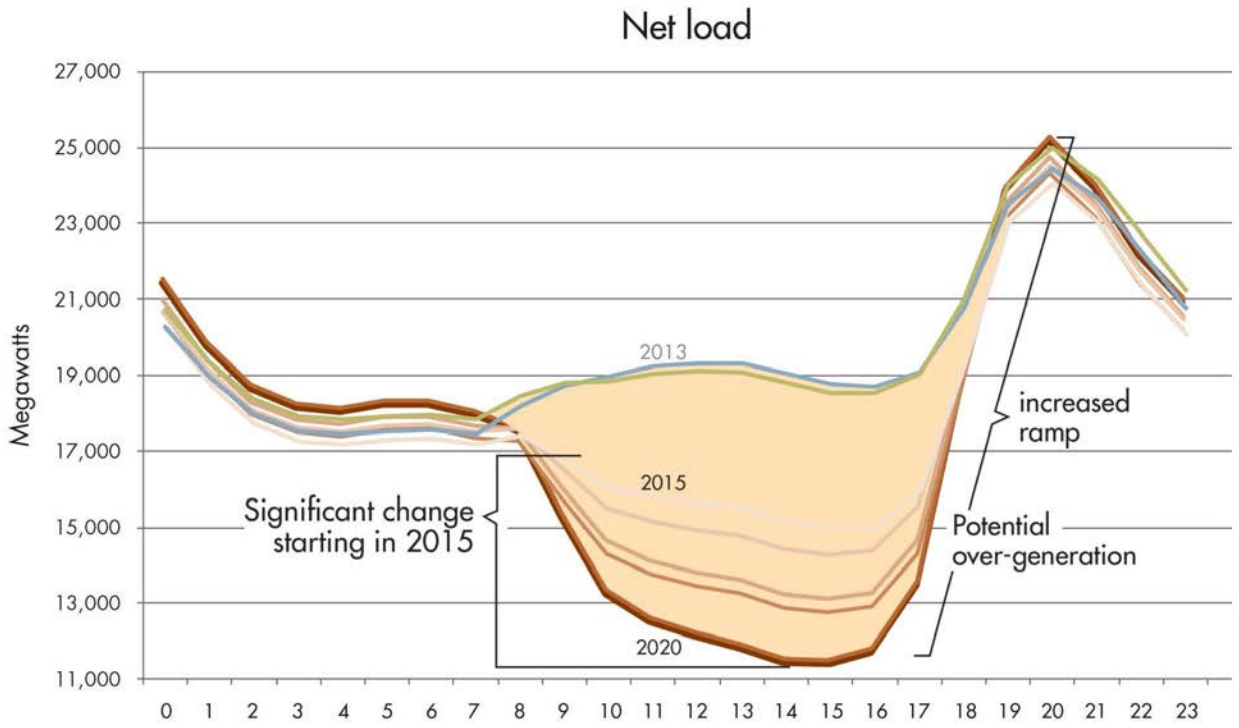
Self-Reliance From Rooftop Solar

Institute for Local Self-Reliance

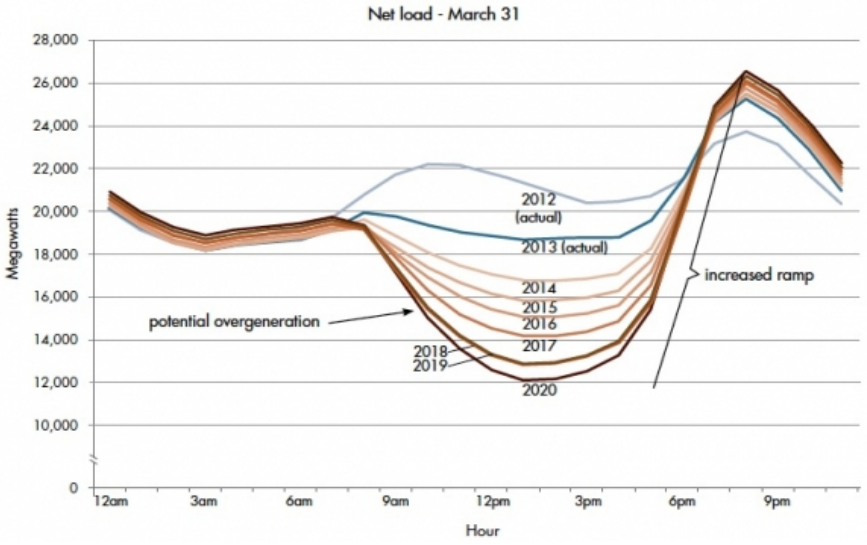


The Duck

Growing need for flexibility starting 2015



The Duck


Net load - March 31
Megawatts
28,000
26,000
24,000
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0
12am
3am
6am
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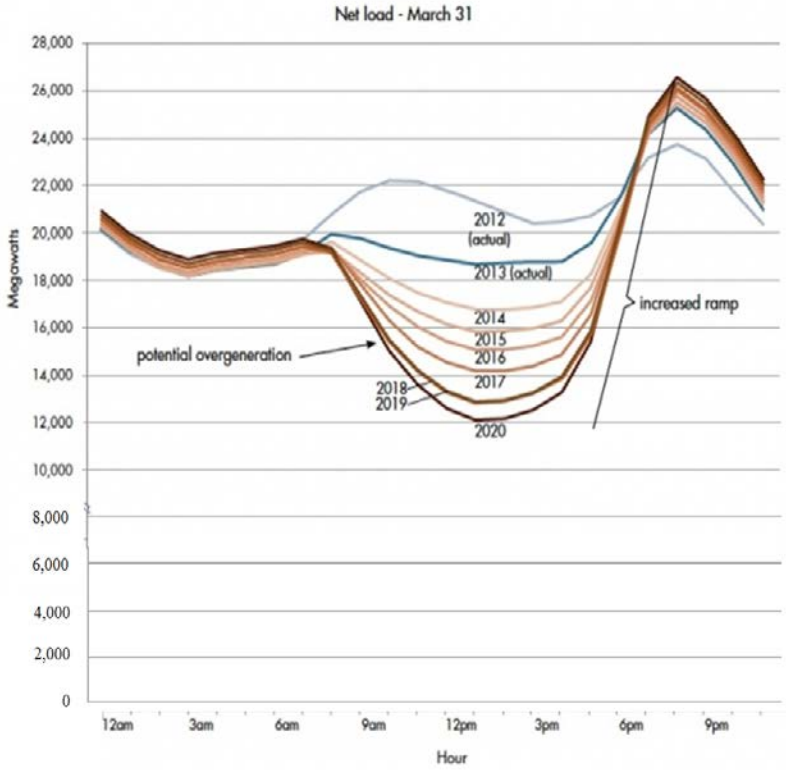
Hour
2012 (actual)
2013 (actual)
2014
2015
2016
2017
2018
2019
2020
potential overgeneration
increased ramp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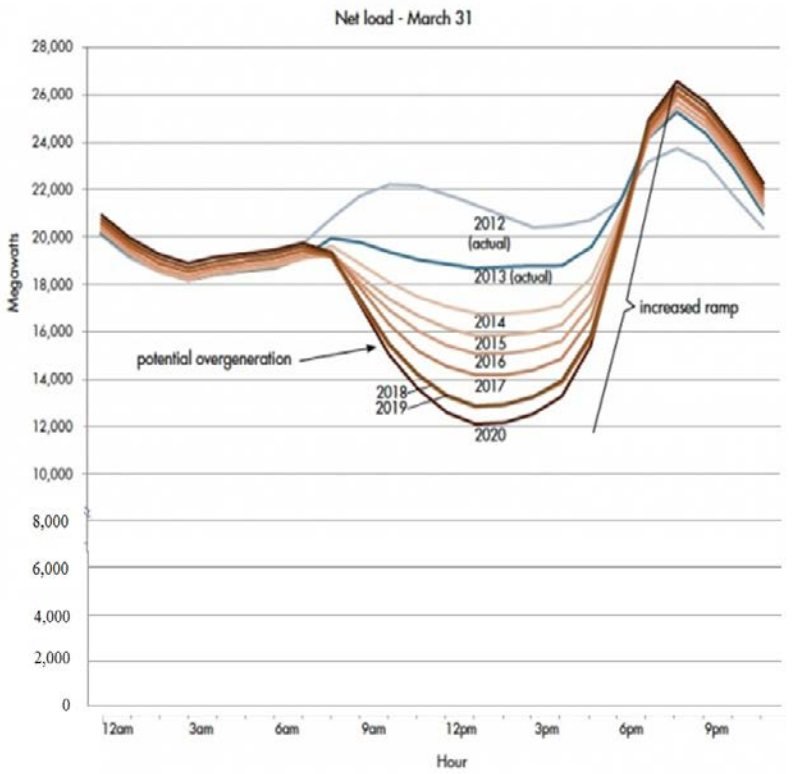
The Duck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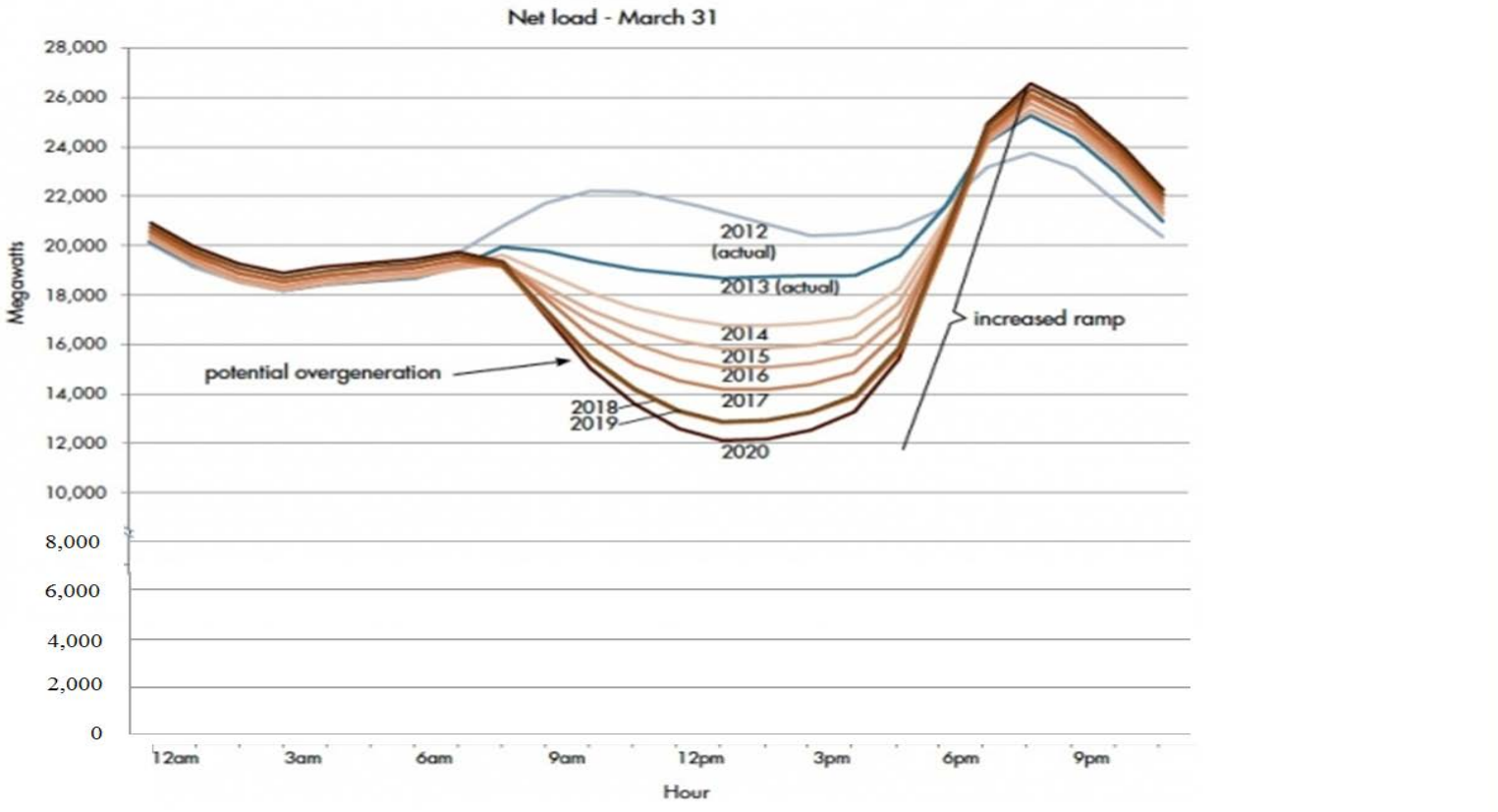
The Duck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Hour
2012 (actual)
2013 (actual)
2014
2015
2016
2017
2018
2019
2020
potential overgeneration
increased ramp

California ISO
Shaping a Renewed Future

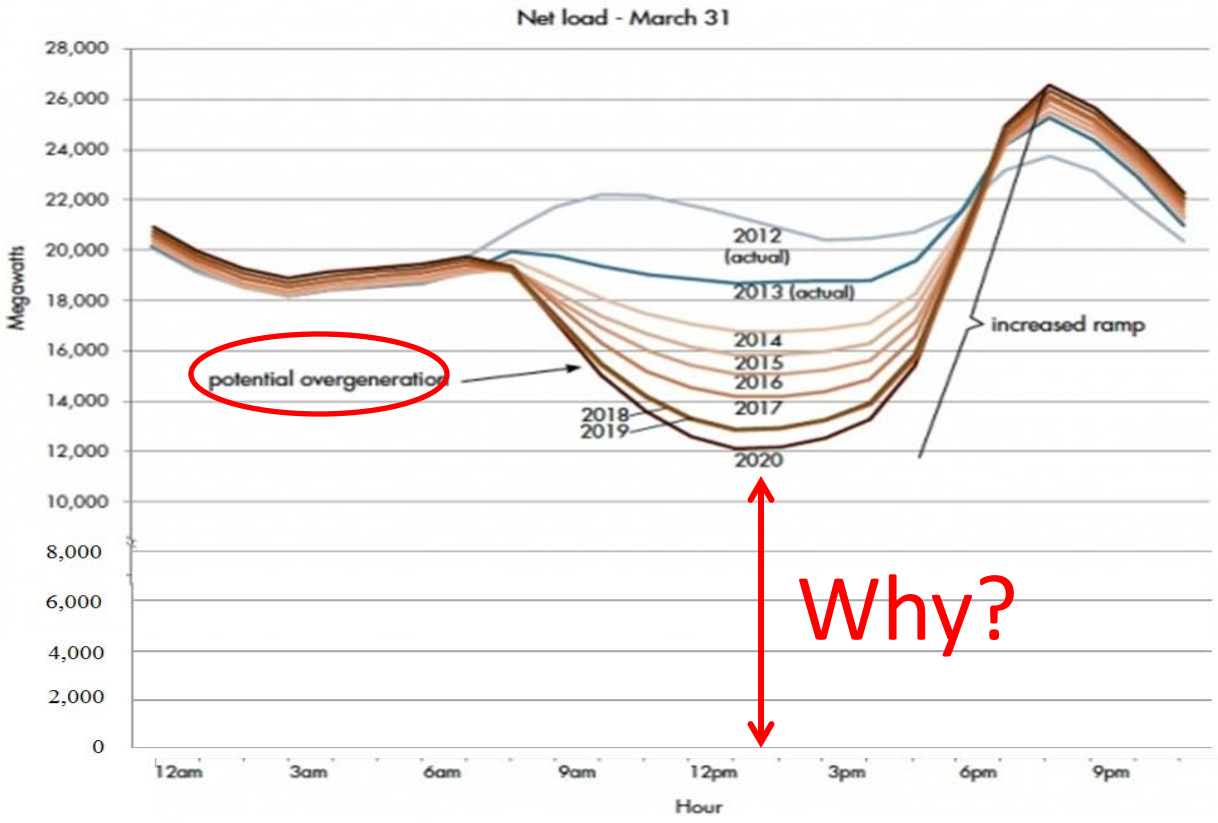
California ISO Peak Load History
1998 through 2014

Year	Megawatts at Peak Load*	Date	Time
1998	44,659	August 12	14:30
1999	45,884	July 12	16:52
2000	43,784	August 16	15:17
2001	41,419	August 7	16:17
2002	42,441	July 10	15:01
2003	42,689	July 17	15:22
2004	45,597	September 8	16:00
2005	45,431	July 20	15:22
2006	50,270	July 24	14:44
2007	48,615	August 31	15:27
2008	46,897	June 20	16:21
2009	46,042	September 3	16:17
2010	47,350	August 25	16:20
2011	45,545	September 7	16:30
2012	46,846	August 13	15:53
2013	45,097	June 28	16:54
2014	45,089	September 15	16:53

Typical peak demand in March: 30,000 MWs

* This value is an instantaneous MW value at the time specified in the Time column.

The Duck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12am
3am
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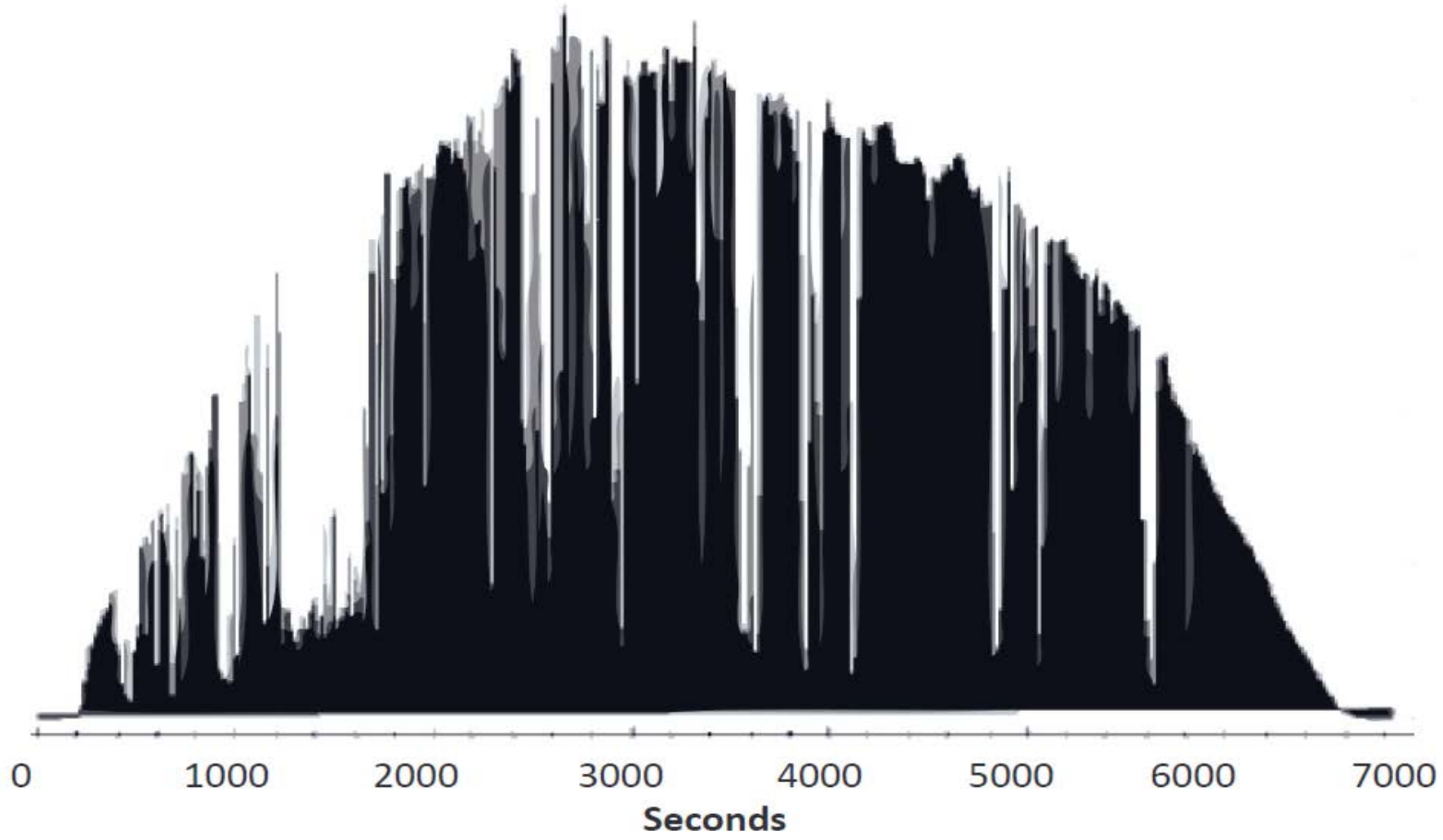
12pm
3pm
6pm
9pm
Hour
2012 (actual)
2013 (actual)
2014
2015
2016
2017
2018
2019
2020
potential overgeneration
increased ramp
Why?

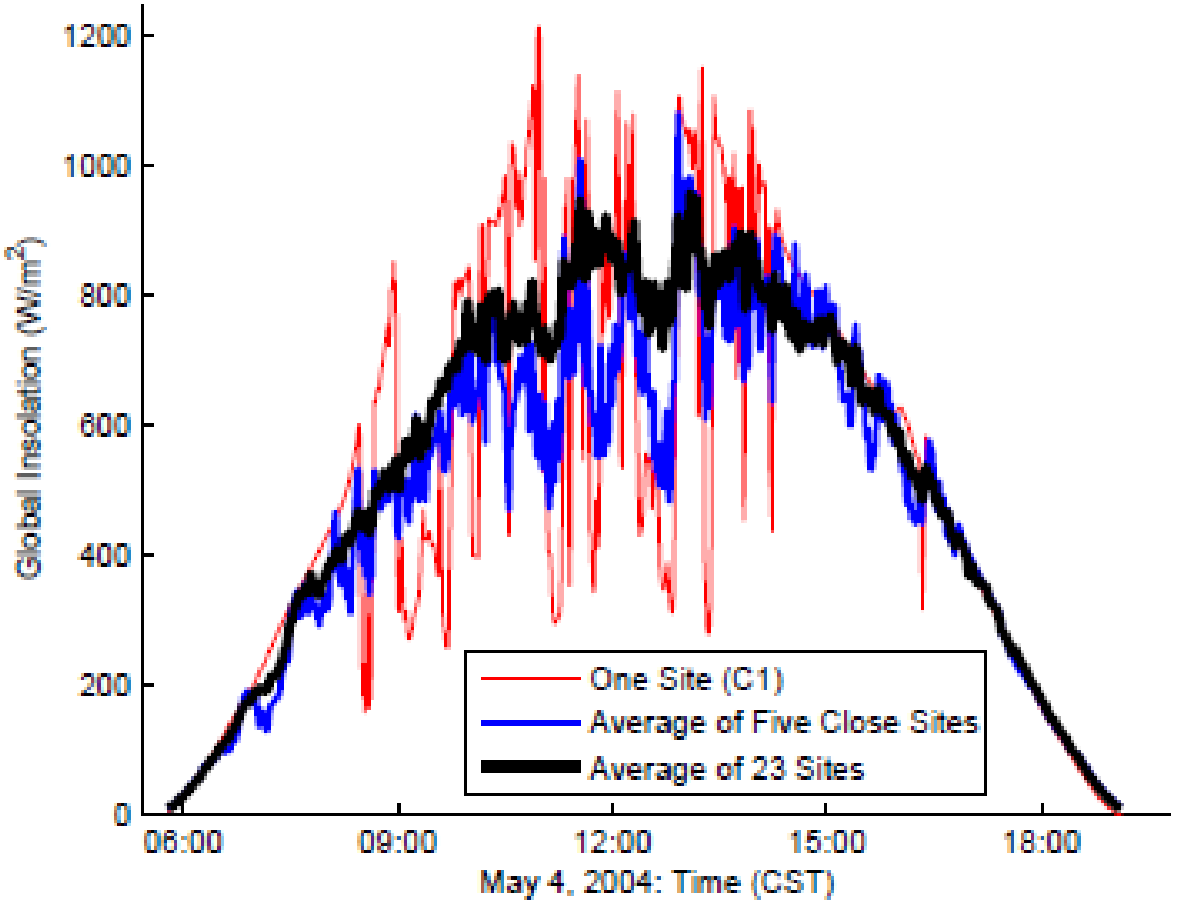
The Duck – What to Do?

- Shoot the duck
- Diversify renewables
- Spread out the PV
- Deploy storage
- Use Demand Response tools
- Encourage more energy efficiency
- Improve Gas-Fired Generation Dispatchability

Photovoltaic facility daily output EPRI



Implications of Wide-Area Geographic Diversity for Short-Term Variability of Solar Power LBNL 2010




TESLA

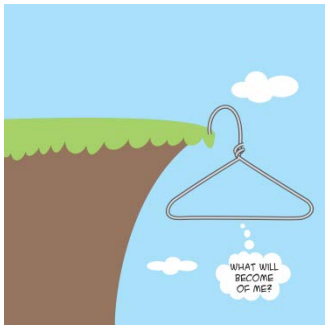
The Spiral

- Distributed solar reduces load and avoids fixed costs
- Same thing with efficiency
- Remaining customers face higher rates and are more likely get their own solar
- As the pattern repeats, rates skyrocket, more customers leave, and the utility tanks

The Spiral – Why Not?

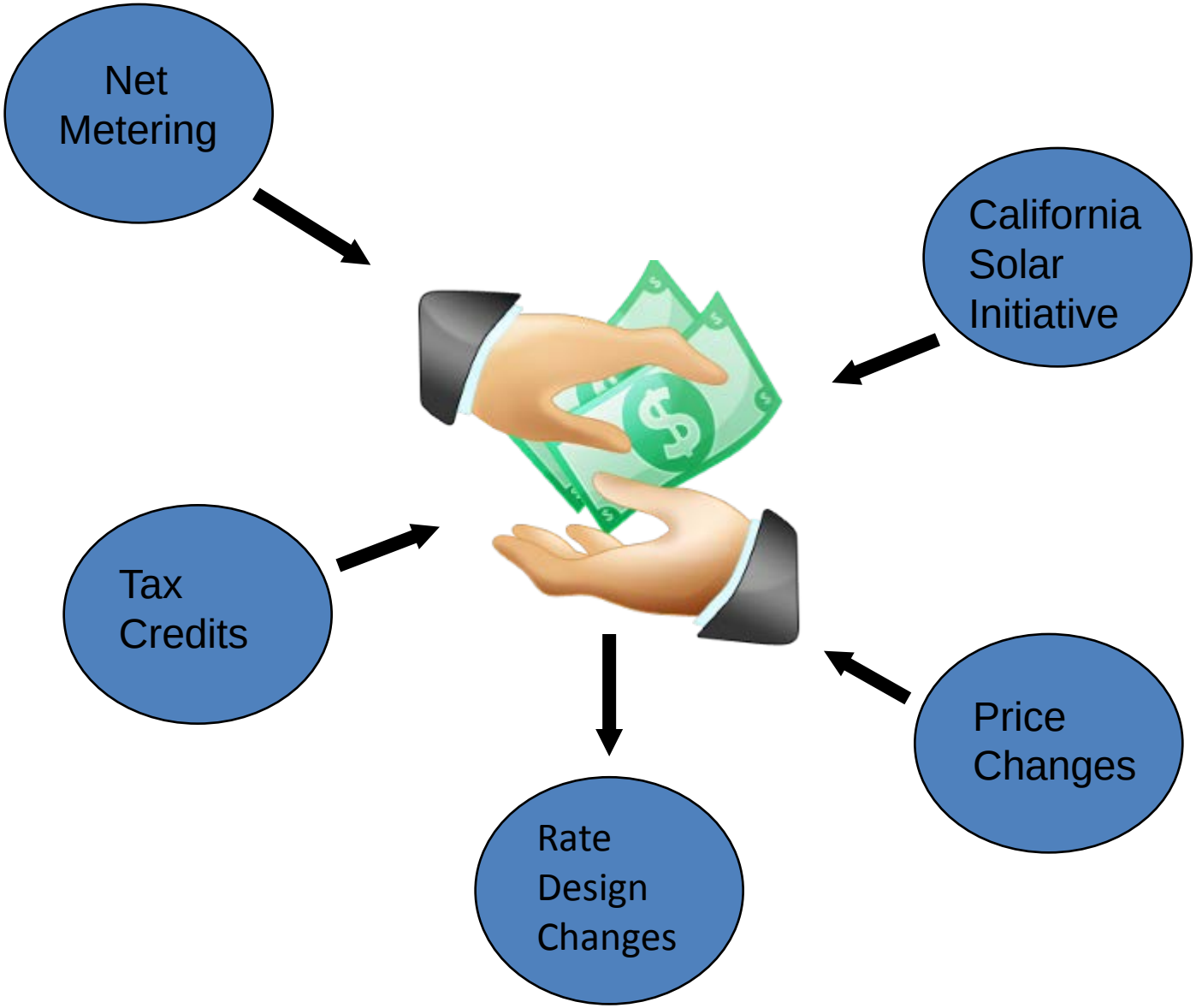
- Distributed solar can only go so far
- Normal load growth will fill in some of the gap
- Extraordinary load growth can occur due to electrification
- Utilities can partake in new markets, too

The Cliff



- Investment tax credit cut by 2/3 in 2017
- California net metering only safe through 2017
- Chinese-U.S. trade dispute continues
- Money could become expensive

Encouraging Local Renewable Power



DSIRE™

Database of State Incentives for Renewables & Efficiency

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

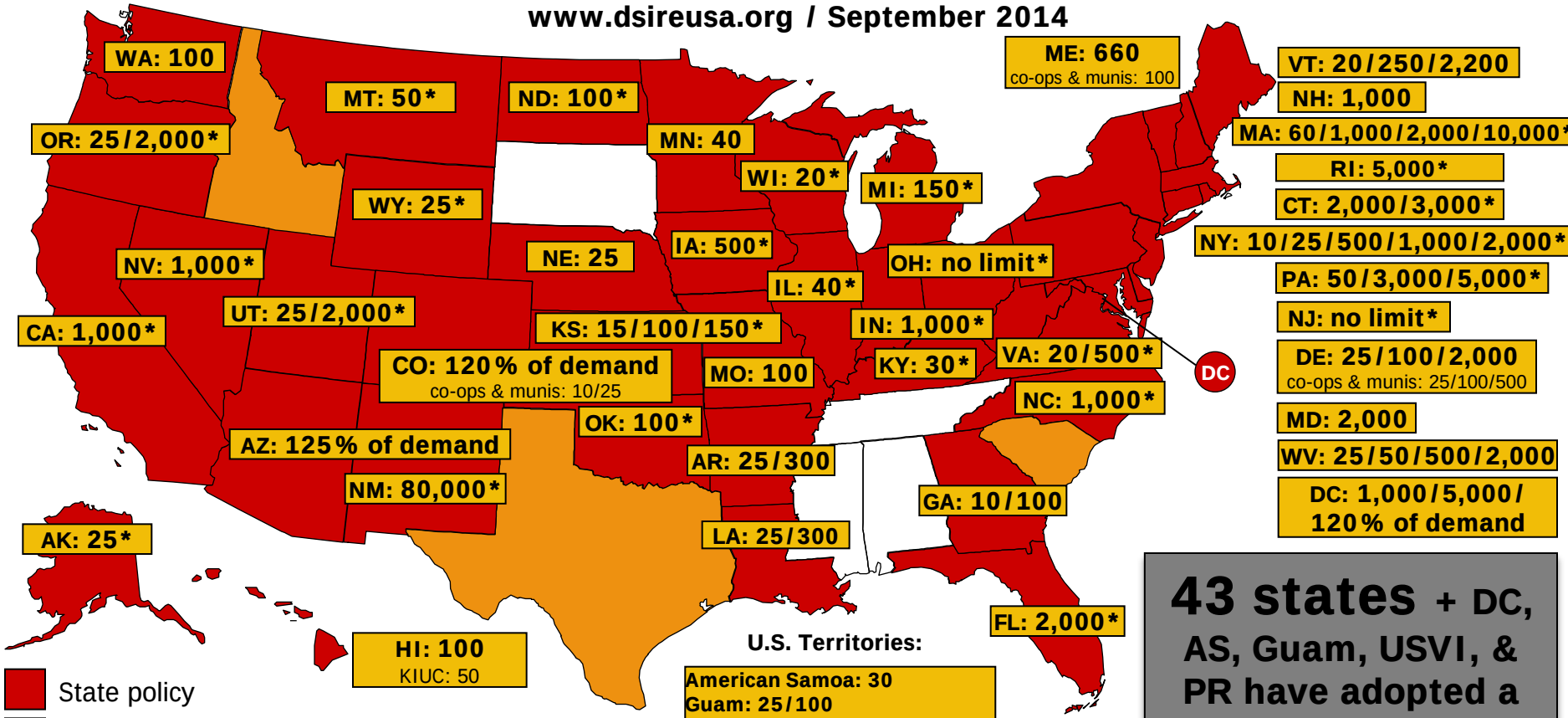
IREC Interstate Renewable Energy Council

NORTH CAROLINA Solar Center

Net Metering

www.dsireusa.org / September 2014

Note: Net Metering rules are being actively discussed in over a dozen state public service & utility commissions across the country.



U.S. Territories:

American Samoa: 30
Guam: 25/100
Puerto Rico: 25/1,000/5,000
Virgin Islands: 20/100/500

43 states + DC, AS, Guam, USVI, & PR have adopted a net metering policy

State policy

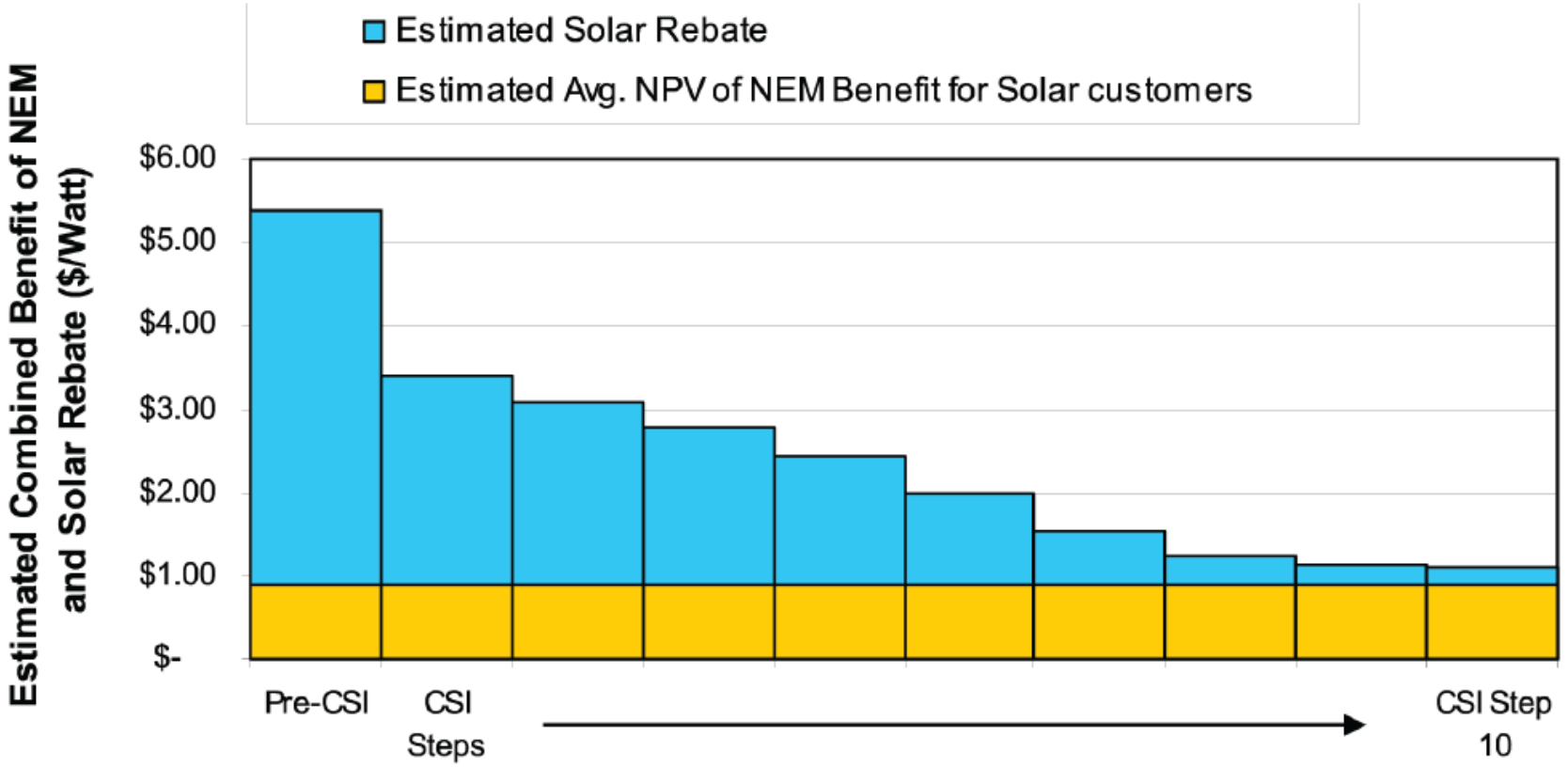
Voluntary utility program(s) only

* State policy applies to certain utility types only (e.g., investor-owned utilities)

State: kW limit residential/ kW limit nonresidential

Note: Numbers indicate individual system capacity limit in kW. Some limits vary by customer type, technology and/or application. Other limits might also apply. This map generally does not address statutory changes until administrative rules have been adopted to implement such changes.

Solar Rebates and Net Metering Together



Chinese Modules Price Effect

LBNL 2014

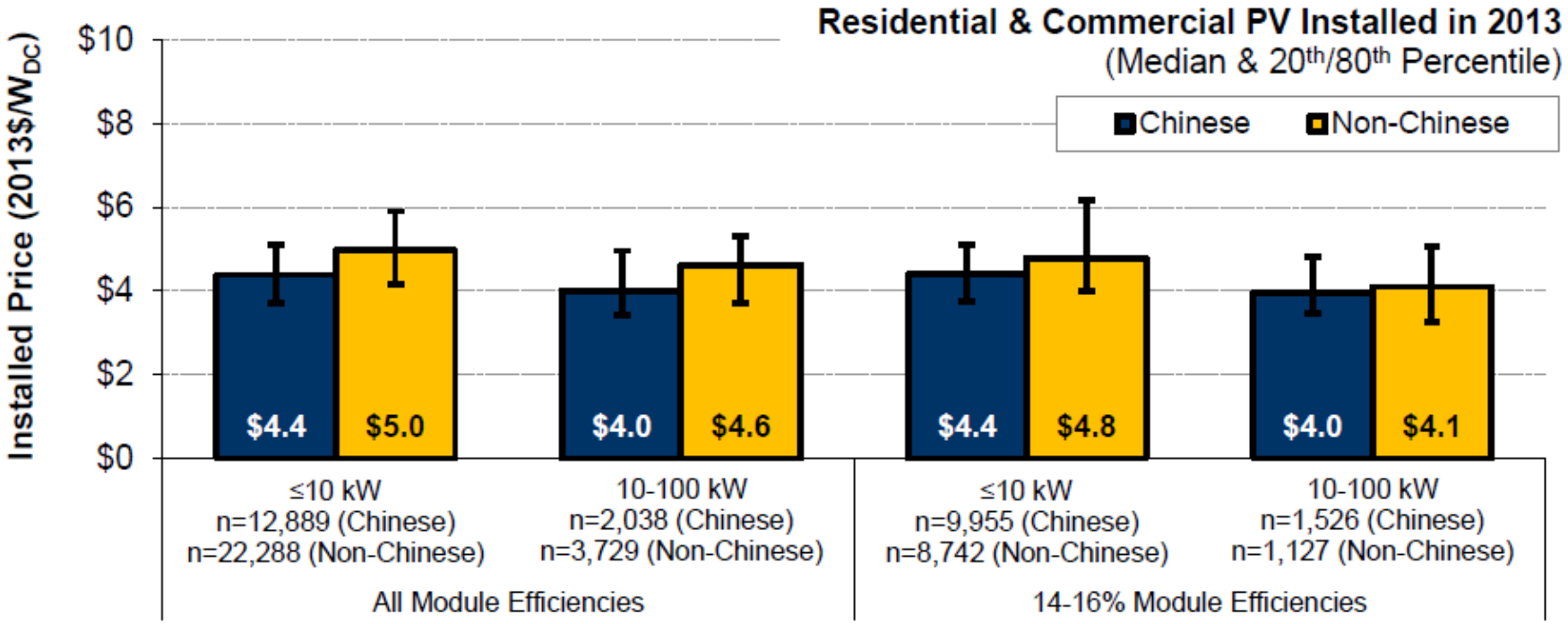
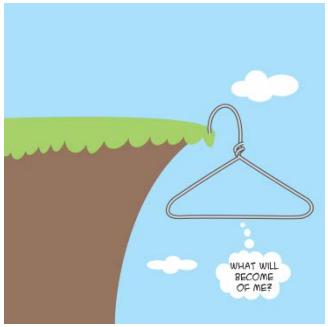


Figure 23. Installed Price of PV Systems with Chinese vs. Non-Chinese Modules

The Cliff Might Not Exist



- Distributed solar may have achieved critical mass
- High sales spur innovation and investment
- Consolidations may improve productivity
- Soft costs are dropping
- Electric vehicles are gaining in popularity
- PACE is still alive
- Push for zero net energy buildings
- The revolution in onsite storage

California's AB 2188

- Local gov't residential permit streamlining ordinance by 9/30/15
- One-stop permit
- Checklist of permit requirements

California's SB 96

- PACE Loss Reserve Fund
- Part of existing bond authority
- Allows for $10 million in reserve funds

Inverted Blocks

Hypothetical monthly inverted block rates:

1-50 khws:	12 cents/kwh
51- 100 kwhs:	16 cents/kwh
101-180 kwhs:	24 cents/kwh
181 or more kwhs:	35 cents/kwh

Inverted Blocks

- Higher tiers may improve the apparent economics of solar
- Flattening the tiers waters down the price signal
- Fixed customer charges reduce kwh rates

Inverted Blocks

- People don’t pay rates -- they pay bills.
- Size matters.
- Power purchase agreements can improve customer economics

DSIRESOLAR™

Database of State Incentives for Renewables & Efficiency

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

IREC Interstate Renewable Energy Council

North Carolina Solar Center

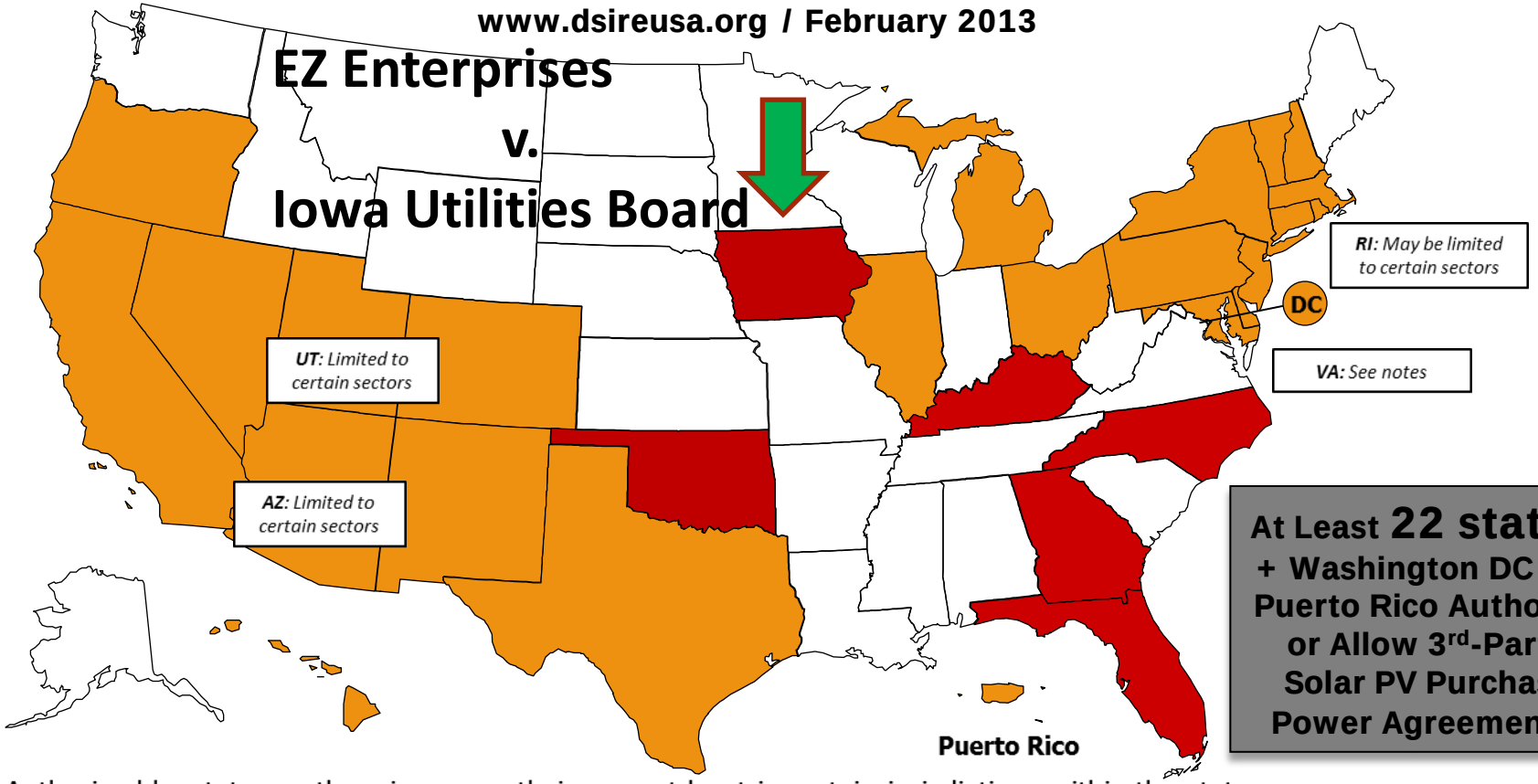
3rd-Party Solar PV Power Purchase Agreements (PPAs)

www.dsireusa.org / February 2013

EZ Enterprises

v.

Iowa Utilities Board



At Least 22 states + Washington DC and Puerto Rico Authorize or Allow 3rd-Party Solar PV Purchase Power Agreements

Authorized by state or otherwise currently in use, at least in certain jurisdictions within the state

Apparently disallowed by state or otherwise restricted by legal barriers

Status unclear or unknown

Note: This map is intended to serve as an unofficial guide; it does not constitute legal advice. Seek qualified legal expertise before making binding financial decisions related to a 3rd-party PPA. See following slides for additional important information and authority references.

RENEWABLE POLICY FRAMEWORKS

STATE

- RPS/IRP
- Net Metering
- Feed-in Tariff
- DG subsidy
- SBC/PGC
- QF policy
- GHG requirements
- Voluntary Green Pricing

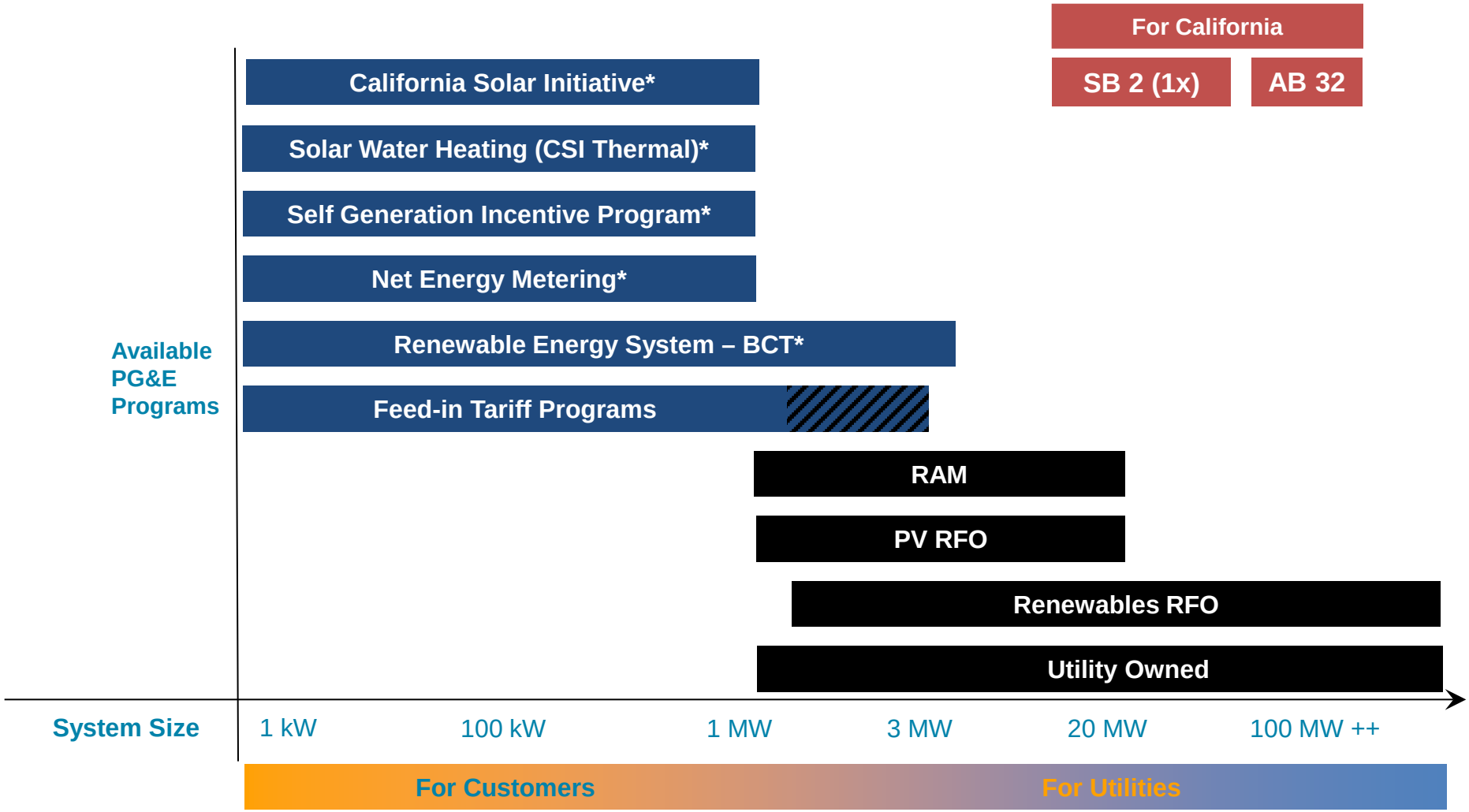
REGIONAL

- GHG trading systems
- Transmission Coordination

FEDERAL

- Federal Power Act
- PURPA
- ~~RPS~~
- Commerce Clause
- Research & Development, Grants, Loan Guarantees
- Tax Credits (PTC/ITC)
- ~~GHG Cap-and-Trade / Carbon regulation / Carbon Tax~~

Renewable Energy Programs



Note: not all programs count towards RPS requirements

in regulatory proceeding

Things to Look For

- New York REV – Ban on utility ownership
- Distribution Resource Plans
- Integrated Demand-Side Management
- Net Metering Legislation
- Renewable Portfolio Standard Expansion
- Right to Self-Generate

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