

Supporting Solar Power in Renewables Portfolio Standards: Experience from the United States

Ryan Wiser and Galen Barbose

Lawrence Berkeley National Laboratory

Edward Holt

Ed Holt & Associates

October 2010



This work was supported by: the Office of Energy Efficiency and Renewable Energy (Solar Energy Technologies Program) and the Office of Electricity Delivery and Energy Reliability (Permitting, Siting, and Analysis Division) of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231; the National Renewable Energy Laboratory under Contract No. DEK-8883050; and the Clean Energy States Alliance.

Key Report Findings

- State RPS programs have not yielded a significant diversity of renewable resources thus far, though there are signs that this may be changing in some regions
- Many states have adopted RPS policy designs explicitly aimed at supporting greater renewable resource diversity, and solar energy in particular
- The design of solar and distributed generation (DG) set-asides varies widely across states
- Solar and DG set-asides have played a significant role in the recent growth of the U.S. solar market
- Compliance with solar/DG set-aside targets has been mixed, highlighting the importance of careful policy design
- The estimated retail rate impacts of solar/DG set-asides have thus far been relatively modest, though compliance costs have reached or are approaching 1% in some states
- State RPS programs, including both those with and without solar/DG set-asides, are poised to drive significant growth in the U.S. solar market
- A variety of emerging issues will affect the impact of RPS policies on solar growth

Presentation Overview

- 1. State RPS Policy Background**
- 2. Supporting Resource Diversity within an RPS**
- 3. Solar/DG Set-Aside Design Variations**
- 4. Solar/DG Set-Aside Impacts and Expectations**
- 5. Conclusions and Lessons Learned**

What Is a Renewables Portfolio Standard?

Renewables Portfolio Standard (RPS):

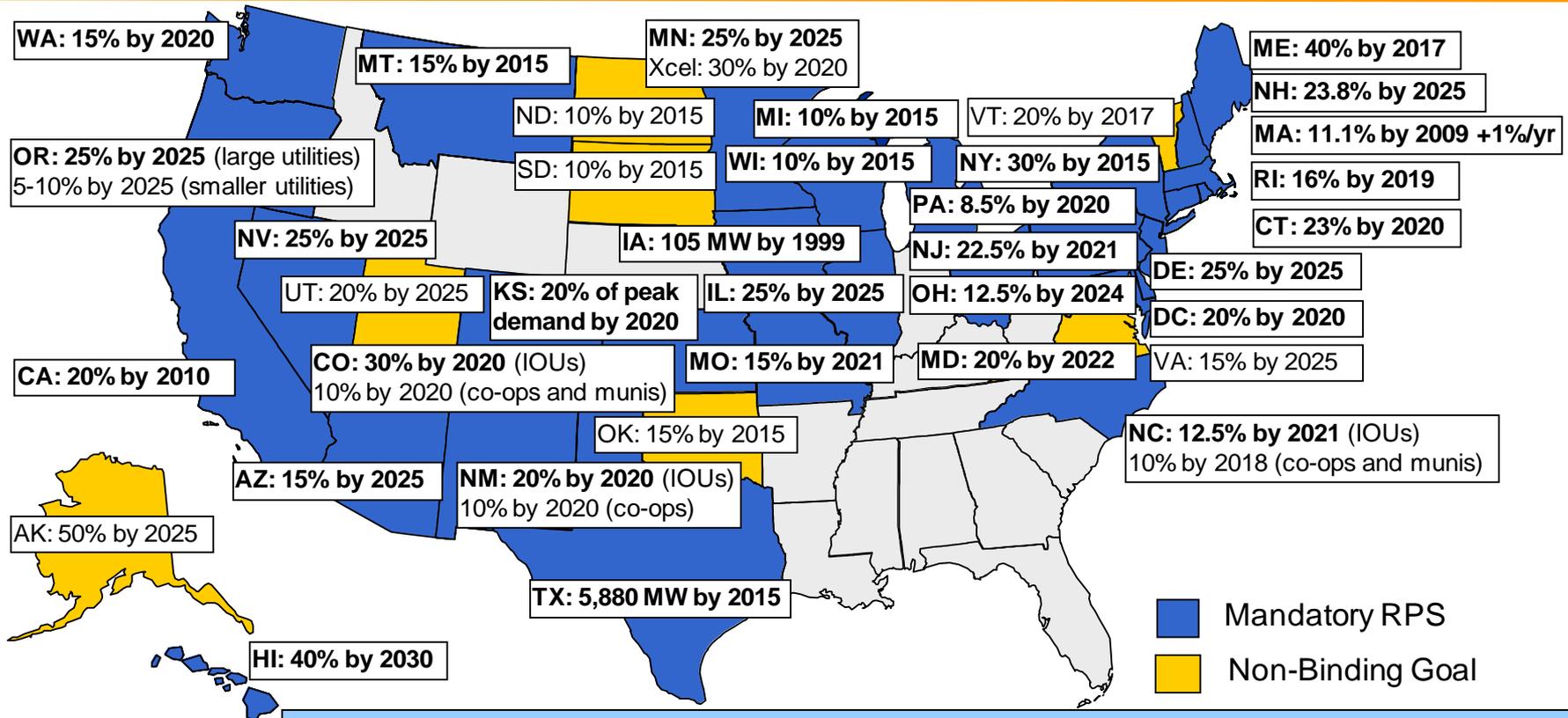
- A requirement on retail electric suppliers...
- to supply a minimum percentage or amount of their retail load...
- with eligible sources of renewable energy.

Typically backed with penalties of some form

Often accompanied by a tradable renewable energy credit (REC) program, to facilitate compliance

Never designed the same in any two states

State RPS Policies: 29 States and D.C. (7 More States Have Non-Binding Goals)



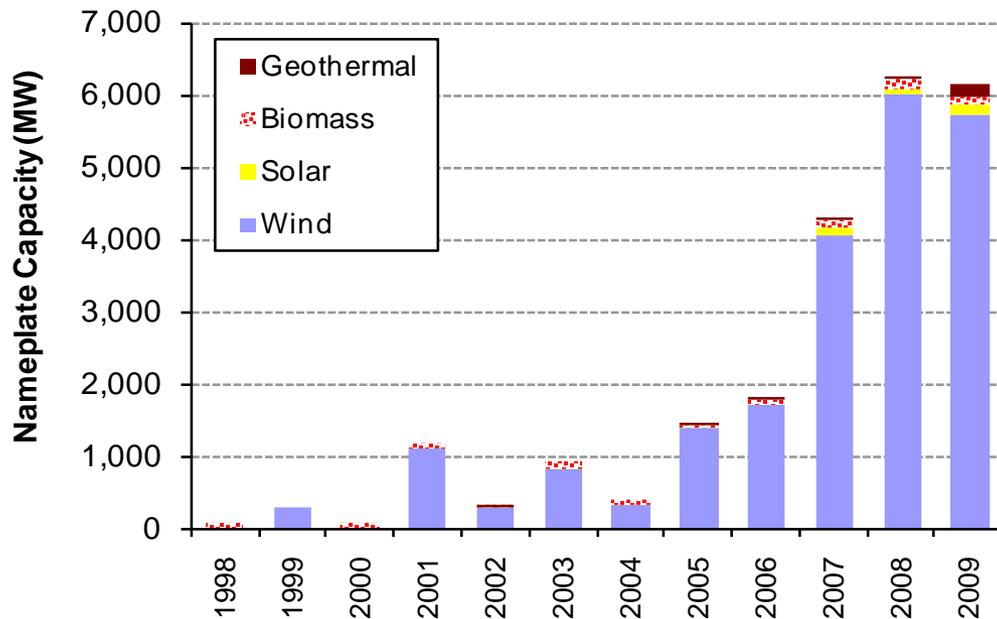
Source: Berkeley Lab

Existing RPS policies will apply to **56%** of U.S. electricity demand once fully implemented; require **73 GW** of new RE capacity by 2025
 Of the 37 GW of RE capacity added from 98-09, **23 GW** occurred in states with active or impending RPS compliance obligations

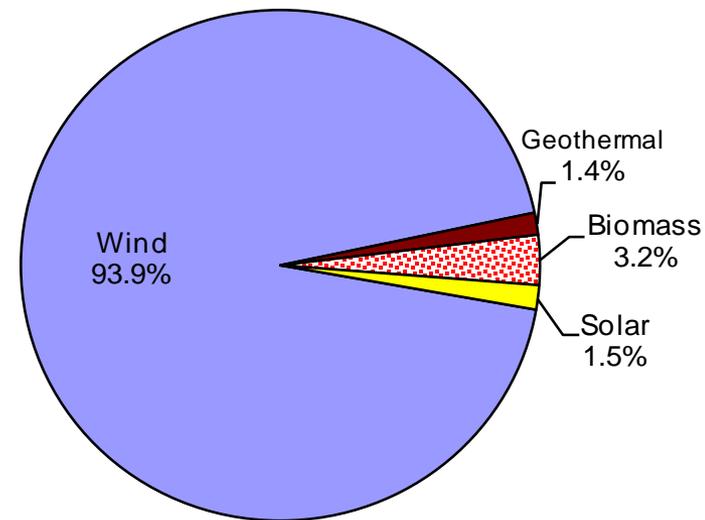
State RPS' Have Largely Supported Wind: Resource Diversity Limited So Far

RPS-Motivated* Renewable Energy Capacity Additions from 1998-2009, by Technology Type

Annual RPS-Motivated Capacity Additions



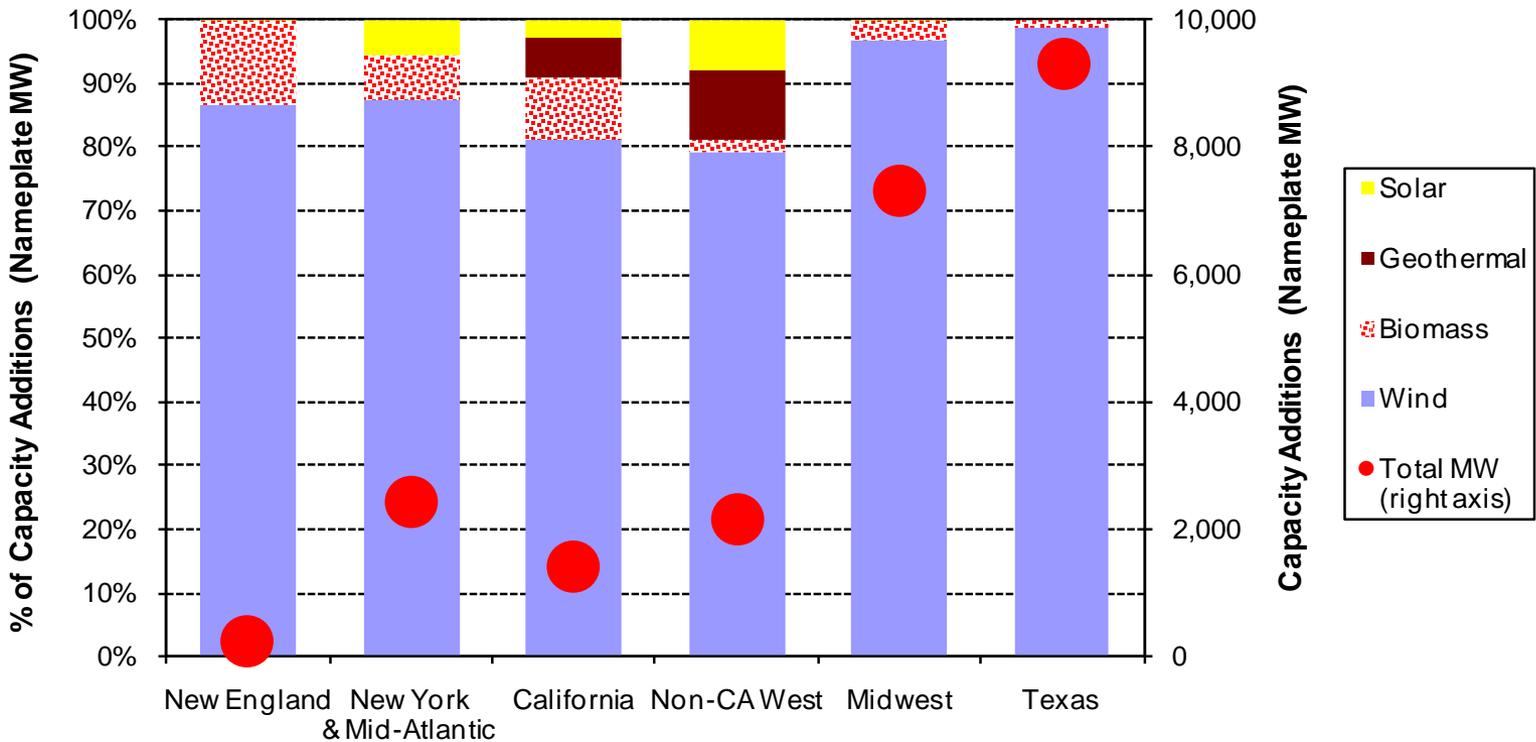
Total RPS-Motivated Capacity Additions (1998-2009)



*Renewable additions are counted as "RPS-motivated" if and only if they are located in a state with an RPS policy and commercial operation began no more than one year before the first calendar year of RPS compliance obligations in the host state.

RPS Resource Diversity Is Greater in Some Regions, but Still Remains Limited

RPS-Motivated* Renewable Energy Capacity Additions from 1998-2009, by Region and Technology Type



*Renewable additions are counted as "RPS-motivated" if and only if they are located in a state with an RPS policy and commercial operation began no more than one year before the first calendar year of RPS compliance obligations in the host state.



Why Have We Seen So Little Renewable Resource Diversity Under State RPS?

- **By design, most RPS policies originally designed to be technology-neutral, stimulating competition among all eligible resources**
- **RPS programs of this design are not likely to provide much impetus for more-costly technologies, or for smaller projects:**
 - Cost barriers: only the lowest-cost technologies can compete effectively
 - Solicitation barriers: smaller projects not always able to easily participate in competitive solicitations
- **10 of 30 state RPS policies provide no differential support for solar/distributed energy; experience shows that:**
 - ➔ These RPS policies are unlikely to provide meaningful support to customer-sited PV in the near term
 - ➔ With the exception of the Southwest, these policies are unlikely to greatly benefit utility-scale solar (PV and CSP) in the very near term
 - ➔ But... with solar costs declining, some of these “facts” may change

Declining Solar Costs May Increase RPS Resource Diversity in Some Regions

Wind power is facing increased competition in CA from solar; the same is true elsewhere in the Southwest and, to a lesser extent, in other regions

Increased competition largely driven by price reductions for utility-scale solar

More than 21,000 MW of contracts with new renewable generators signed in California since 2002*

Wind	53%
Solar	41%
Geothermal	3%
Biomass/MSW	3%
Small hydro	<1%
Ocean	<1%

**Based on CPUC RPS contract database for IOUs and LBNL analysis of contract announcements by POUs*

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RPS Policies Are Increasingly Being Designed to Support Resource Diversity

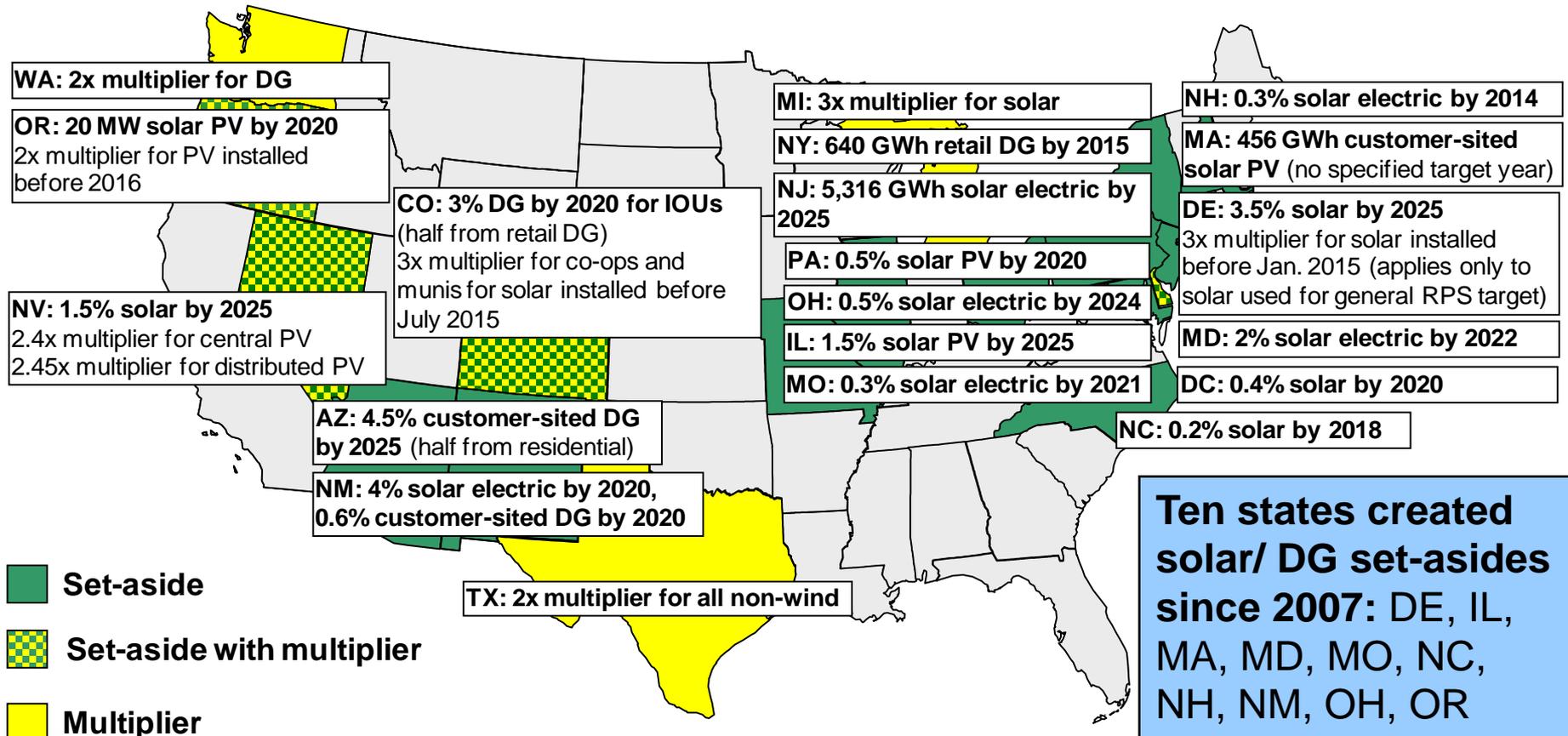
Set Asides: A requirement that some portion of the RPS come from certain technologies, technology types, or applications

Credit Multipliers: Provides selected technologies or applications more credit than other forms of generation towards meeting the RPS

Set-Asides			Credit Multipliers
General Technology	Specific Technology	Specific Application	
Class I vs. II: CT, DC, MA, MD, ME, NJ	<u>Solar Energy</u> : DC, DE, IL, MA, MD, MO, NC, NH, NJ, NM, NV, OH, OR, PA <u>Wind Energy</u> : IL, ME (goal), MN, NJ (offshore), NM <u>Existing Biomass/Methane</u> : NH <u>Existing Hydropower</u> : NH <u>Geothermal or Biomass</u> : NM <u>Swine Waste</u> : NC <u>Poultry Waste</u> : NC <u>Non-Wind</u> : TX (goal)	<u>Distributed Generation</u> : AZ, CO, NM, NY <u>Community Ownership</u> : MN (goal), MT (wind), OR (goal, community and small scale)	<u>Solar Energy</u> : DE (general RPS), MI, CO (POUs), NV (PV), OR <u>Wind Energy</u> : DC, MD, DE (offshore) <u>Methane</u> : DC, MD <u>Fuel Cells</u> : DE <u>Waste Tires</u> : NV <u>Non-Wind</u> : TX <u>Distributed Generation</u> : NV (PV), WA <u>Community Ownership</u> : CO, ME
No Differential Support : CA, IA, KS, WI			

Solar/DG-Specific RPS Designs Becoming Common Nationwide

16 states & D.C. have solar or DG set-asides, sometimes combined with credit multipliers; 3 other states only have credit multipliers



Set-Asides and Multipliers Each Have Advantages and Disadvantages for Solar

Set-Asides	Credit Multipliers
<p>Advantages</p> <ul style="list-style-type: none"> • Recognizes unique benefits of solar • Greater certainty in the amount of solar deployment • Targets cost and solicitation barriers • Does not reduce effective RPS percentage • Less risk of over-subsidization of solar • May enable larger market for solar than multiplier depending on details <p>Disadvantages</p> <ul style="list-style-type: none"> • Greater risk of higher/uncertain cost impact • May cause overall RPS cost cap to be reached, if a separate cost cap for set-aside is not established • Picks winners more directly than multiplier • Establishing level of set-aside is challenging • Set-aside often rigidly set without easy ability to alter given changes in market conditions 	<p>Advantages</p> <ul style="list-style-type: none"> • Recognizes unique benefits of solar • Lower risk of higher/uncertain cost impact • Allows policymakers to clearly signal the degree to which solar is valued relative to other resources • Does not “pick winners” as directly as set-asides • May enable larger market for solar than set-aside depending on details <p>Disadvantages</p> <ul style="list-style-type: none"> • Does not ensure certain amount of solar deployment • Does not directly target solicitation barriers for smaller solar projects • Reduces effective RPS percentage • Establishing multiplier value at “correct” level over time is challenging: requires supervision • If multiplier is not reduced as costs decline, could lead to over-subsidization

Recent move towards set-asides (away from multipliers) due to greater assurance that these instruments will drive investment decisions

Experience with Multipliers for Solar/DG

Suggest Modest Impacts To Date

Though there is relatively limited experience on which to draw, there is no evidence to date of significant impacts from solar or *DG credit multipliers*

- **CO:** 3x solar multiplier for coops and munis has had little impact to date (IOU set-aside has had an effect)
- **TX:** non-wind multiplier has had limited effect and RPS target fully achieved in 2008; small PV market driven by municipal utilities outside RPS
- **DE, MD, NM:** previous credit multipliers without set-asides had limited impact; replaced with set-asides
- **WA and MI:** RPS compliance obligations have not yet begun, but no significant impact on solar to date
- **NV:** PV multiplier within solar set-aside has shifted solar development away from CSP and towards PV

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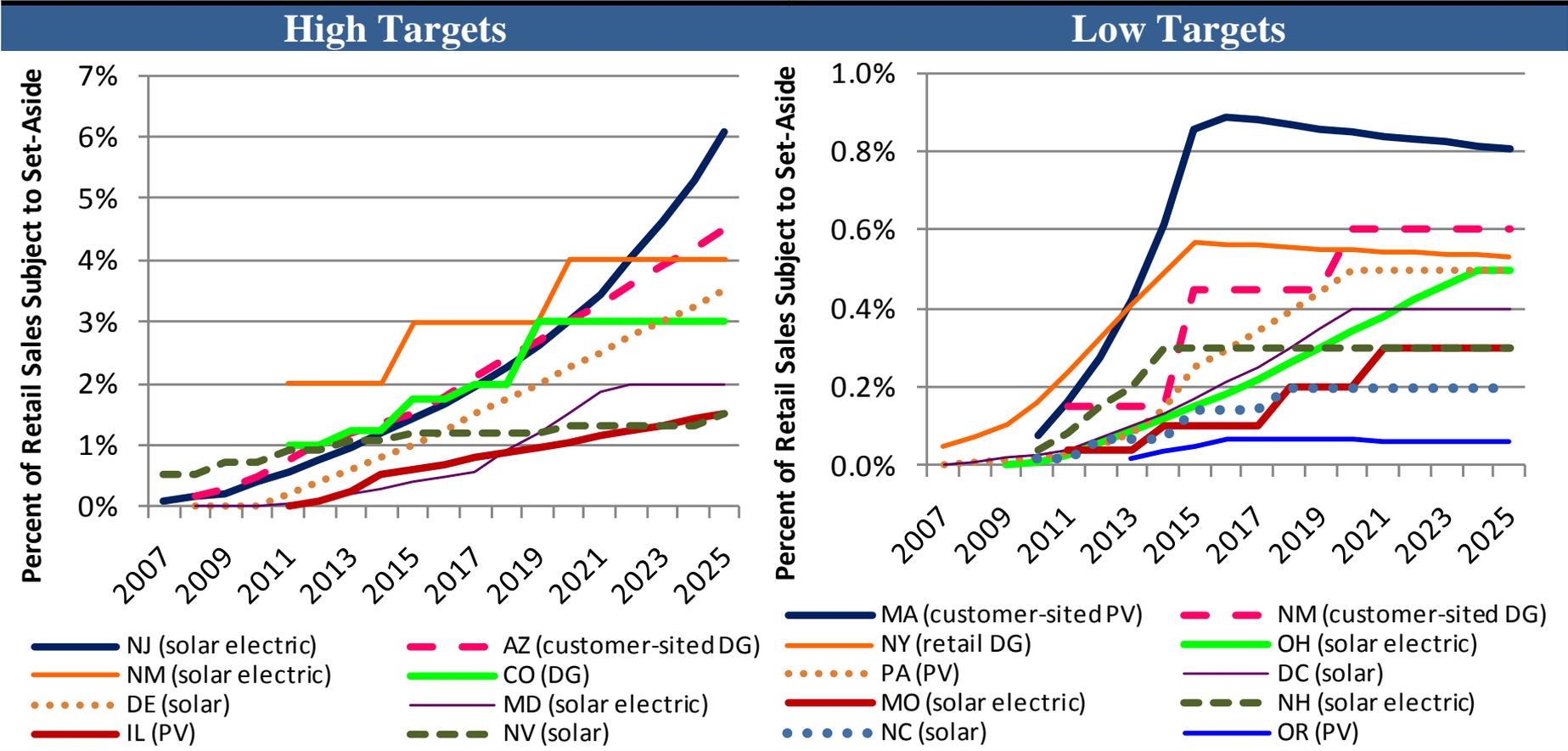
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State RPS Solar/DG Set-Asides Can Be and Are Designed in Multiple Ways

- **Percentage targets and timeframes**
- **Solar-specific or broader DG eligibility**
- **Solar technology eligibility**
 - Photovoltaics only
 - Photovoltaics and solar thermal electric
 - Inclusion of solar heating and cooling
- **Requirements/preferences for certain types of applications**
- **In-state vs. out-of-state eligibility and preferences**
- **Use of multipliers in addition to set-asides**
- **Contracting requirements and incentive programs**
- **Metering, measurement, and tracking protocols**
- **Cost caps, alternative compliance payments, funding limits**

Ultimate Solar/DG Targets Vary Widely

8 states have targets that rise to >1.5% of retail sales by 2025



Technology Eligibility Also Varies, Depending in Part on Policy Goals

State	PV	CSP	SHC	Non-Solar DG
AZ	✓	✓	✓	✓
CO	✓	✓		✓
DC	✓	✓	✓	
DE	✓	✓	✓	
IL	✓			
MA	✓			
MD	✓	✓		
MO	✓	✓		
NC	✓	✓	✓	
NH	✓	✓		
NJ	✓	✓		
NM	✓	✓		✓
NV	✓	✓	✓	
NY	✓		✓	✓
OH	✓	✓		
OR	✓			
PA	✓			

- All states allow PV; most CSP
- Six states allow solar heating and cooling (SHC)
- Four states have DG targets that include non-solar technologies
 - NM has both DG and solar set-asides
- As an alternative to outright restriction, multipliers can be used to steer compliance towards certain technologies
 - NV (PV)

States Sometimes Direct Compliance Towards Certain Types of Applications

■ Eligibility restrictions

- Customer-sited (AZ, MA, NM) or “retail DG” (NY)
- Certain project sizes: CO (≤ 30 MW), MA (≤ 6 MW), OR (500 kW - 5 MW)
- Solar heating/cooling must displace electricity (AZ, DE, NY)

■ Requirements that a portion of target be met with certain applications

- Residential: AZ (50%)
- Retail DG: AZ (90%), CO (50%)

■ Credit multipliers

- NV provides slightly higher multiplier for distributed PV than central-station PV (2.45x vs. 2.4x)

Many States Require or Encourage In-State Solar/DG Resources

Geographic Eligibility and Delivery Requirements	States
In-state generation <i>requirement</i>	
Applies in all conditions	AZ (retail DG), CO (retail DG), MA, NJ, NM (DG); NY, OR
Out-of-state allowed only if in-state is insufficient	DC, MD
In-state generation <i>encouragement</i>	
Multiplier for in-state	CO (wholesale DG), MO
Cost-effectiveness test	IL (IOUs)
Limit on RECs from out-of-state generators	NC, OH
<i>In-region</i> generation requirement	PA
Electricity <i>delivery</i> requirement	
To state or utility	AZ (wholesale DG), NC (except RECs), NM (solar), NV, OH
To broader region	DE, NH

Recent legal challenge to MA requirements under the Commerce Clause may affect the future design and viability of some of these mechanisms

Contracting and Incentive Policies Can Be Critical to Program Success

- Exclusive reliance on short-term REC purchases may be costly and ineffective, given political risk
- Of greatest concern in states with retail electric competition, and for smaller customer-sited systems

States have sought to address these concerns through:

- **Long-term REC contracting requirements**
 - **Strict Requirements:** MD (>15 yrs), CO (>20 yrs), NV (>10 yrs), NC (“of sufficient length to stimulate development of solar energy”)
 - **Implicit Encouragement** through fixed ACP schedules (NJ, MD, DC, DE, NH)
- **Central procurement (NY, IL)**
- **Distribution utilities enter long-term contracts as wholesalers (NJ)**
- **Central auction with price floor (MA)**
- **Target adjustments to minimize REC price risk (MA and NJ)**
- **Extensions to REC lifetime under periods of oversupply (DE)**
- **Standard offer incentive payments (up-front or performance-based)**
- **Utility solar asset ownership**



Central Procurement Models Have Been Used to Address Contracting Barriers

New York:

- Investor-owned distribution utilities collect a surcharge on retail sales for RPS implementation
- NYSERDA uses these funds to purchase RECs through a competitive process for general RPS obligations, and also to provide financial incentives for customer-sited DG, including solar

Illinois:

- The Illinois Power Agency (IPA) issues competitive solicitations for renewable energy or RECs on behalf of the state's large IOUs, though it is up to the individual utilities to contract with the winning bidders
- IPA has begun to solicit 20-year contracts; prior contracts were short-term
- The IPA also purchases RECs with compliance payments made by competitive retail suppliers
- Solicitations have thus far been for general RPS resources; solar set-aside does not commence until 2011/2012 (IOUs) and 2015/2016 (competitive suppliers)

Other Models for Supporting Long-Term Solar Contracting Have Also Emerged

New Jersey:

- PSE&G Solar Loan Program: Provide up-front payment for PV; system owner repays the loan with SRECs over 10-15 years (2-year program, 51 MW)
- The state's other regulated electric distribution companies issue competitive solicitations for 10-15 year SREC contracts (3-year program, 65 MW)
- The distribution companies auction SRECs to retail suppliers with RPS obligations

Massachusetts:

- The Department of Energy Resources plans to hold annual SREC auctions (termed the *Solar Credit Clearinghouse*)
- SRECs are auctioned at a fixed price of \$300/MWh; bidders nominate the volume of SRECs to be purchased at that price
- Auctions are intended to provide a backstop SREC market and price, thereby providing greater revenue certainty to solar project developers and investors
- However, a 5% auction fee is levied on project owners to encourage bilateral contracting, instead of reliance on the auction

Solar and DG Often Require Specific REC Measurement/Tracking Protocols

- **The expense of revenue-grade metering and telemetry may not be warranted for small systems**
 - Electricity generation of small (<10-15 kW) PV systems in some states may be estimated (CO, DC, MO, NC, NJ, NV, PA)
 - Thermal energy production from SHC may also be estimated (DC, NC, NV)
 - Where separate metering required, utility may bear cost (CO, NC)
- **Other issues**
 - Whether generation data can be self-reported or must be reported by an independent third-party
 - Frequency with which generation data must be reported
 - Whether solar RECs are tracked within the same REC tracking systems as standard RECs

Cost Caps, ACP Levels, Funding Limits May Impede Achieving Solar Targets

Alternative Compliance Payments

- NH (\$160/MWh), DE (\$400-\$500/MWh), DC (\$500/MWh), MD (\$400/MWh dropping to \$50/MWh), MA (\$600/MWh), NJ (\$711 dropping to \$594/MWh)
- Some of these may be **below** what is needed to make solar economic, absent other forms of state funding or continuation of federal ITC

Cost Caps and Funding Limits (several of these could become binding)

- **Solar/DG set-aside:** DE (1% increase in retail rates), MD (1%), NJ (2%), NM (\$0.10-0.15/kWh cap on price of solar contracts)
- **Overall RPS:** CO (2% increase in retail rates), IL (2%), MO (1%), NC (per-customer cost cap), NM (2% and per-customer cost cap for large customers), OH (3%), OR (4%)
- **Funding Limits:** AZ (prior limits were *severely* binding), NY

Possible Force Majeure Events

- NV, OH, PA, others

Penalties Outside of States with ACPs

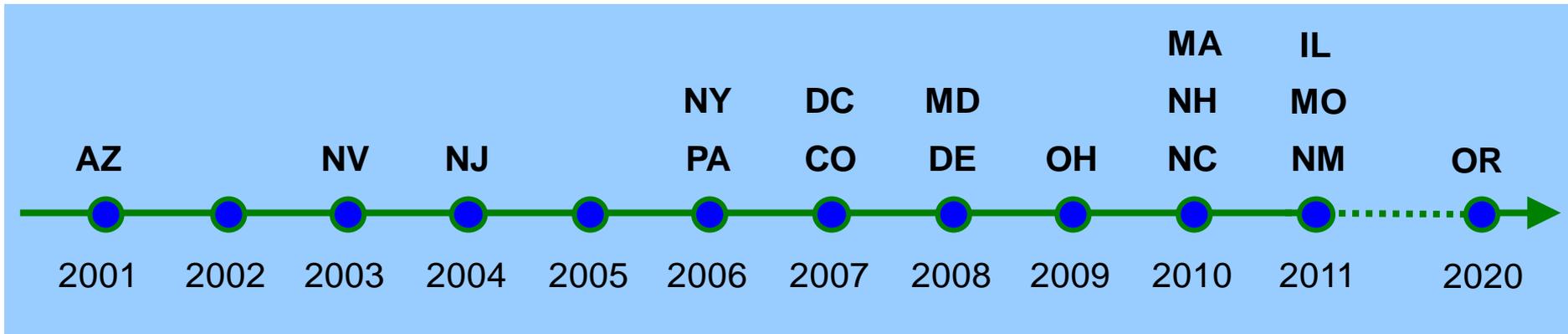
- Automatic financial penalties (MO, OH, PA); regulatory discretion to apply financial penalties (AZ, CO, NV), general enforcement powers (NM, NC)

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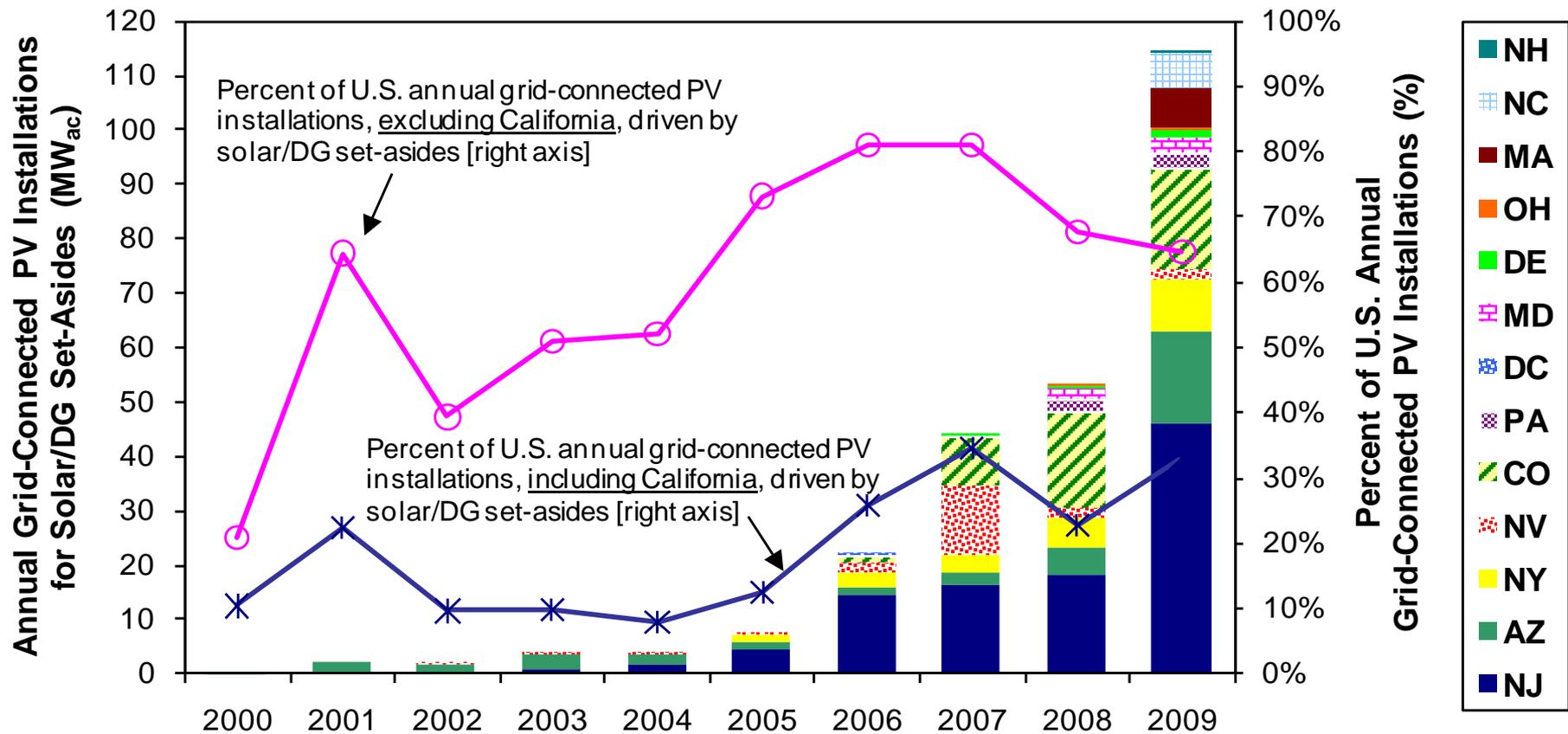
State RPS Solar/DG Set-Asides: Experience Remains Limited

First Compliance Year of Solar or DG Set-Asides



- **Duration of experience is limited:** Only three states have had more than five years of experience with a solar/DG set-aside so far
- **Magnitude of compliance obligations is still relatively low:** 10 of the 13 states with compliance obligations in 2010 have targets that require the equivalent of <25 MW of PV

Impact of Solar/DG Set-Asides Is Growing: 253 MW_{ac} of PV from 2000-2009



* PV additions are counted as being motivated by a solar/DG set-aside if and only if they are located in a state with an solar/DG set-aside policy and installation occurred no more than one year before the first calendar year of set-aside compliance obligations in the host state. The only exception is the 10 MW_{ac} El Dorado PV project installed in Nevada in 2008; the electricity generated by this project is being sold into California, and therefore is not attributed to Nevada's set-aside. Data on annual state PV capacity provided by Larry Sherwood (IREC).

Set-Asides Provided the Most-Recent Kick-Start for Solar-Thermal Electric

Arizona: 1 MW Saguaro Solar Station came online in 2006; nation's first parabolic trough power plant built since 1990

Nevada: 64 MW Nevada Solar 1 was commissioned in 2007 to help meet the Nevada RPS

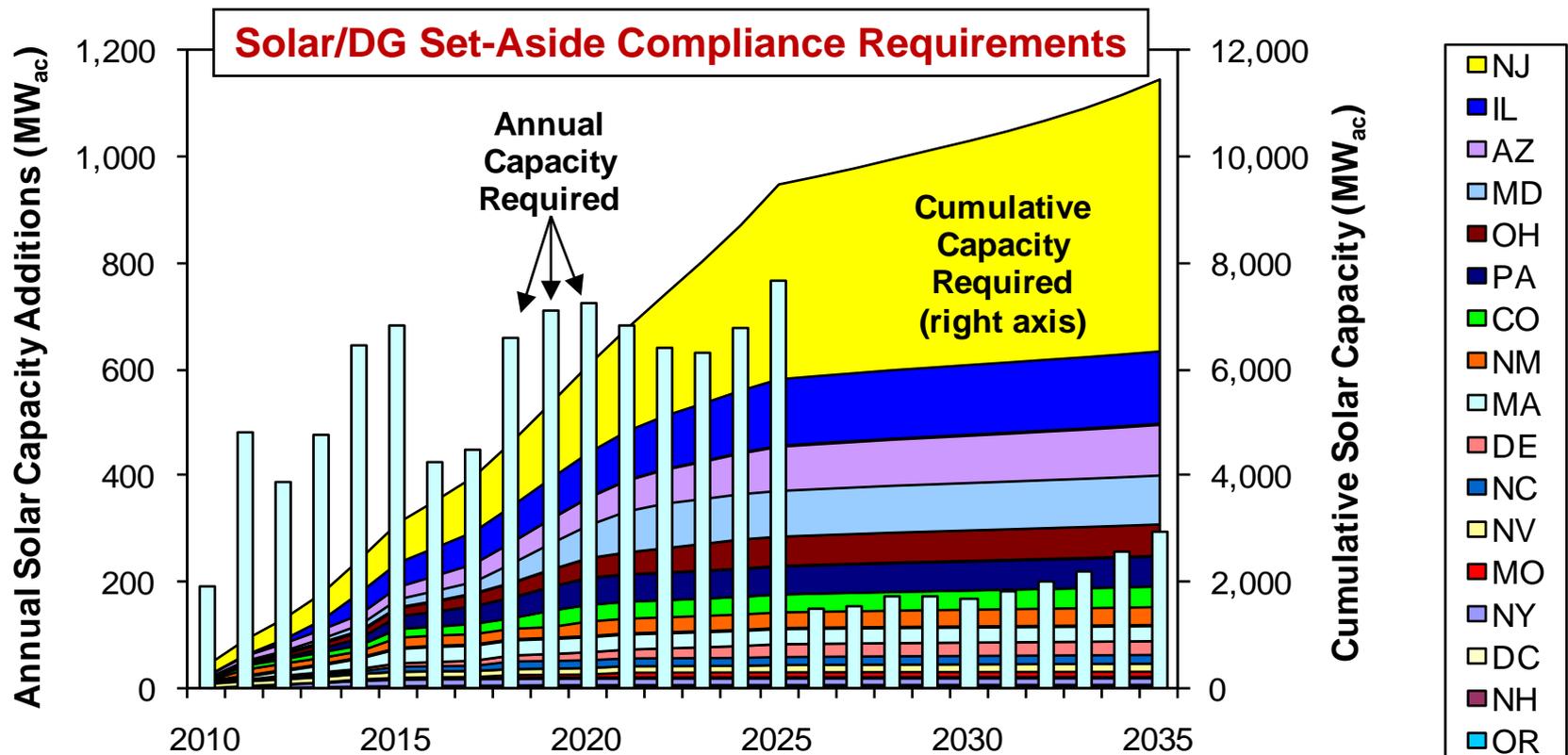
But... More recent CSP (and utility scale PV) activity in CA and the desert SW has also been motivated by traditional RPS programs

In comparison, the impact of set-asides on the SHC market has been quite limited

- Small impact partially the result of limited SHC eligibility
- States where SHC is eligible under an RPS set-aside constituted about 6% of the SHC market in 2008

Solar/DG Set-Asides Will Require Substantial Growth in Solar Capacity

- Cumulative capacity requirement grows to 9,500 MW by 2025
- Required average annual solar capacity additions of ~400 MW/yr from 2010-14, ~600 MW/yr from 2015-25



Emerging Issues Will Influence Future Impacts of RPS Policies on Solar Growth

- **Utility-scale solar appears competitive against other renewables in the Southwest**
- **Full compliance with set-asides has not been achieved in many markets**
 - Uncertain and fragmented solar REC markets
 - Incomplete contracting/incentive policies
- **Cost caps/funding limits may become binding**
- **Fate of in-state geographic requirements unclear**
- **Other technical design considerations**

Solar Set-Asides Now Less Important for Utility-Scale Solar in Some Markets

In regions with a strong solar resource (e.g., desert Southwest), utility-scale solar can now compete against other renewables within a traditional RPS

Utility-Scale Solar Project Announcements

State	MW	RPS Drivers
CA	15,492	General RPS obligations
NV	3,367	General RPS obligations (primarily) and solar set-aside (~110 MW target in 2020)
AZ	2,225	General RPS obligations (primarily) and DG set-aside
NM	429	General RPS obligations (primarily) and solar set-aside (~300 MW target in 2020)
TX	381	Not RPS-driven
FL	208	Not RPS-driven
Other states with solar/DG set-asides (CO, DE, MA, MD, NC, NJ, NY, OR, PA)	380	General RPS obligations and/or solar set-aside
Other RPS states without solar/DG set-aside (HI, MN, WA)	97	General RPS obligations
Other states without RPS (ID, GA, TN, VT)	38	Not RPS-driven
Total	22,617	

Source: LBNL analysis of data compiled by the Solar Energy Industries Association (SEIA)

States with Solar/DG Set-Asides Are Not Universally Achieving their Solar Targets

Purchase and retirement of solar electricity/RECs in 2008, relative to 2008 set-aside requirements, has been mixed

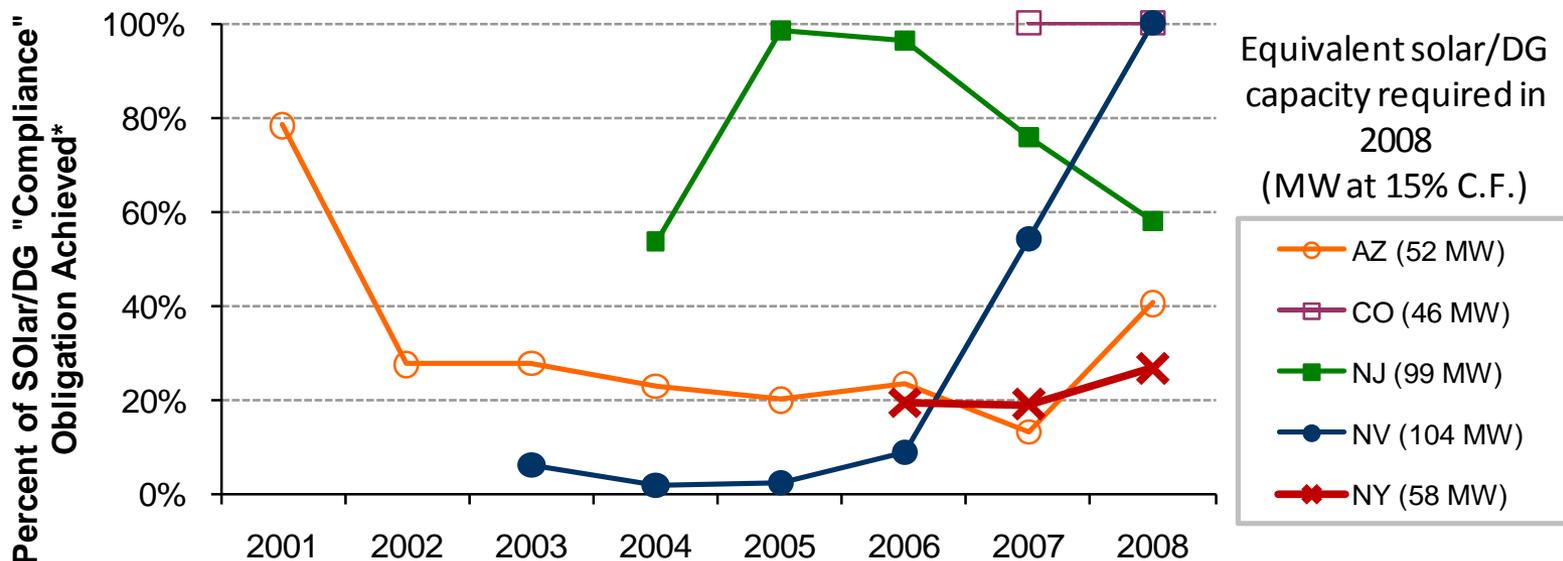
State	2008 Solar/DG Set-Aside Compliance Obligation		Percent of “Compliance” Obligation Achieved*
	% of Applicable Retail Sales	Equivalent Capacity @ 15% capacity factor (MW _{ac})	
Nevada	0.54%	104	100%
New Jersey	0.16%	99	58%
New York	0.07%	58	27%
Arizona	0.18%	52	40%
Colorado	0.20%	46	100%
Maryland	0.01%	2	7%
Washington D.C.	0.01%	1	0%
Pennsylvania	0.01%	1	100%
Delaware	0.01%	1	84%
Weighted Average			68%

* Percent of “Compliance” Obligation Achieved excludes ACPs but includes applicable credit multipliers. In cases where this figure is below 100%, suppliers may not have been technically out of compliance due to solar ACP compliance options, funding limits, and force majeure provisions.

States with Solar/DG Set-Asides Are Not Universally Achieving their Solar Targets

Early-year purchase and retirement of solar electricity/ RECs, relative to set-aside requirements, has been mixed

States with Large Solar/DG Targets in 2008

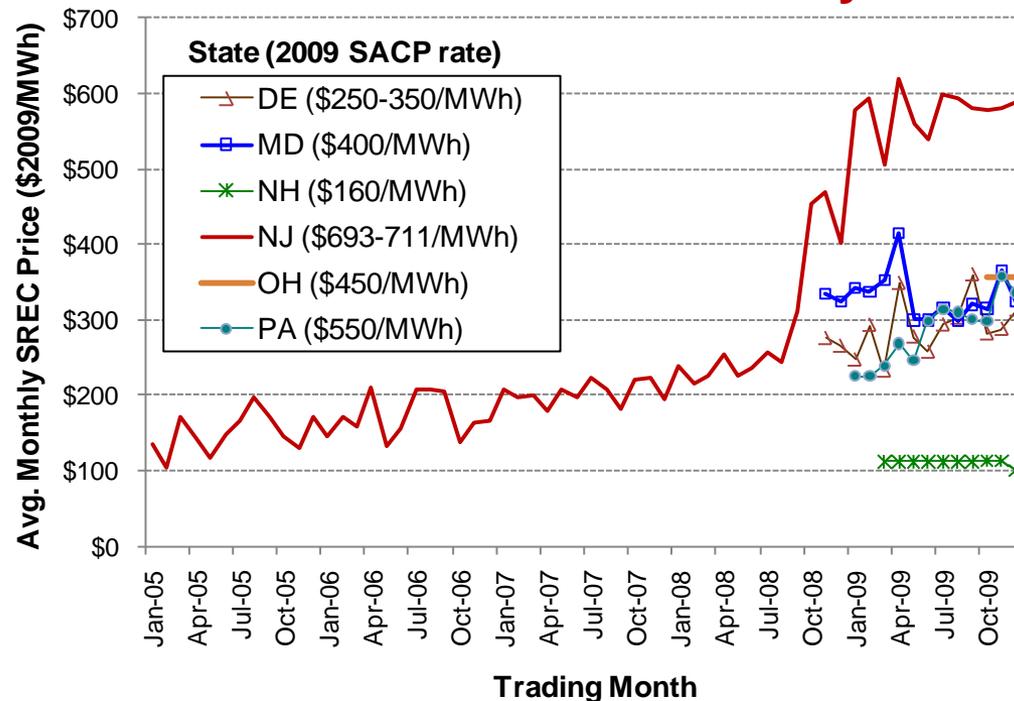


Note: Percent of "Compliance" Obligation Achieved excludes ACPs but includes applicable credit multipliers. In cases where this figure is below 100%, suppliers may not have been technically out of compliance due to solar ACP compliance options, funding limits, and force majeure provisions.

Contracting-Related Challenges Persist

- **Uncertain and Fragmented REC Markets:** lack of liquidity/price certainty creates financing challenges
- **Incomplete Contracting/Incentive Policies:** especially of concern in states with retail competition, and for smaller solar systems

Solar REC Price History

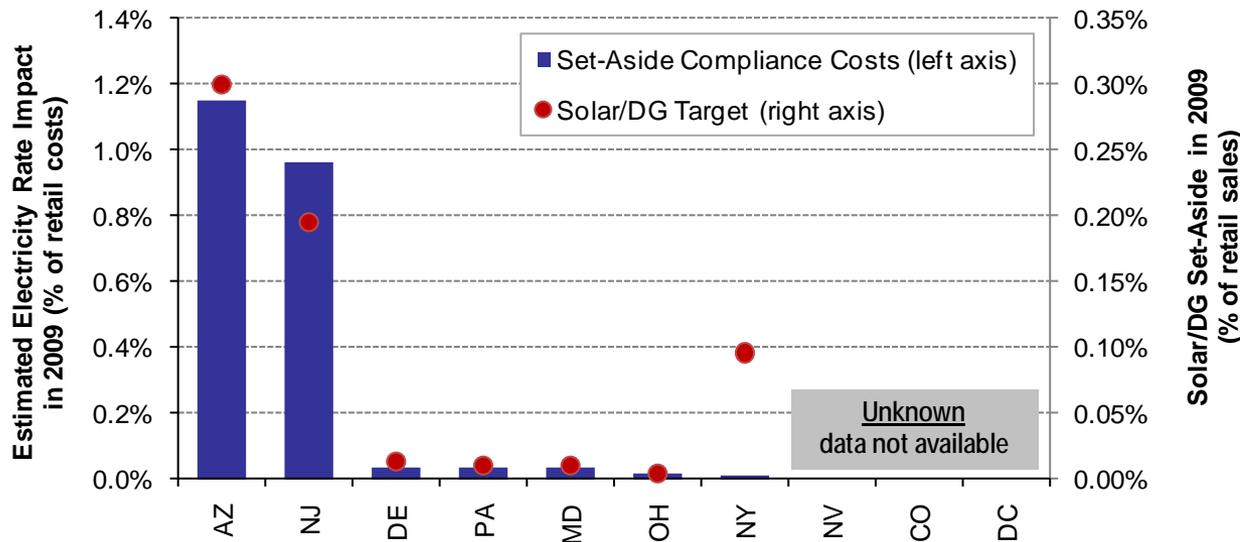


Sources: New Jersey Clean Energy Program (NJ), Spectron (NH), PJM-GATS (all other states). Plotted values are the weighted average selling price, except NH, where they are the mid-point of the reported Bid and Offer prices for the current or nearest compliance year.

Cost Caps or Funding Limits May Become Increasingly Binding

- Funding limits have already impeded target achievement in AZ and NY
- Estimated solar/DG set-aside compliance costs in 2009 approached 1% of total retail electricity costs in AZ and NJ; rate impacts were lower in other states with lower set-aside targets or lower compliance levels

Retail Rate Impacts of Solar/DG Set-Asides in 2009*



* Retail rate impacts were estimated based on average solar REC prices (NJ, DE, PA, MD, OH) or actual/budgeted funding levels (AZ, NY)

Caps on Retail Rate Impact*

Solar or DG Set-Aside	
DE	1%
MD	1%
NJ	2%
Overall RPS	
CO	2%
IL	2%
MO	1%
NM	2%
OR	4%

* Other types of cost caps/funding limits exist in NC, NM, NY, and OH; ACPs cap costs in other states, and may constrain development

Requirements for In-State Generation Are Coming Under Constitutional Fire

The constitutionality of RPS “in-state generation” requirements has long been an open question. Until recently, no party has felt sufficiently aggrieved to issue a challenge.

- On April 16, 2020, TransCanada filed suit against Massachusetts in U.S. District Court, alleging that the solar set-aside “in-state generation” requirement violates the Interstate Commerce Clause
- TransCanada is a competitive retail supplier in MA and claimed that the requirement forces it to pay higher prices for solar RECs and/or solar ACPs
- MA and TransCanada have since settled this issue without requiring a change to the “in-state” provision of the solar set-aside
- It remains to be seen whether this is a harbinger of similar legal challenges to come

Other Design Considerations Will Affect Impact of Set-Asides on Solar Growth

Broader DG set-aside	Competition with other resources makes market size for solar uncertain
Credit multipliers	Reduces effective requirement, can shift compliance towards certain applications
Eligibility of solar thermal electric	Affects fate of PV
Eligibility of utility-scale solar	Affects fate of customer-sited installations

Of course, the existence of Federal tax incentives and other state policies and incentive programs will also affect the impact of set-asides on solar growth

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Conclusions and Lessons Learned

- **Traditional RPS designs may not provide as much renewable resource and application diversity as policymakers desire**
- **State RPS policies that include set-asides of various types have become popular, and are increasingly driving solar deployment, though a number of design challenges have emerged**
- **Current solar/DG set-aside targets will require a ramp-up in solar capacity over the coming years, but...**
 - Adequately addressing financing challenges (especially in restructured markets and for small systems) will be key to reaching those targets
 - RPS ACPs/cost caps/funding limits may constrain the impact of solar set-asides in some markets, unless redesigned
- **Careful attention to policy goals needed during (re)design**
 - Utility-scale solar competitive within traditional RPS in some markets
 - In-state requirements and encouragement at some risk

For Further Information...

Download the report:

<http://eetd.lbl.gov/ea/emp/re-pubs.html>

Contact the authors:

Ryan Wiser, RHWiser@lbl.gov, 510-486-5474

Galen Barbose, GLBarbose@lbl.gov, 510-495-2593

Ed Holt, edholt@igc.org, 207-798-4588