SEC 598 Solar Commercialization

Memorandum

Colorado and Massachusetts Review of Approaches and Best Practices for Renewable Implementation

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Introduction

In response to your request to research and analyze the programs in place in states that have already passed Clean Energy Standards (CESs), this report serves to document key findings for the states of Massachusetts and Colorado. The four main sections: Utility realm, consumers, policy, and technology include a summary of the findings for the given questions and, where applicable, a high-level summary of how the information reviewed is relevant to the Arizona Energy Modernization Plan. Key takeaways are included in the conclusion section for quick reference.

Utility realm

Massachusetts Utilities

There are several differences between Massachusetts and Arizona that make some of what Massachusetts is pushing for in the utility realm less practical if it were to be applied to Arizona in its attempt to achieve the goals of the Arizona Energy Modernization Plan. Although, Massachusetts has already accepted a Clean Energy Standard that is much like the Arizona Energy Modernization Plan in terms of goals; the ultimate result being 80% of electricity being sold coming from clean sources by 2050[1]. Massachusetts is well on its way to achieving this, the exact mix of utility-scale, non-residential scale, and residential scale being illustrated in the chart below.

![Massachusetts Annual Solar Installations](image)

**Figure 1:** Massachusetts solar installations by year. Several state programs incentivize residential and non-residential solar installs. These are supported by a strong Net-Metering policy and retention of ownership of the Renewable Energy Credits by the owner of the system. The growth these policies have can be seen in the growth of the respective sectors[2].

One of the Unique things about the Massachusetts solar industry is that it is not focused on large utility-owned solar farms. This is due to a few reasons. One of which is that there is not the same amount of unshaded, unoccupied
space available for such systems in Massachusetts near most of the existing infrastructure. Another reason is the strong net-metering policy which utilities cannot take advantage of, incentivizing a market where commercial properties and residents with optimal land area can provide enough electricity to meet more than their needs at any particular moment\[^3\]. Any Renewable Energy Certificates (RECs) generated by the owner of the system can be sold freely on the market created by the state. Regulated Distribution Utilities and Competitive Suppliers must obtain a certain percentage of the electricity they provide to their customers from certified renewable energy facilities. There are different classes of facility, characterized by the nameplate power they produce which effects the subsidies and benefits they receive\[^4\].

In summary, Massachusetts should serve as an example that meeting the goals of a Clean Energy Policy does not require that only large, utility-owned projects be considered. Providing the right incentives to fuel growth, creating new markets, and making the application criteria clear and easy to use for all participants is what is most important. The goal Massachusetts set for 250 MW by 2017 was met four years ahead of schedule. It was then upped to 1.6 GW by 2020, which was surpassed when a capacity of over 2 GW was reached in 2017\[^5\].

**Colorado Utilities**

In a rather stark contrast to Massachusetts, Colorado has been particularly slow in recent years to develop the different sectors of solar facilities. Colorado has one of the strongest Net-Metering policies in the country and was also the first to set a Renewable Portfolio Standard for their electrical utilities. The Renewable Portfolio Standard currently stands at 30% of electricity sold by investor-owned utilities, 20% for cooperative utilities, and 10% for municipal utilities to come from renewable sources by 2020\[^6\]. Utilities in Massachusetts report extremely similar yearly retail sales of electrical energy at ~52 TWh, so the percentages set by their RPS goals are a one-to-one comparison\[^7\][^8\]. The significantly smaller goal set by Colorado, as well as the lack of direct state incentives, seem to have a link to the amount of capacity being installed.

![Colorado Annual Solar Installations](image)

**Figure 2:** Colorado solar installations by year. Colorado has one of the strongest Net-Metering policies in the country which has supported the growth of residential system installations. Community solar is something emphasized by the state which allowed benefits of solar installations to be extended to multiple customers who pay into the system. This falls under the non-residential PV field which explains the steady installation rate of these systems. Utility-scale PV still largely dominates the installed capacity\[^9\].
The only significant progress with solar that has been made toward their goals was a few large-scale utility plants. Even with their strong Net-Metering policy, Colorado is not making leaps and bounds that Massachusetts is with solar. It is important to note that they are focusing a lot on wind power. In 2016, 17% of the electricity produced by Colorado came from wind turbines compared to solar at 1%. Coal still holds on to the majority of electricity generation which is likely one of the things slowing the push to renewables because it keeps prices low. Electricity is still very cheap at around $0.11/kWh while Massachusetts is around $0.22/kWh. To compete in bids for new generation plants, the only solar systems that make sense are utility-scale.

Initially, it seems that Massachusetts is the model to follow because of their success in energizing the growth of photovoltaics. This success came about because of programs that incentivized non-utility owned solar systems. However, this conclusion is incomplete because it only considers solar installations. When moving towards RPS or CES goals, it is important to take advantage of the most abundant resources first, which Colorado has done by deploying large amounts of wind power. As a result, a larger percentage of energy consumed by the state comes from renewable sources in Colorado than it does in Massachusetts. The best mix of scale depends on the land and resources available. For Arizona, we have a lot of land and a great solar resource. This combined with a lack of wind and the answer is that the new standard should be met largely by utility scale solar farms to minimize the cost to consumers.

Consumers

Community choice aggregation (CCA), also known as municipal aggregation, are programs that allow local governments to procure power on behalf of their residents, businesses, and municipal accounts from an alternative supplier while still receiving transmission and distribution service from their existing utility provider. This can be used to switch everyone in a town who is on basic service over to cleaner energy. An energy broker helps the community purchase the amount of energy which best fits their needs. Residents may opt out at any time. The energy is still distributed and billed through the town's original utility.

Community solar refers to local solar facilities shared by multiple community subscribers who receive credit on their electricity bills for their share of the power produced. There are 42 states with at least one community solar project in progress. These projects may be located publicly or in jointly-owned property and is an easier way for consumers to benefit from a local solar energy project.

Community Choice aggregation in Massachusetts

Since 1997, Massachusetts state law allowed a city or town to choose the electricity supplier for residents and businesses within that municipality. This is called municipal aggregation or community choice aggregation. It allows for important energy decisions to be made at the local level rather than by an investor-owned utility or by a for-profit competitive electricity supplier. The oldest and largest example in Massachusetts is the Cape Light Compact, which buys electricity and runs energy efficiency programs for all the towns on Cape Cod plus Martha’s Vineyard.

GMA, Green Municipal Aggregation, is a model devised by Green Energy Consumers and Good Energy that adds more renewable energy to residents' electricity at a competitive price. When a community decides to enact GMA, it goes out to bid for an electricity supplier and secures a long-term price and a cleaner electricity supply. That
supplier replaces the utility's basic service, and offers a more stable price (usually cheaper in the long run, too) right on everyone's regular electricity bill.\[14,15,16\]

**Why do Community Choice Aggregation?**

Through CCA, local governments and their constituents are achieving a powerful range of objectives:
- Competitive, often significantly lower, electricity rates
- Transition to a cleaner, more efficient energy supply
- Consumer choice, consumer protection, and local control
- Local jobs creation and local power resiliency
- Complementary energy programs such as net energy metering, energy efficiency retrofits, distributed rooftop and community solar, electric vehicle incentives and demand response technologies
- New renewable power development \[18\]

**How it benefits the consumers?**

When local governments procure power on behalf of residents, it impacts the current utility provider. So, there won’t be a monopoly in the market. What this means for the electricity market is that one single company will not hold control over a city's electric supply. In case the company cannot meet the demand, the government can step in to provide the excess energy.

Community solar also plays a vital role in moving towards green energy goals. Many American households and businesses do not have access to solar because they rent, live in multi-tenant buildings, have roofs that are unable to host a solar system, or experience some other mitigating factor. A community solar project helps the consumers better access solar. This also expands consumer choice because they have the option to either go with a renewable energy or other forms of energy

**Policy**

Introducing “electricity choice” through a deregulated retail market would play a vital role in increasing the renewable energy deployment. So what is a deregulated energy market?

In deregulated electricity markets, utilities no longer control the entire energy process. New “retail suppliers” are able to enter the market to form and sell energy and compete with utilities, and each other, for customers. Hence, customers finally have an “Electricity choice” over who they buy power from.\[19\]

There are numerous benefits of deregulated electricity market like cost savings, uninterrupted service, better customer support, more options to go renewable etc. Out of these, the most important and unique advantage would be the privilege to opt for power from renewable sources. Energy Deregulation has created a competitive environment in which suppliers turn to renewable energy offerings as a way to differentiate themselves from their competitors. Table 1 reflects a number of different ways for end users to procure green power, including retail electricity choice (shown as “competitive suppliers” in the table).
Within the approximately 77.9 TWh of green power sold to about 4.3 million electricity customers in 2015, 15.4 TWh was purchased as a result of retail electricity choice. Retail electricity choice also enables customer adoption of an off-site voluntary power purchase agreement (PPA).\textsuperscript{[20],[21]}

Massachusetts entered the deregulated energy market by deregulating both electricity and gas in 2005, calling their official energy choice program “Energy Switch Massachusetts.” Since then, thousands of consumers across the state have taken advantage of the benefits electric choice offers. Because of deregulation, Massachusetts consumers have the option to choose green energy plans from renewable energy sources, such as solar, wind, geothermal and biomass. Massachusetts was the first state in the nation to build an offshore wind project, Cape Wind, which is expected to deliver wind-powered electricity to consumers in Massachusetts.\textsuperscript{[22]}

On the contrary, Colorado still has a regulated electricity market. However, since the passage of Amendment 37 in 2004, renewable energy has increased from 2% to almost 22% of total electricity generated. It has seen large investments in wind, solar, biomass, geothermal, small hydroelectric and other renewable energy resources in the last decade. In 2004, the state passed the first voter-led Renewable Energy Standard in the nation, requiring electricity utilities to obtain a percentage of their power from renewable energy sources. The legislature has increased the minimum requirements three times since 2004, spurring the development hundreds of new renewable energy projects across the state. Wind energy accounts for the largest percent of renewable generation in Colorado, with more than 17% of total electricity generated in the state in 2016. Colorado also is ranked eleventh in the nation for installed solar capacity, with 926 MW installed as of 2016.\textsuperscript{[23]}

To conclude, deregularization of electricity market has helped Massachusetts to increase renewable energy deployment while on the other hand, in spite of having regulated electricity market, Colorado has not lagged behind in deploying renewable energy due to its favorable policies. Hence, Arizona which is also an electricity regulated state, can follow the footsteps of Colorado to emerge as a leader in renewable energy.
Technology

Massachusetts

Massachusetts has already begun showing signs of the “Duck Curve” which prompted policy makers to put a plan in place to adopt 200 MWh of storage by the beginning of 2020[12]. This is the Energy Storage Initiative which also provided funding for a study, called “The State of Charge”, on the potential for energy storage in the state. The technologies examined and their classifications are listed in the table below.

![Technologies examined in the State of Charge study conducted as a result of Massachusetts Energy Storage Initiative. The study found an optimal point of total power provided by energy storage to total cost of investing in deploying that storage][13].

The optimal figure came out to be ~1.8 GW/2.1 MWh which provides savings to the ratepayer of near $2.3 billion. This was a bit of an impractical goal, especially for the first policy on the subject. It was scaled down when available funding and policy measures were taken into account in the later parts of the study. The ultimate recommendations, if implemented, are projected to add 600 MW of storage by 2025. This would provide ratepayers savings of $800 million. Currently, Massachusetts has rewarded and contract to a Vanadium Flow battery manufacturer as well as several large-scale lithium ion storage facilities[14].

The smaller, more distributed solar systems in place in Massachusetts would require a similar type of storage option. The Lazard study of the Levelized Cost of Storage (LCOS) states that the cheapest battery for almost every situation and scale is lithium-ion[15]. The falling prices of this battery chemistry also bodes well for meeting the storage goals that have been laid out by Massachusetts.

Colorado

The storage industry in Colorado is nascent due to cheap electricity, relatively low demand charges and less regulatory support. As the state has emerged as an attractive market for both wind and solar generation projects, the energy storage has also entered the state’s energy planning in a big way. Colorado is on its way to implement its first energy storage-specific legislation. The bill will give the customers a right to interconnect and use batteries
without restrictions and hence allow customers to benefit from resiliency and cost savings that can be provided by residential storage. The recent projects have shown that utility scale storage is also viable. Xcel Energy, which is the state’s largest power provider, announced that it received record low bids for new solar, wind and storage projects.

**Table 2: Xcel Energy all source solicitation bid summary.** [24]

<table>
<thead>
<tr>
<th>Technology</th>
<th># of Projects</th>
<th>Total MW</th>
<th>Median Bid Price</th>
<th>Pricing Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>42</td>
<td>17,380</td>
<td>$18.10</td>
<td>$/MWh</td>
</tr>
<tr>
<td>Wind with Battery Storage</td>
<td>8</td>
<td>5,097</td>
<td>$21.00</td>
<td>$/MWh</td>
</tr>
<tr>
<td>Solar PV</td>
<td>75</td>
<td>13,435</td>
<td>$29.50</td>
<td>$/MWh</td>
</tr>
<tr>
<td>Wind and Solar and Battery Storage</td>
<td>7</td>
<td>4,048</td>
<td>$30.60</td>
<td>$/MWh</td>
</tr>
<tr>
<td>Solar PV with Battery Storage</td>
<td>59</td>
<td>10,813</td>
<td>$36.00</td>
<td>$/MWh</td>
</tr>
</tbody>
</table>

*Source: Xcel Energy*

These record low prices highlight the growing maturity of combined renewables plus storage projects, and the relatively low cost to add storage to wind or solar projects as system integration expertise has improved. [24]

**Conclusion**

In the utility realm, with regards to what entity should own new solar farms, there is evidence to suggest that either utility or independent power producer ownership works when trying to spur growth to meet new RPS goals. As seen in Figures 1 and 2, large amounts of growth were achieved when goals and incentives were put in place for either potential owner. When comparing who owns the largest amount of installed capacity of all renewables in both states, it is much more clear that independent power producers are the clear choice. Scale comes down to land and solar resources of the location. For Arizona, in order to avoid as much cost being transferred to the consumer, a majority utility scale solar farms should be deployed, much like Colorado did with wind.

Consumers when given the opportunity to participate in Community Choice Aggregation will on average opt to get their power from cleaner sources. The long-term contracts keep prices steady for the members of the community and allow for better customization of service from the suppliers to the consumers.

Electricity choice through deregulation has been successful in Massachusetts in terms of saving money for consumers, but Colorado, which is still regulated, has introduced more renewables than Massachusetts to date. It could be argued that this is because of the political backlash that has been seen on large-scale wind project proposals in Massachusetts, but nevertheless the deregulated market does not seem to have a fundamental impact on renewable deployment.

Massachusetts has opted for popular battery chemistries such as vanadium flow and lithium ion to try and achieve its storage targets. This matches nicely with the distributed nature of the solar that has been deployed there. Colorado will most likely go for larger, more centralized storage facilities. There is also the potential for community storage plans where people pay into the system and get a percentage of the benefits. The chemistry would most likely be the same, but they could be bold and try some of the alternative storage methods like mentioned in Figure 3.
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