SMART GRID MARKET ANALYSIS: US

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Executive summary

There are a multitude of opportunities awaiting Swedish providers within the American smart grid market, highlighted by a widespread need for updated infrastructure supporting the world's second largest producer and consumer of electricity. However, entry into the U.S. will require a targeted approach to maximize success, given the considerably different regulatory environment, grid structures, and market opportunities within each state.

MARKET SUMMARY

Electricity generation and consumption within the U.S. is increasingly shifting away from the "coal-first" mentality that has historically driven the energy market. Coal production has dropped by 37% over the past decade and over the same period, renewable energy sources have increased by over 150%. Despite the current administration's renewed interest in restoring coal to its former primary position, market mechanisms are already in place to maintain this declining coal trend for the foreseeable future. Beyond renewables like solar and wind, natural gas generation has become a dominant market player, currently functioning as the primary generation and end-consumption source.

Although some trends are applicable on a national level, the U.S. "market" consists of 50 micro-markets, corresponding to the 50 states. Each state operates a slightly different approach to energy regulation and smart grid policies. Within highly regulated states, electricity generation, transmission, and distribution are all handled by the same entity. The vertically integrated providers are closely watched by state regulatory agencies, but can facilitate value-chain wide infrastructure developments via a single stakeholder. Conversely, highly deregulated states are supported by separate generation, transmission, and distribution entities, functioning within self-contained open markets. States are driving the smart grid agenda on an individual basis and the federal policy has little impact, either positive or negative, on states wishing to modernize their grid. Most initiatives regarding smart grids are supported on a state level.

TYPICAL STAKEHOLDERS

Within each state, there are several stakeholders that are fundamental connective nodes for outside vendors. First, there are the state regulatory agencies called Public Utility Commissions (PUCs), Public Service

Commissions (PSCs) or similar. These government entities are primarily engaged in overseeing fair and technologically appropriate end-consumer provision. These entities not only function as ideal relationship-fostering entities for Swedish providers, they also oversee and approve the allocation of funding for new market infrastructure.

Next, State Energy Agencies are another regulatory entity that can facilitate relationship development for outside solution providers. As the key policy-making entity in most states, these stakeholders are able to both inform Swedish organizations about the state's energy roadmap and be influenced by Swedish organizations' solutions as it pertains to shaping this roadmap.

An obvious stakeholder is the collection of utilities that service each state. In regulated and deregulated markets, these entities are typically the market participant responsible for the implementation, operation, and funding of grid upgrades. Many of these utilities have existing smart grid opportunities ongoing, but will need to be assessed and interacted with on an individual basis.

SMART GRID OPPORTUNITIES

Five states have been highlighted in this report as states with the highest potential for collaboration with Swedish vendors. A summary of the potential for opportunities in each state and smart grid area is summarized in the table below.

SUMMARY OF SMART GRID POTENTIAL IN TARGET STATES						
++ = High Potential for Opportunities	*+ = Medium Potential for Opportunities*		*(blank) = Low/No Potential for Opportunities or not identified*			
Smart grid area	***CA***	***NY***	***TX***	***MN***	***MA***	***Number of Swedish companies***
Wide-area monitoring and control	++					Low
Information and communication technology integration	+		+		+	Medium
Renewable and distributed generation integration, incl. storage	++	++	++	++	++	Medium

Transmission enhancement		++	++	+		Low
Distribution grid management	++		++	+	++	Medium
Advanced metering infrastructure	++	+	++		++	Medium
Electric vehicle charging infrastructure	++	++		++	++	Low
Customer-side systems	++		++		++	High
Cyber security[1]	++	++	++	++	++	Low

A large number of Swedish SMEs offer customer-side solutions, and there is also a significant number of companies in the advanced metering, renewable generation and information technology sectors. While California and Texas show the greatest potential for smart grid opportunities across the board, the largest states also have the greatest competition. For Swedish SMEs, this means it may be easier to target the smaller states such as New York and Massachusetts, in areas of high potential such as electric vehicle charging and advanced metering. State-specific initiatives and opportunities for Swedish SMEs to enter each of the specific markets are described in detail in this report.

[1] Cyber security is an inherent element of all states' smart grid growth plans, but it is rarely highlighted as a primary focus.

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1 Introduction

The United States is the largest economy in the world and is currently undergoing a strong period of recovery and economic growth after the financial crisis that plagued its economy for several years. Combined, the 50 states of the U.S. represent a vast market, full of potential for business and growth opportunities for U.S. and international companies alike. The U.S. functions as many "smaller" markets with each state having a strong economy, large population and multitude of business opportunities.

The individual states are largely able to govern themselves, relatively free from restriction by the federal government. Policy making, regulatory oversight, and incentive structuring all frequently occur on the state level, with the federal government offering more generic, top-level processes. This holds especially true for the U.S. energy market, a market characterized by state-by-state differences in policy, confusing ownership structures for generation and distribution, and a federal government that swings wildly in favor of and then against technologies like renewables and smart infrastructure.

During the previous Presidential administration, major strides were made in the adoption of renewable energy sources at the expense of traditional, carbon-footprint heavy generation sources like coal. Since 2007, production of renewable energy has increased by more than 1.5 x as of 2016[2]. In contrast, coal production has fallen by 37% and coal-based electricity usage has fallen by 35%[3]. However, the current Trump administration has a more conservative view on climate change. This includes the withdrawal of the U.S. from the Paris Agreement while also rolling back several of the Obama-era initiatives relating to energy, including regulations on coal and vehicle emission standards. In the "absence" of federal regulatory, states have taken own initiatives of decreasing emissions and adopting a more diverse energy mix.

The U.S. electrical grid is reliable despite being old and in need of updates. The U.S. is currently modernizing the grid to make it smarter, more resilient, reliable and efficient to meet increased challenges. Several areas of improvement that have been identified by the U.S. Department of Energy include grid scale energy storage, solid-state transformers, power flow controllers that can optimize power delivery and enhance resilience, adaptive/responsive grid and intelligent communication systems.

[2] https://www.eia.gov/totalenergy/data/browser/?tbl=T10.01#/?f=A&start=1949&end=2016&charted=6-7-8-9-14

[3] https://www.eia.gov/coal/data/browser/#/topic/20?agg=0,2,1&geo=vvvvvvvvvvvvo&freq=A&start=2001&end=2016&ctype=linechart&ltype=pin&rtype=s&pin=&rse=0&maptype=0

1.1 States for focus

Five states have been highlighted in this report as states with the highest potential for collaboration with Swedish vendors based on four factors: state-level legislation promoting or supporting smart grid development; existing grid modernization efforts; potential market share from smart grid projects; and demonstrated intentions for continued development. The five highlighted states – California, Massachusetts, Minnesota, New York, and Texas – offer very different market opportunities, each with its own uniquely interesting strategic value. A description of the selection criteria for the highlighted states is found in Appendix 1.

GridWise Alliance is an influential group in the United States electricity sector, with members from major corporations, utilities, and government entities. The Alliance's goal is to leverage the different perspectives of stakeholders in the electricity market to highlight the benefits of grid modernization and encourage policy-related measures and changes in the U.S. As part of this, they have created a Grid Modernization Index (GMI) which ranks the individual states based on state support, customer engagement, and grid operation measures. The 2018 GridWise Alliance GMI report supports the focus of the states chosen in this report, with California ranked as the number 1 progressive state for 2018. In addition, all of the states for focus were identified as either leaders or movers within the industry, and all were among the top 11[4].

While the five states for focus have been identified as the top most promising ones for Swedish SMEs to enter, there are a handful of additional noteworthy secondary states to consider for their progressive regulatory smart grid efforts as traction in the US market is gained, notably:

- *Colorado* has approved Xcel's plan to retire coal power plants and shift to renewables integrated with storage. The utility estimates that 55% of Colorado's electricity will be generated using renewables by 2026. The towns of Boulder and Fort Collins are leading in the smart grid initiative. Also, with the presence of renewable energy companies and the National Renewable Energy Laboratory (NREL) in Colorado makes it a progressive state with regard to promoting smart grid and renewable energy integration initiatives.
- *Hawaii* is highly dependent on fossil fuels. In efforts to gain energy independence and lower electricity costs, Hawaii is integrating renewables as a significant portion of their energy resource. In addition, because electricity costs are so high, newer technologies that are still gaining cost-competitiveness may make sense in this market. For example, Hawaii is one of the early adopters of energy

[4] https://www.gridwise.org/resource-downloads/GWA_18_GMI-2018_FinalReport_12_17_18.pdf

storage technologies. This may provide an interesting market to novel smart grid technologies offered by SMEs.

- *Arizona* has committed to the smart grid initiative. Arizona is an ideal location for solar installations due to the high irradiance and therefore is pushing many large-scale installations to the grid. This will naturally require more investment in smart grid and demand response technologies, and therefore may be an attractive market to consider soon.
- *Washington, DC* has an active smart city initiative which includes clean energy goals. Also, the city faces mobility challenges where almost one million people commute in and out of the city every day. This has potential opportunity for increasing EV infrastructure.

2 Electricity market

As a whole, the U.S. is the second largest consumer of electricity in the world[5]. In 2016, Americans used the equivalent of 2.3 billion metric tons of oil to power their lives. This puts the US energy use just behind China's 3.1 billion metric tons equivalent, but well ahead of India's 723.9 million metric tons equivalent. However, electricity consumption *growth* has declined each decade for the past 70 years[6] and is forecasted to remain flat until 2050. This stems largely from two factors: a major federal- and state-level push for energy efficiency measures and an increasingly widespread adoption of "behind-the-meter" generation mechanisms (e.g. residential solar panels).

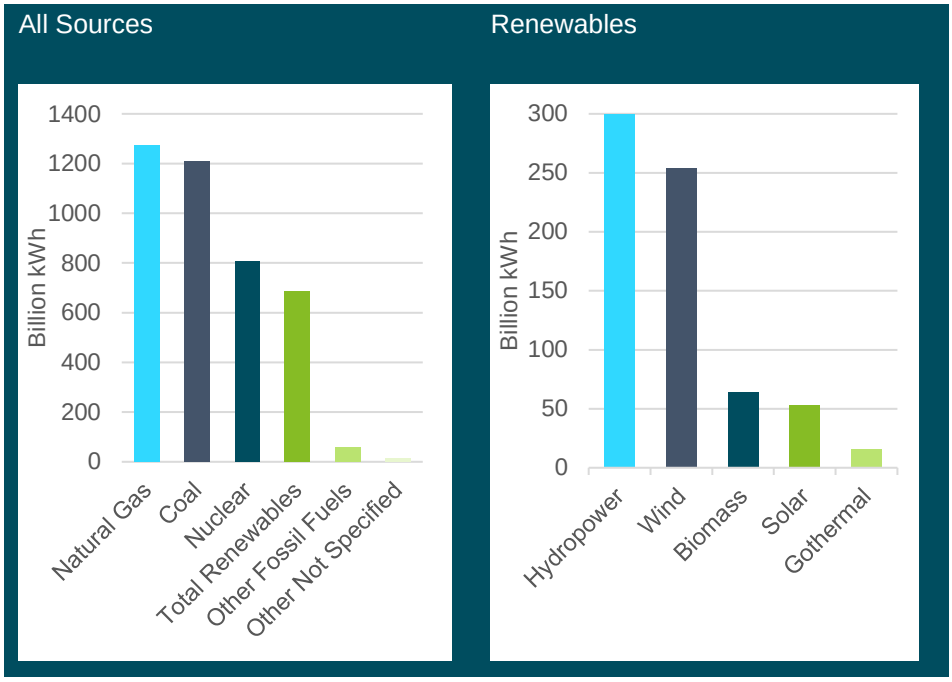
The Obama administration unveiled the Clean Power Act in 2015 and with it the U.S. aimed to realize the commitments it made at the Paris Climate Summit. The aim of the Clean Power Act was to cut the power sector's emissions by 32% by 2030 relative to the levels in 2005. Many states joined the plan and began shifting away from coal. As a result of the Clean Power Act and other recent regulations, the use of emissions-heavy power sources like coal decreased at the same time that natural gas prices benefitted from a supply-driven reduction in price[7]. These factors, coupled with environmentally informed public opinion to reduce coal usage, natural-gas based electricity generation has become the predominant energy source in the U.S as of 2017.

[5] https://www.statista.com/statistics/263455/primary-energy-consumption-of-selected-countries/

[6] https://www.energy.gov/sites/prod/files/2017/01/f34/Electricity%20End%20Uses,%20Energy%20Efficiency,%20and%20Distributed%20Energy%20Resources.pdf

[7] https://www.nytimes.com/2016/06/11/business/energy-environment/coal-production-decline.html

Figure 1: U.S. Electricity Generation by Source



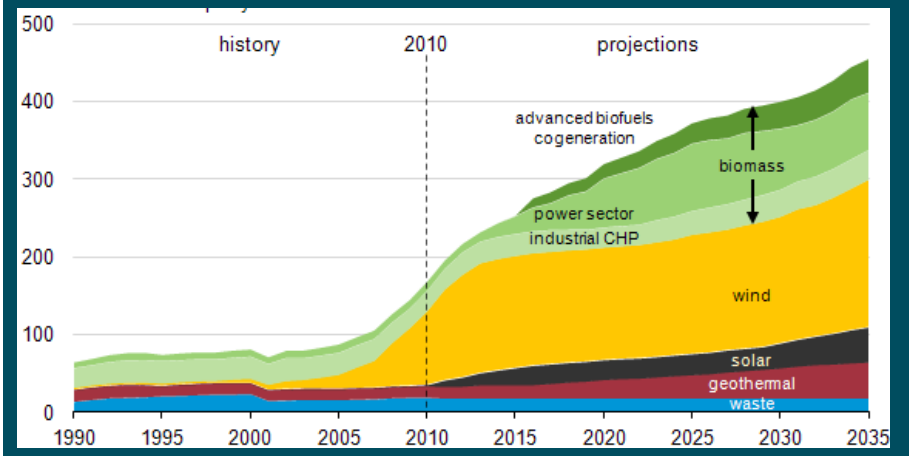
The U.S. Energy Information Agency (EIA) has provided three likely scenarios for the future of American electricity generation, and in all three cases, natural gas is predicted to be the predominant source. A conservative estimate predicts natural gas to continue to be the most used resource, totaling approximately 35% of supply by 2050. Likewise, renewable energy resources are anticipated to make up about 30% of the U.S. electricity supply by 2050, with coal and nuclear sources dropping steadily[8]. However, these percentages are highly susceptible to the cost of natural gas extraction. In a natural gas high cost scenario, renewables would likely become the predominant energy source by as early as 2030. Continued policy development around natural gas extraction will be pivotal in shaping this energy mix moving forward.

It is expected that coal will continue its decline despite the Trump administration's recent push to encourage coal. This is mainly due to natural gas being cheaper and the decreasing costs of wind and solar power, as well as a grid that is evolving towards a more flexible and distributed model. Cities, states and businesses have pledged to honor the goals set by the Paris Agreement through initiatives such as increasing renewable energy

[8] https://www.eia.gov/outlooks/aeo/

generation[9]. It will be the states that will be driving the climate agenda and meeting carbon emission targets, as renewables are forecasted to continue their growth.

Figure 2: Projected Non-Hydropower Renewable Electricity Generation, 2010-2035, billion kWh per year

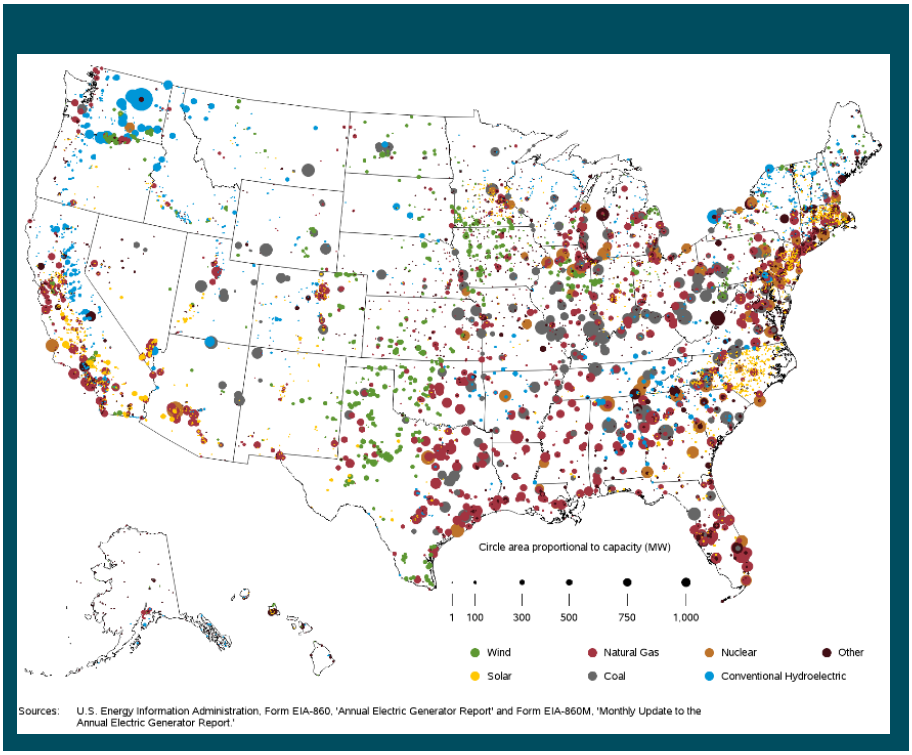


Source: EIA

In addition to the various initiatives that drive the energy mix on a state level, the energy supply is heavily determined by geography. Natural-gas based generation occurs predominantly in Central and Eastern states. The majority of coal production occurs in the so-called "rust belt," a string of states ranging west-to-east from Kansas to Pennsylvania. Nuclear plants are very few in number and are located primarily along the Eastern coast and in Illinois. Renewable energy generation and hydroelectric plants are particularly common along the Pacific coast and in the southeastern coastal states. Similarly, solar plants are most common in California and the Carolinas, whereas wind plants are located almost exclusively in a south-to-north line from Texas through Minnesota. As such, it is important to understand each state's renewable energy goals and note the geographical variances driving generation.

[9] https://www.eia.gov/todayinenergy/detail.php?id=5170

Figure 3: Operable Utility-scale Generating Units as of January 2018



2.1 Ownership of Utilities, Generation and Transmission Companies

The U.S. electricity transmission and distribution grid consists of more than 9,200 electrical generating units, 600,000 miles of transmissions lines and more than 3,000 electric utility companies that provide some combination of generation, transmission and distribution services[10]. Each state can have a different structure for its generation, transmission and distribution, identified by the labels "regulated" or "deregulated." This is a reflection of how states self-govern and the limits of overarching federal policies.

A regulated market is one that features a vertically integrated supply chain of generation, transmission, and distribution. In other words, a market player providing generation will also be the provider of transmission and distribution within its service area. When these entities are privately owned, they are referred to as investor owned utilities (IOUs); when they are publicly owned, they are referred to as municipal utilities (aka munis) or cooperative utilities (aka coops). Regulation, then, refers to the monopolistic control that market providers and their overseeing utility commissions have over a state's energy

[10] https://www.smartgrid.gov/the_smart_grid/smart_grid.html

supply. Utilities are free to provide an energy mix that consists of whatever sources they desire, as long as it meets utility commission minimums for renewable energy when present. Consumers that desire to consume all or most of their energy from renewable sources are subject to the whim of their local provider.

Deregulated energy markets are those that break up the provisioning of generation, transmission, and distribution. In deregulated markets, energy generation is provided by independent entities typically referred to as independent power producers (IPP). Likewise, distribution is provided by independent entities that are solely responsible for end-use distribution. These entities are typically referred to as retail electricity providers (REP). No U.S. state operates a fully deregulated market; the closest is Texas, where 85% of residents have access to a free market of retail electricity providers, with the remaining 15% relying on their local muni or coop[11]. In deregulated markets, an important facet is the concept of consumer choice. Most consumers will have access to an open market supply of generation providers but be stuck with whatever transmission and distribution utility happens to operate in their area. End consumers are able to choose the generation provider that meets their energy mix demands, which creates clear market preferences that drive the implementation of increased renewable energy generation. This is similar to the Swedish electricity market where consumers are able to freely choose the generation provider but not the transmission and distribution utility.

A concrete example of regulated versus deregulated can be exemplified by looking at two states on opposite ends of the spectrum. On the regulated side, there is Minnesota. Its three primary IOUs (Minnesota Power, Otter Tail Power Company, and Xcel Energy) own the generation and transmission infrastructure within the state and are also the sole retail electricity providers for the majority of the state's residents. On the other side, there is Texas – the state that offers deregulated services to the largest percentage of its population. There are five IOUs that operate within Texas, and most Texans have access to a large market of electricity service providers to choose from which source their electricity from an open wholesale market provided by many independent power producers.

Swedish SMEs should be aware of the regulated/deregulated nature of the state they hope to enter, since it has clear implications for the key influence points and which stakeholders to approach. De-regulated markets may be easier targets for Swedish SMEs, as they are more progressive and open to incorporating smart grid technologies and offer an opportunity to create demand by influencing consumers directly. That considered, there is also value if Swedish companies can enter a regulated market, as it would be a

[11] https://www.electricchoice.com/map-deregulated-energy-markets/

way to expand quickly, though interest in new technology adoption needs to be instigated at the utility level.

A summary of the regulatory status and the number of utilities in the five target states in this report is shown in the table below. It is hard to draw general conclusions based on the table, but it can be seen that regulated states have more publicly owned actors (munis/coops) than deregulated ones.

	CA	MA	MN	NY	TX
Regulatory Status	Partially deregulated	Partially deregulated	Fully regulated	Partially deregulated	Nearly fully deregulated
Number of IOUs	3	3	4	7	4
Number of IPPs	500+	225+	Unclear	Unclear	381
Number of Munis/Coops	51	41	153	50+	150

Table 1: Breakdown of Utilities in Target States

3 Regulation

3.1 Federal regulations

Unlike other countries, the U.S. does not have a roadmap or clear federal goals regarding smart grid development. Instead, the responsibility falls to the states to set their own agendas and goals. This therefore limits the purview of the federal government in driving the smart grid agenda and providing incentives for smart grids or tenders.

On the federal level, The Legislative Outline for Rebuilding Infrastructure in America, a roadmap of proposed investment within national infrastructure, was outlined in early 2018. Of the 1.5 trillion USD in the plan, there are zero dollars allocated to smart grid development. In fact, the plan calls for federal entities to sell off the electricity transmission infrastructure they currently own, to minimize federal engagement in what the administration believes is better handled by private entities[12].

In addition, reports indicate that the current administration is aiming to reduce the budget of the Office of Energy Efficiency and Renewable Energy, a sub-office of the Department of Energy (DOE), by as much as 72%[13]. Rick Perry, the Secretary of Energy and head of the DOE, has actively lobbied against regulations supporting renewable energy development. Taken together, these structural realities indicate that there will be little federal-level support of grid development.

However, there are federal regulations related to the energy industry and these usually fall into two basic categories – financial incentives and regulatory policy. These categories are applied to two broad policy goals: Energy Efficiency and Renewable Generation.

The majority of the energy efficiency programs incentivize the usage of energy efficient appliances and the improvement of buildings' overall efficiency. An example of a renewable energy policy is the Green Power Purchasing Goal for Federal Government which establishes minimum renewable electricity consumption percentages for federal agencies and buildings[14]. These have a limited effect on smart grid developments.

There are a multitude of financial incentive mechanisms in place to support renewable energy generation. The majority of these incentives are provided by the United States Department of Agriculture (USDA) and its Rural

[12] https://www.elp.com/articles/2018/02/1-5t-trump-infrastructure-plan-does-not-include-smart-grid.html
[13] https://www.washingtonpost.com/business/economy/white-house-seeks-72-percent-cut-to-clean-energy-research-underscoring-administrations-preference-for-fossil-fuelsv/2018/01/31/c2c69350-05f3-11e8-b48c-b07fea957bd5_story.html?utm_term=.3c6710c00958
[14] http://programs.dsireusa.org/system/program/detail/1060

Development department. There are also incentives available through the Department of Energy (DOE) from time to time.

Applicable incentives on federal level that may be relevant for smart grids include:

Rural Energy for America Program (REAP) Energy Audit & Renewable Energy Development Assistance Grants	
Description:	Grants are provided to applicants to support energy audits, renewable energy technical assistance, and/or renewable energy site assessments
Who can apply:	State government entities, federally recognized tribes, colleges/universities, rural electric cooperatives, public power entities, or instrumentalities of a state or tribe
***How to apply*:**	Visit the USDA page for application details[15]
Electric Infrastructure Loan & Loan Guarantee Program	
Description:	Loans or loan guarantees are provided to support the development of generation, transmission, or distribution facilities in rural areas
Who can apply:	State government entities, federally recognized tribes, or any for-profit business
***How to apply*:**	Visit the USDA page for application details[16]
Distributed Generation Energy Project Financing	
Description:	Loans or loan guarantees are provided to support the development of distributed energy projects, including those from renewable resources
Who can apply:	Energy project developers or rural utilities
***How to apply*:**	Visit the USDA page for application details[17]
Note:	The last solicitation for this funding occurred in 2015, and it is unclear when the next solicitation will occur

Table 2: Rural Energy for America Program (REAP) Energy Audit & Renewable Energy Development Assistance Grants

[15] https://www.rd.usda.gov/programs-services/rural-energy-america-program-energy-audit-renewable-energy-development-assistance
[16] https://www.rd.usda.gov/programs-services/electric-infrastructure-loan-loan-guarantee-program
[17] https://www.rd.usda.gov/programs-services/distributed-generation-energy-project-financing

Title XVII Renewable Energy & Efficient Energy Projects Solicitation	
Description:	Loan guarantees to support the development of broad renewable generation facilities, distributed energy infrastructure, and electric vehicle charging infrastructure
Who can apply:	Any entity
***How to apply*:**	Visit the DOE page for application details[18]
Note:	This broad solicitation will remain open indefinitely, until the diminishment of funds, or until support is revoked by the standing administration[19]
Denali Commission High Energy Cost Grants	
Description:	Grants are provided to support the lowering of electricity costs in high per-household energy costs through generation, transmission, and/or distribution initiatives
Who can apply:	Any company, individual or group of individuals
***How to apply*:**	Visit the USDA page for application details[20]
Note:	The last solicitation for this funding occurred in 2015, and it is unclear when the next solicitation will occur

Table 3: Title XVII Renewable Energy & Efficient Energy Project Solicitation

Federal financial incentive mechanisms are suited for supporting energy change across all sectors. Foreign market players should be able to participate in the projects associated with these regulations with no penalty. However, their role will primarily be as support agents, since many financial incentives are applicable only to U.S.-based organizations. With regard to this, the federal regulations may probably not offer major opportunities for Swedish SMEs.

3.2 State level regulations

State-level regulations related to smart grid development are of much more relevance to Swedish SMEs. Some of these regulations stem from a national entity, the Federal Energy Regulatory Committee (FERC), but are limited in scope to interstate transmission. FERC is primarily ensuring the mechanics of these transmission systems conform to specific standards, rather than providing legislation to promote development.

The majority of state-level regulations are instituted by each state's Public Utilities Commission or similar entity. Regulations are similar to those of FERC

[18] https://energy.gov/lpo/title-xvii/title-xvii-application-portal
[19] https://energy.gov/lpo/services/solicitations/renewable-energy-efficient-energy-projects-solicitation
[20] https://www.rd.usda.gov/programs-services/denali-commission-high-energy-cost-grants

– establishing standards to ensure uniform development quality in the transmission systems. In general, state-driven policies on concepts like net metering and renewable portfolio standards (RPS) are providing incentives to support renewable generation and to adopt smart grid technologies[21]. RPSs set minimum amounts of renewable energy generation that regulated utilities must source; special electric rate schedules; data standards; and advanced meter infrastructure mandates.

The adoption of advanced metering has proven how incentives and policies can be successful in driving change. Almost half of all U.S. electricity customers now own smart meters, totaling around 71 million total installations[22]. The Energy Information Administration stated that “differences in smart meter penetration rates are often driven by state legislation and regulation” further driving home the point that states are in the driving seat, with some states more driven than others.

The lack of uniformity in regional- and state-level regulation however exacerbates the existing discrepancy in standardized adoption of smart grid technologies across the U.S. and SMEs will need to understand what is important for each state within their smart grid space. SMEs should look for states with legislation and regulation promoting smart grid development.

An overview of regulation in the five selected states in this report follows below.

3.2.1 California

California operates a hybrid regulated/deregulated energy market. Although the system is nominally deregulated, some of the "rules" of deregulation do not apply. For instance, the major investor owned utilities (IOUs) within the state own the generation and transmission infrastructure connected to their utility markets. In addition, most consumers do not have access to a competitive market for their electricity purchases, and instead must accept electricity from their local utility. However, some elements of deregulation still apply. For instance, the state operates a wholesale power market with generation stemming from a mixture of IOUs, large private electric providers, and other independent power producers. Residential and commercial customers have limited access to this market, particularly for renewable generation and natural gas[23,24].

[21] https://www.energy.gov/sites/prod/files/2017/01/f34/Electricity%20End%20Uses,%20Energy%20Efficiency,%20and%20Distributed%20Energy%20Resources.pdf
[22] https://www.eia.gov/todayinenergy/detail.php?id=34012
[23] https://www.saveonenergy.com/California/
[24] http://infocastinc.com/insights/solar/regulated-deregulated-energy-markets/

The majority of California falls within the operating area of the California Independent System Operator (CAISO). As an ISO, CAISO is in charge of operating the wholesale electricity market for the state's electricity purchasers, in addition to undertaking long-term planning for and management of the transmission grid's reliability. CAISO also functions as an "air traffic controller" for the state's transmission infrastructure[25].

California's state-level governmental regulatory organization related to energy is the California Energy Commission (CEC). Its rate-setting counterpart is the California Public Utilities Commission (CPUC). Together these organizations provide regulatory oversight for the state's utilities and other energy stakeholders. Within CAISO's oversight, CPUC is in charge of regulating the rates and operations of the utilities within its jurisdiction. For several decades, the predominant function of the CPUC was to monitor and regulate the investor-owned utilities (IOU) that served around 75% of Californians' energy needs. The remaining 25% of the load has historically been managed by publicly owned utilities (POU), such as municipal utilities. Due to a number of factors, such as state-issued renewable energy generation goals and widespread subsidization of customer-side generation like solar, it is predicted that IOU-generated retail load could drop by 85% over the next 10 years. This represents a fundamental shift in the manner in which the state's electricity market will be run, and the demarcation of future oversight responsibilities remains unclear.

The proliferation of behind-the-meter and other distributed generation systems, in addition to the rise of community choice aggregation (CCA), has created the need for an increasingly deregulated market structure, without abandoning the centralized planning and management that has helped California's energy system evolve into the reliable system that it is today. It is likely that California's grid will continue to bend towards deregulation moving forward, as the various players work to integrate aggressive GHG emission, renewable energy generation, and energy efficiency policies.

This structural development is a double-edged sword: although it clearly creates opportunities for third-party providers, particularly within distributed energy resources (DERs) and grid management, it signals an impending regulatory destabilization that could negatively impact the high-capital, high-risk investments required for this sort of development.

3.2.2 New York

New York operates a primarily deregulated gas and electricity market. Transmission, end distribution, and maintenance of these systems is handled

[25] http://www.energy.ca.gov/commission/fact_sheets/documents/Fact_Sheet_California_Energy_Governing_Institutions.pdf

by the state's six IOUs, but customers have access to an open market of electricity providers known as "energy service companies" (ESCO). Generation is provided by a number of independent power producers. Unique to New York is the New York Power Authority (NYPA), a state-run public power organization with generation, transmission and distribution capabilities, primarily for commercial and government end-use[26].

The primary entity in charge of regulating the state's utilities is the Department of Public Service (DPS; aka the Public Service Commission, PSC)[27]. DPS provides dispute resolution services for end consumers, in addition to overseeing policy development for numerous public service related activities.

3.2.3 Massachusetts

Like California, Massachusetts operates a mostly deregulated electricity market. End delivery of electricity occurs via one of the commonwealth's local electric utilities, which own the distribution infrastructure; however, residents have access to a competitive market for the supply of their electricity[28].

The primary agency for developing energy-related policy within the commonwealth is the Department of Energy Resources (DOER) [29]. DOER's primary tasks include overseeing the implementation of cost-effective energy efficiency measures, fostering the development and availability of renewable energy resources, and fostering energy strategies that ensure reliable supply for the commonwealth. DOER works alongside the Department of Public Utilities (DPU), which among other tasks, is the rate-setting agency for IOUs.

Massachusetts falls within the purview of ISO New England (ISO-NE)[30]. ISO-NE regulates power plants providing *wholesale* supply of electricity, as well as transmission facilities[31]. Within the oversight of ISO-NE, DPU then regulates retail electricity supply operations (for both competitive suppliers and electric utilities), as well as retail delivery services and metering facilities.

3.2.4 Minnesota

Minnesota operates a fully regulated gas and electricity market. Minnesota residents have access to three primary IOUs for their electricity distribution needs (Minnesota Power, Otter Tail Power Company, and Xcel Energy), as well as very limited service from a fourth (Northwester Wisconsin Electric Company). These utilities also own the transmission and generation infrastructure. In addition, a large proportion of the state is covered by

[26] https://www.nypa.gov/
[27] http://www.dps.ny.gov/
[28] https://www.mass.gov/service-details/electric-service-overview
[29] https://www.mass.gov/about-doer
[30] https://www.iso-ne.com/
[31] https://www.mass.gov/service-details/electric-service-overview

municipal or cooperative electric service providers[32]. These cooperatives receive their electricity almost wholly via Great River Energy, a "cooperative of cooperatives"[33].

There are two primary entities in charge of regulating the state's energy market. The Minnesota Public Utilities Commission[34] is the main regulatory entity, performing rate setting, energy resource planning, M&A guidance, and complaint management for all electric utilities. In addition, the commission oversees all siting, routing, and permitting for both electric generation and electric transmission facilities within the state.

The Department of Commerce is the other entity involved with the energy market, functioning primarily as a research and technical assistance arm for the PUC[35].

3.2.5 Texas

Texas operates a nearly fully deregulated gas and electricity market, with around 90% of consumers having access to an open electricity provision market.[36] Electricity generation and transmission is provided by a significant number of utilities; most Texas residents then have access to an open market of retail electric providers (REP) for their electricity provisioning services[37]. Like other partially deregulated states, the state's five major IOUs still provide end-distribution services for all state residents.

The vast majority of Texas falls within the administrative service area of the Energy Reliability Council of Texas (ERCOT)[38], an ISO performing the operational, managerial, and monitoring tasks typical of ISOs nationally. The Public Utility Commission of Texas (PUCT)[39] is the only regulatory body overseeing electric generation and distribution in the state.

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[32] http://minnesota.maps.arcgis.com/apps/webappviewer/index.html?id=95ae13000e0b4d53a793423df1176514/

[33] http://greatriverenergy.com/we-are-a-cooperative/the-cooperative-difference/our-28-members/

[34] https://mn.gov/puc/about-us/

[35] https://mn.gov/commerce/industries/energy/

[36] https://www.electricchoice.com/tx/

[37] http://www.powertochoose.org/scorecard/Scorecard.pdf

[38] http://www.ercot.com/

[39] http://www.puc.texas.gov/

4 Commercial and political development

There are very few public stakeholders on the federal level that are directly involved with the implementation of smart grid solutions. The federal entities that are involved are almost exclusively providing judgment on siting applications for projects that affect multiple states such as FERC. Other federal entities that engage in grid development projects include the Department of Energy (DOE), as well as some of its sub-agencies such as the Office of Energy Efficiency and Renewable energy; the Department of Agriculture (USDA); the National Renewable Energy Laboratory (NREL); and the Department of Homeland Security (DHS).

The U.S. government also invests heavily into research and federal funding is provided to national laboratories across the U.S., research institutes and universities. The National Renewable Energy Laboratory is an example of one such research laboratory that conducts a wide variety of research across topics such as: renewable energy and grid integration, microgrids, smart homes, energy storage, and demand response. Universities also have dedicated research centers, such as University of California Los Angeles (UCLA), which operates a Smart Grid Energy Research Center and is dedicated to engineering solutions related to the new electricity grid.

One resource that summarizes previous federal involvement in smart grid activities can be found at the U.S. Smart Grid website[40]. This site pools information from the various federal agencies aligned with smart grid, including various initiatives and some future opportunities.

The states have a large degree of leeway to shape their energy policies and essentially all smart grid development is currently occurring on a state level. The large majority of smart grid developments are implemented by the various utilities within the state, both public and private. In regulated states, regulated utilities typically finance their investments through rate increases, which must be approved by utility commissions. In deregulated states, utilities finance their investments through typical project finance mechanisms like bank-backed debt. This is particularly true for renewable generation infrastructure, which tends to be constructed by non-regulated, private entities.

In many cases, generation assets are paid for through power purchase agreements (PPA) which are contractual agreements that support asset repayment structures backed by banks. In exchange for guaranteed power delivery to utilities or other large customers over 20-30 year windows, generation developers receive up-front project financing. PPAs are the primary financing mechanism for utility-scale generation construction. For residential-scale generation, projects are sometimes financed through “feed-

[40] https://www.smartgrid.gov/

in-tariffs," in which electricity is paid for by utilities when it enters the broad grid. In addition, many states offer rebates for commercial- and residential-scale renewable energy installations, paid for by state government funds.

Outside of generation asset development, projects like zero-emission vehicle charging infrastructure are generally supported through state government rebates. Projects that are typically the realm of regulated utilities, such as advanced metering infrastructure (AMI) implementation or demand management programs, are funded through rate adjustments or other internal profit-sharing mechanisms.

The private sector is also a driver for smart grid deployment. The majority of private-sector development within the smart grid sector centers on renewable generation, implementation and integration. In addition to being the primary owners of utility-scale generation assets, private developers and organizations are also essentially the only mechanism driving implementation of commercial- and residential scale generation, such as rooftop solar. Beyond this, private companies are driving implementation of smart grid technology on a smaller, less organized scale. For example, companies like Tesla Motors have been major drivers of the implementation of zero-emission vehicle charging infrastructure. Although Tesla receives rebates and rate incentives for these assets, the primary driver for their implementation is to support sales of their electric vehicles.

Another area in which private companies are driving smart grid development is within the customer-side software. There are a number of companies providing software solutions supporting demand management, appliance integration, and efficiency auditing, among many others. Utilities providing end-consumer services are adopting some of this technology to provide to their customers, in addition to help manage their internal systems. As software solutions become increasingly integral for efficient operations, it is likely that utilities will continue to seek out the services of these private providers, in addition to upgrading their infrastructure to fully maximize the software's effectiveness.

4.1 Commercial and political development in the five focus states

Every state has a different approach for commercial and policy development.

4.1.1 California

California's energy is primarily generated in-state; nearly 50% of this in-state generation comes from natural gas sources, with renewables providing an additional 28%[41]. 41% of this generation comes from electric utilities (including investor-owned utilities, IOUs), with the remaining 59% generated by

[41] http://www.energy.ca.gov/almanac/electricity_data/total_system_power.html

independent power producers[42]. California has experienced an explosion of renewable generation over the last 5-10 years, creating specific challenges for grid management and distributed energy resources integration. Swedish providers can look to capitalize on this development.

Table 4 Utilities central for grid development in California

Generation Owners	**Many IOUs, Munis, Coops, and IPPs[43]**
Transmission Owners	WAPA; Select Utilities – Imperial Irrigation District; LA Department of Water & Power; Pacificorp; PG&E; Southern California Edison; San Diego Gas & Electric; Sacramento Municipal Utility District[44]
Distribution Owners	Load-Serving Entities – incl. many IOUs, Munis, Coops, CCAs, and IPPs[45]

California is a signatory to the Governors' Accord for a New Energy Future. Within this accord, participant states have made a pledge focused on 6 areas:

- Planning for an energy transition
- Diversifying energy generation
- Expanding clean energy sources
- Modernizing energy infrastructure
- Encouraging clean transportation
- Working collaboratively with other signatory states

Participation in the accord is not a guarantee of future political action, but it is a strong indicator of the state's commitment to implementing an improved, cleaner grid. Governor Brown also signed an agreement with the Chinese Minister of Science and Technology focused on a collaborative implementation of pre-commercial and implementation-ready low-carbon technologies[46]. California and Sweden have a Letter of Cooperation which was signed in 2017 and relates to the field of climate change. Through this initiative, Sweden and California hope to support the efforts of states and cities to share ideas and best practices on how to reduce greenhouse gases and promote the development of renewable energy. Research and innovation are identified as the key areas to further develop existing cooperation.

[42] https://www.eia.gov/electricity/state/california/index.php
[43] http://www.energy.ca.gov/almanac/electricity_data/web_qfer/
[44] http://www.energy.ca.gov/maps/infrastructure/transmission_lines.html
[45] http://www.energy.ca.gov/almanac/electricity_data/utilities.html
[46] https://www.gov.ca.gov/wp-content/uploads/2017/09/6.5.17_Jiangsu_MOU.pdf

California is also a signatory to the U.S. Climate Alliance, a collection of 17 states and territories committed to upholding the tenets of the Paris Accord, from which the U.S. withdrew in accordance with President Trump's strategic directive.

California's 2017 Integrated Energy Policy provides strategic direction for the energy policy for the next several years[47]. This document emphasizes a number of topics directly aligned with smart grid developments, including GHG emission reduction, distributed energy resources, transportation electrification, and demand response. The Integrated Energy Policy is based on Senate Bill 350, a document that codifies the implementation of several clean energy practices into the California legislature, including an increase to 50% renewable generation, a reduction of petroleum use for transportation by 50%, and a doubling of energy efficiency within buildings by 2030[48].

California's Renewable Portfolio Standard (RPS), overseen by the CPUC, creates a mandate for renewable energy procurement within the state. IOUs, ESPs, and CCAs are all required to work toward the state's goals of 33% total renewable procurement by 2020[49] and 50% total renewable procurement by 2030[50]. IOUs within the state are largely already on track for their renewable generation, or indeed, in some cases have already surpassed the target[51]. However, the continued presence of the RPS creates an incentive for these utilities to invest in the infrastructure surrounding renewable implementation, including distributed energy resources, advanced metering infrastructure, demand management, and wide area monitoring.

As detailed above, the California Energy Commission (CEC) is California's primary policy and planning agency for energy. CEC maintains a list of active solicitations[52]. Similarly, the California Public Utilities Commission (CPUC) is California's primary regulatory agency for electricity. CPUC does not maintain a list of active solicitations, but there is a detailed description of the RFO procedure available[53]. Finally, California ISO (CAISO) oversees grid reliability for the majority of California. CAISO also does not maintain a list of active solicitations, but there is detailed information available for 3rd parties hoping to enter the market[54].

For Swedish providers, a relationship with all three of these stakeholders is imperative for success within the market. Although opportunities may not be

[47] http://www.energy.ca.gov/2017_energypolicy/
[48] https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB350
[49] http://www.cpuc.ca.gov/RPS_Overview/
[50] http://docketpublic.energy.ca.gov/PublicDocuments/17-IEPR-01/TN222377_20180126T144311_Proposed_Final_2017_Integrated_Energy_Policy_Report_Clean_Versi.pdf
[51] http://www.cpuc.ca.gov/RPS_Homepage/
[52] http://www.energy.ca.gov/contracts/#current
[53] http://cpuc.ca.gov/Utility_Scale_RFO/
[54] http://www.caiso.com/participate/Pages/default.aspx

provided directly by the entity, their connections and understanding of market needs is fundamental for identifying and securing the opportunities that are available.

California is a large, wealthy state characterized by a very high state-level support of grid modernization and increased renewables integration. There is a historic precedent supporting implementation of new infrastructure, in addition to clear signals from both the State and the regulatory bodies suggesting this is the continued path forward.

There are however a few issues to consider in California. First, there is a relatively unclear future outlook for the regulated/deregulated nature of the state. Relatedly, the roles of the major regulatory bodies moving forward are in flux, especially as energy becomes increasingly distributed. As a result, there are unclear revenue structures for IOUs with increasingly distributed energy generation – a potential indicator of market instability. Finally, as California is undoubtedly the nation's most prominent and popular location for forward-looking, environmentally friendly technology there are many incumbent providers within the state, all vying for the same limited number of tenders and RFPs – Swedish providers will need to ensure they are positioning themselves strongly if they wish to be taken seriously.

4.1.2 New York

End-use electricity consumed within New York comes primarily from a mixture of natural gas-fired (35%) and nuclear (33%) sources[55]. Renewables provided an additional 28% of the end-load, but 83% of this came from hydroelectric sources. The state's IOUs generated approximately 26% of this load, with the remaining 74% coming from IPPs[56]. Moving forward, it is anticipated that a substantially increasing proportion of New York's generation load will come from behind-the-meter assets. As such, the state is actively looking for ways to manage these distributed resources, a clear opportunity for Swedish providers.

[55] https://www.eia.gov/state/?sid=NY#tabs-4
[56] https://www.eia.gov/electricity/state/NewYork/

Table 5 Utilities central for grid development in New York

Generation Owners	IPPs (many); New York Power Authority (NYPA)
Transmission Owners	IOUs – Consolidated Edison, Orange & Rockland Utilities, Central Hudson Gas & Electric, Rochester Gas & Electric, Long Island Power Authority, New York State Electric & Gas, and National Grid; NYPA
Distribution Owners	IOUs – same as above; NYPA

New York is also a signatory to the Governors' Accord for a New Energy Future, providing the forward-looking signals of grid development that this entails. In addition, Governor Cuomo was a key driver of New York's 2015 State Energy Plan[57]. This coordinating document provided a roadmap for the state's various agencies to meet aggressive clean energy goals by 2030, including a 40% reduction in GHG emissions, a shift to 50% renewable electricity, and 600 trillion Btu increase in energy efficiency. As part of this initiative, all coal-based power plants are slated to be shut down by 2020.

As a mechanism for implementing these goals, Governor Cuomo also initiated the Reforming the Energy Vision (REV) program[58]. REV details a clear and comprehensive strategy for the state, including a number of projects and initiatives directly aligned with the Energy Plan goals. These projects are detailed below. Importantly, the REV also calls for a complete overhaul of the state's utility structure. The PSC aims to have utilities become local organizers of distributed energy resources (DERs), providing tariffs, operational structures, purchasing & aggregation services, and operational infrastructure[59]. The ultimate goal is to facilitate an open market for 3rd-party providers of behind-the-meter services, supported by a utility-managed network of DERs. Swedish providers are highly encouraged to begin participation as soon as possible by connecting with DPS.

New York is the state that does the best job of clearly structuring and organizing its many ongoing development initiatives. Those deemed relevant for Swedish SMEs are outlined below, but curious readers may also investigate the 2015 Energy Plan or the 2017 Biennial Report directly[60].

As part of New York's REV, Governor Cuomo implemented a zero emission vehicle (ZEV) sales mandate, requiring the sale of between 800,000 and 1,000,000 ZEVs by 2025. In support of this, the Charge NY initiative aims to

[57] https://energyplan.ny.gov/
[58] https://rev.ny.gov/
[59] https://www.greentechmedia.com/articles/read/new-york-launches-major-regulatory-reform-for-utilities#gs.K4IJmlc
[60] https://energyplan.ny.gov/

support broad ZEV adoption within the state[61]. In addition to providing $5,000 rebates for ZEV purchases, it also provides $250,000 for EV charging infrastructure development, provided it is for public use. NYPA will continue to offer financing and installation services to four as-yet-unchosen municipalities to support the development of 68 charging stations[62].

In-depth data regarding the state of the charging infrastructure within the state is available via NREL and its Alternative Fuels Data Center[63].

The Energy Highway initiative, implemented in 2012, focused on upgrading and modernizing New York's transmission infrastructure[64]. Although all RFIs closed several years ago, the program is slated to continue, with ongoing evaluation of upgrade opportunities, particularly around the reduction of congestion stemming from high demand. Recently, Governor Cuomo announced a USD $24 million investment into transmission upgrades[65]. Swedish providers of transmission technology should connect with NYPA directly to discuss future opportunities for collaboration.

June 2017 saw the largest renewable energy solicitation ever by a state, with projects selected in early 2018 being developed for a total of USD 1.4 billion[66]. A follow-up solicitation is expected to occur on 25th April, 2018, which will include provisions for 1.5 GW of energy storage.

NY-Sun is an initiative designed to increase customer-side access to solar generation technology[67]. Based on current completion of Energy Plan goals, the ongoing activities of the program primarily include facilitating increased renewable consumption at state agencies and state universities. The K-Solar initiative is yet another Energy Plan project that aims to support solar implementation at New York elementary, middle, and high schools[68]. The program's next steps include a doubling of the annual investments into solar and energy efficiency by NYPA to USD $300 million, to support the installation of 125 MW of solar generation. Swedish providers with applicable technology should connect with NYPA, as they are structuring the PPAs supporting this program[69].

The Reducing Barriers to Distributed Energy Storage Deployment initiative seeks to reduce the so-called "soft costs" undermining effective and efficient DER storage. The state's IOUs are required to have installed at least two

[61] https://www.nyserda.ny.gov/All-Programs/Programs/ChargeNY
[62] https://www.nypa.gov/innovation/programs/chargeny
[63] https://www.afdc.energy.gov/states/ny
[64] http://www.nyenergyhighway.com/
[65] https://www.governor.ny.gov/news/governor-cuomo-announces-24-million-investment-advance-statewide-transmission-system
[66] https://solarindustrymag.com/new-york-makes-historic-investment-in-renewable-energy
[67] https://www.nyserda.ny.gov/All-Programs/Programs/NY-Sun
[68] https://www.nypa.gov/innovation/programs/k-solar
[69] https://www.nypa.gov/procurement

energy storage projects at substations in their service area by the end of 2018. Relatedly, the Energy Storage R&D and Commercialization initiative is currently offering funds for technologies and business models related to DER storage. Swedish providers can participate in either initiative by collaborating with the New York Battery and Energy Storage Technology Consortium[70].

New York stands out for the many, very clearly delineated initiatives in place surrounding smart grid development. Bolstered by strong governmental support, the Energy Plan and associated REV should continue to drive smart grid technology implementation for the foreseeable future. In particular, the wide array of DER-related projects offer 3rd-party providers many opportunities for local engagement. Supporting this, the forthcoming realignment of utility to support DERs provides additional opportunities for customer-side providers and DER management providers alike. Further opportunities within ZEV charging and transmission enhancement make New York a top choice for diverse Swedish organizations.

Like any large and progressive state, New York provides many opportunities but also many challenges, mainly related to competition. Furthermore, the size of New York City and surrounding cities require vendors to have the ability to offer solutions that can be implemented on a fairly large scale, at least when compared to what is being offered in Sweden. A strong local presence is almost required in order to gain any traction with the major customers in this state.

4.1.3 Massachusetts

The commonwealth's[71] primary mechanism for electricity generation is natural gas, with about 75% of all end-use electricity coming from natural-gas fired power plants[72]. Of the electricity generated within the state, only 7% comes from electric utilities (including IOUs), with the remaining 93% coming from independent power producers[73]. Massachusetts has recently passed legislation supporting large-scale implementation of off-shore wind generation assets, in an attempt to increase regulated utilities' generation resiliency. Swedish providers aligned with this goal have a great opportunity to engage with these regulated entities; other generation-level partnerships will almost exclusively be with private sector power producers.

[70] https://www.ny-best.org/
[71] Note that Massachusetts is technically a commonwealth, not a state, and so will be referred to as such throughout the report
[72] https://www.eia.gov/state/?sid=MA#tabs-4
[73] https://www.eia.gov/electricity/state/massachusetts/index.php

Table 6 Utilities central for grid development in Massachusetts

Generation Owners	**Many IPPs; IOUs (only National Grid)**
Transmission Owners	Many IPPs; IOUs (Eversource; National Grid; Unitil)
Distribution Owners	Retail Electricity Suppliers (Eversource; National Grid; Unitil; Many Munis)

Like Governor Brown in California, Massachusetts governor Charlie Baker is a signatory to the Governors' Accord for a New Energy Future. Beyond this, Governor Baker has been a key driver of major legislative changes that support the modernization of the energy infrastructure within Massachusetts, including sweeping energy diversity legislation signed into effect in 2016[74]. Massachusetts first instituted their renewable portfolio standard (RPS) in 2002[75]. The bill requires electric utilities to ensure 15% of their generated load comes from a renewable source by 2020, with an additional requirement to increase this by 1% each year thereafter[76].

A new solar "carve-out" was implemented in 2010, which facilitated the development of 650MW of solar generation in the state[77]. This carve-out was updated in 2014 to support an additional 1,600MW capacity. This update will be further supplemented by the development of the Solar Massachusetts Renewable Target (SMART) program, which is scheduled to be implemented in 2018.

In 2016, Governor Baker signed into effect An Act Relative to Energy Diversity[78]. This bill had the goal of increasing the procurement of both on-shore and off-shore renewable energy. Electric utilities were mandated to competitively solicit 1200 MW of on-shore energy, with an emphasis on hydropower, as well as 1600 MW of offshore wind generation. In addition, the bill created Property Assessed Clean Energy (PACE), a tool that offers commercial & industrial facility owners' tax abatements in return for upgrading on-site renewable generation.

The Energy Storage Initiative is a program, signed into legislation in 2015, which funded research into the potential for energy storage infrastructure development within the commonwealth[79]. As a follow up to the Energy Storage Initiative, the Energy Storage Target was announced as part of the commonwealth's Act Relative to Energy Diversity in 2016[80]. This amendment

[74] https://www.mass.gov/news/governor-baker-signs-comprehensive-energy-diversity-legislation
[75] https://www.mass.gov/service-details/statutes-regulations-and-guidelines
[76] http://programs.dsireusa.org/system/program/detail/479
[77] https://www.mass.gov/service-details/program-summaries
[78] https://www.mass.gov/news/governor-baker-signs-comprehensive-energy-diversity-legislation
[79] https://www.mass.gov/energy-storage-initiative
[80] https://www.mass.gov/service-details/energy-storage-target

requires electricity distribution companies to work towards implementing 200MWh of energy storage capacity by 2020. As a result of these two bills, in late 2017, the program supported 26 energy storage projects for a total of 20MUSD, via the Advancing Commonwealth Energy Storage (ACES) program[81].

In addition, the commonwealth's large utilities have included distribution grid management strategies in their Grid Modernization Plans. These plans, mandated by the commonwealth in 2013[82], provide a strategic direction for the utilities with regard to asset implementation, infrastructure development, and subsequently required rate changes to cover these costs. The specifics of these plans can be viewed via the Eversource[83], National Grid[84], and Unitil[85] Grid Modernization Plans.

The large utilities' Grid Modernization Plans do not mandate the implementation of advanced metering infrastructure (AMI), but they do create a platform that encourages and incentivizes the utilities to consider AMI as a component of their modernization strategy. Thus far, two IOUs have implemented some form of AMI implementation. National Grid, as part of its Smart Energy Solutions program, has installed around 15,000 smart meters within the city of Worcester, MA[86]. The IOU also has estimated a total installation of 50,000 smart meters by 2020, as part of their grid modernization plan[87]. Unitil has installed around 100,000 smart meters, split between Fitchburg, MA and Concord, NH[88]. This achieves their goal for AMI installations by 2020.

The Massachusetts legislature has enacted a goal to have 300,000 zero-emission vehicles on the road by 2025. In support of this goal, the Governor signed into effect An Act Promoting Zero Emission Vehicle Adoption in early 2017[89]. This act has four primary components:

1. Public charging station owners are prohibited from utilizing subscription/membership fee structures

[81] https://www.mass.gov/news/baker-polito-administration-awards-20-million-for-energy-storage-projects
[82] https://www.greentechmedia.com/articles/read/massachusetts-makes-smart-grid-mandatory#gs.Tn2FERQ
[83] https://www.eversource.com/content/docs/default-source/rates-tariffs/2017-rate-case--revenue-requirements-testimony.pdf
[84] http://170.63.40.34/DPU/FileRoomAPI/api/Attachments/Get/?path=15-120%2fNGrid_initial_brief_72817.pdf
[85] http://170.63.40.34/DPU/FileRoomAPI/api/Attachments/Get/?path=15-121%2fUnitil_GMP_Report_81915.pdf
[86] https://www.nationalgridus.com/MA-Home/Smart-Energy-Solutions/FAQs
[87] http://www.edisonfoundation.net/iei/publications/Documents/IEI_Smart%20Meter%20Report%202017_FINAL.pdf
[88] http://www.edisonfoundation.net/iei/publications/documents/final%20electric%20company%20smart%20meter%20deployments-%20foundation%20for%20a%20smart%20energy%20grid.pdf
[89] An Act promoting zero emission vehicle adoption

2. Allows municipalities and private businesses to restrict parking spaces for zero-emission vehicles
3. Charges the Board of Building Regulations and Standards to establish regulations for residential- and commercial-based charging infrastructure
4. Incentivizes electric distribution companies to create RFPs for the creation of publicly available charging infrastructure

In-depth data regarding the state of the charging infrastructure within the state is available via NREL and its Alternative Fuels Data Center[90].

In addition to the commonwealth's regulatory bodies, there are many municipal providers that are attractive outreach targets. The Massachusetts Municipal Wholesale Electric Company (MMWEC) is an overarching organization that provides financing, resource planning, development, and compliance services for the commonwealth's municipal utilities. Swedish providers can use this entity as a first stop before reaching out to the commonwealth's many municipally owned electric companies[91].

The Massachusetts Clean Energy Center (MassCEC) offers an interesting alternative to the obvious fully private or public stakeholders within the commonwealth. A quasi-public development agency, MassCEC focuses on accelerating clean energy growth by providing research-driven innovation, connecting relevant stakeholders, and investing in programs that support this development. In addition to being a core, useful resource for Swedish providers looking to build relationships within Massachusetts, MassCEC also maintains a list of active solicitations to pursue[92].

Massachusetts has three IOUs that provide end-distribution service to the substantial majority of the state's residents. Each IOU will have opportunities directly available, based in part on its resource plan. As public-facing utilities directly regulated by CPUC, these organizations are typically open for meetings with 3rd-party providers.

In addition to the utility providers, there are a couple of private support organizations operating in the region. First, the Northeast Energy Efficiency Partnerships (NEEP) is a non-profit providing services and information to support market transformation within energy efficiency. Their primary activities focus on research support & propagation, in addition to relationship building. They also maintain a limited list of active solicitations[93].

[90] https://www.afdc.energy.gov/states/ma
[91] https://www.mass.gov/service-details/massachusetts-municipally-owned-electric-companies
[92] http://www.masscec.com/active-solicitations
[93] http://www.neep.org/about-neep/requests-proposals

Next, the Massachusetts Public Interest Research Group (MASSPIRG) is a consumer advocacy group. The organization's Campaign for Safe Energy provides advocacy for electric generation and provision that does not rely on what it believes to be unsafe sources, such as coal or nuclear materials. MASSPIRG does not maintain a list of active solicitations, but they do sponsor research on EVs that may be of interest[94].

A disadvantage with Massachusetts is that the commonwealth has experienced relatively small adoption of AMI. This indicates demand-side challenges for broader technology implementation related to the smart grid. In addition, a high reliance on (and preference for) natural gas generation limits the potential for renewable development.

4.1.4 Minnesota

End-use electricity consumed within Minnesota is primarily coal-fired (44%), with non-hydro renewables and nuclear sources combined providing another 42% of end-use electricity95. Approximately 81% of net generation stemmed from IOU-owned generation facilities, with the remaining 19% coming from IPPs96. Swedish participation on the generation level will primarily be with the vertically integrated, fully regulated entities.

Table 7 Utilities central for grid development in Minnesota

Generation Owners	**Great River Energy; Minnesota Power; Otter Tail Power Company; Xcel Energy**
Transmission Owners	Great River Energy; Minnesota Power; Otter Tail Power Company; Xcel Energy
Distribution Owners	Minnesota Power; Otter Tail Power Company; Xcel Energy; Northwestern Wisconsin Electric Company; Many Munis & Coops[97]

Governor Mark Dayton is also a signatory to the Governors' Accord for a New Energy Future, signaling a strong intent to support grid modernization actions. Minnesota's 2025 Action Plan[98], funded by the US Department of Energy, aims to identify strategies to support the development of a "clean, reliable, resilient, and affordable energy system." Within the plan there are numerous identified policies in place supporting various mechanisms underlying this clean and reliable system, including renewable energy goals and renewable portfolio standards.

[94] https://masspirg.org/reports/map/plugging-readying-americas-cities-arrival-electric-vehicles
[95] https://www.eia.gov/state/?sid=MN#tabs-4
[96] https://www.eia.gov/electricity/state/Minnesota/
[97] https://mn.gov/puc/consumers/help/utility/
[98] http://mn.gov/commerce-stat/pdfs/mn-e2025-finalreport.pdf

The state Renewable Energy Goal calls for 25% of the total energy used in the state to be renewable in nature by 2025 which is an increase from current generation levels. In addition, the state maintains a Renewable Portfolio Standard for the various utilities within the state[99]. Xcel Energy, the state's largest IOU, faces the toughest requirements, with 30% renewables and an additional 1.5% solar carve out required by 2020. Other public utilities must meet an "easier" 25% + 1.5% requirement by 2025. The 2025 Action Plan also identifies various strategies that can be implemented outside of these policy structures. Applicable strategies have been indicated within the smart grid definition areas below.

The 2025 Action Plan broadly calls for the expansion and improvement of utility green energy options. One initiative of note is the Minnesota Community Solar program, which allows communities to participate in communal solar gardens[100]. There are also a number of renewable energy incentives to explore, available via the DSIRE website[101].

The Staff Report on Grid Modernization covers transmission enhancement in depth, but has no specific opportunities to note.

The 2025 Action Plan calls for the integration of storage and demand response systems by utilities, but there are no specific initiatives to note.

The 2025 Action Plan calls for the deployment of AMI, including the enabling of smart inverter functionality and implementing time-based rates. However, there are no specific initiatives to note.

The 2025 Action Plan has four strategies related to electric vehicles:

- Increase adoption of personal electric vehicles
- Electrify fleet vehicles
- Electrify buses
- Increase adoption of alternative-fuel heavy-duty vehicles.

In-depth data regarding the state of the charging infrastructure within the state is available via NREL and its Alternative Fuels Data Center[102].

Drive Electric Minnesota[103] is a program sponsored by the Great Plains Institute, a non-profit focused on energy issues. It works to champion EV deployment and charging infrastructure development. There are no identified

[99] https://www.revisor.mn.gov/statutes/?id=216b.1691
[100] http://mncommunitysolar.com/
[101] http://programs.dsireusa.org/system/program
[102] https://www.afdc.energy.gov/states/ca
[103] http://www.driveelectricmn.org/

opportunities being offered by the program at the moment, but a relationship with the program would be advisable for EV charging infrastructure providers.

The electric vehicle charging tariff, instituted by the PUC, mandates utilities to offer a tariff for EV owners with incentives for time-of-day or off-peak usage. The three primary IOUs active in the state maintain information about EVs and charging infrastructure. However, there are no clear opportunities to note.

Minnesota's two regulatory bodies are a good starting place for Swedish providers interested in entering the state. The department of Commerce[104], which provides public information and assistance related to energy technologies, as well as providing analysis and technical assistance to the Minnesota Public Utilities Commission operates a Project Database[105]. Because Minnesota is a regulated state, this project database ostensibly covers all potential development opportunities occurring within the state.

In addition, vendors can engage with the Minnesota Public Utilities Commission[106], which regulates electricity, natural gas, and telephone provisions within the state. The PUC's solicitation database is managed by the Department of Commerce.

In addition to the regulatory bodies, there are numerous municipal electricity providers[107] active in the state. The best place to start for providers interested in working with these munis is through the Minnesota Municipal Utilities Association[108].

Minnesota Electric Transmission Planning is a cooperative resource, compiled by the state's active electricity utilities, listing planned transmission projects. A full list of past and upcoming projects is available via its website[109].

The Great Plains Institute is a non-profit that supports the positive transformation of the energy system within Minnesota. Its primary focus areas are carbon management, electricity market transformation, alternative fuel research, energy efficiency, and community engagement.

Minnesota Energy Storage Alliance (MESA) is an initiative, driven by the University of Minnesota, to support energy storage transformation. It welcomes collaborations from all stakeholder groups.

However, there are almost no tangible structured opportunities to note. Most other states have specific actionable activities that accompany their action plans, but Minnesota lacks this clear delineation. This requires that Swedish vendors actively engage with the stakeholders to discuss areas of opportunity.

[104] https://mn.gov/commerce/industries/energy/
[105] https://mn.gov/commerce/energyfacilities/Docket.html
[106] https://mn.gov/puc/about-us/
[107] https://mn.gov/puc/consumers/help/utility/
[108] https://www.mmua.org/
[109] http://www.minnelectrans.com/

In addition, as a regulated state, utilities are vertically integrated, creating a disincentive for the rate and incentive structures best suited for supporting grid modernization.

In order to be successful in Minnesota, Swedish providers will need to take the lead, demonstrating feasible means of implementing the clearly desired, but as-yet unstructured strategy of grid modernization.

4.1.5 Texas

End-use electricity generated within Texas is primarily natural gas-fired (40%) and coal-fired (33%), with non-hydro renewables and nuclear sources combined providing another 28% of end-use electricity[110]. Electricity generation is overwhelmingly dominated by IPPs, providing approximately 81% of net generation[111].

With regard to renewables, Texas is the country's most productive wind-generation state, with a total capacity of more than 21,450MW[112]. From a generation perspective, Texas offers a particularly interesting opportunity for utility-scale renewable integration and grid management solutions, such as battery storage.

Table 8 Utilities central for grid development in Texas

Generation Owners	**Many IPPs and Munis[113]**
Transmission Owners	IOUs (AEP Texas; CenterPoint Energy; Oncor; Sharylan Utilities; TNMP; Xcel Energy)
Distribution Owners	IOUs (AEP Texas; CenterPoint Energy; Oncor; Sharylan Utilities; TNMP; Xcel Energy); Many Munis & Coops[114]

Texas is the only state included in this shortlist that is not a signatory to the Governors' Accord for a New Energy Future. Indeed, there is very little evidence to suggest that energy grid advancement is a top priority for the state's government. However, Texas generally operates a hands-off approach to governing across the board, preferring to let free market approaches reign. As such, state-level support for initiatives is nearly non-existent, a dramatic change compared to the other states.

In addition, PUCT does its best to uphold this minimal government approach, preferring to provide the minimal infrastructure required to foster a competitive and robust open market. They, likewise, offer no guidance or support for specific programs related to smart grid development.

[110] https://www.eia.gov/state/?sid=TX#tabs-4
[111] https://www.eia.gov/electricity/state/Texas/
[112] https://www.eia.gov/state/?sid=TX
[113] https://www.puc.texas.gov/industry/electric/directories/pgc/alpha_pgc.aspx
[114] https://callmepower.com/tx/utility

Texas is however strongly interested in developing a stable grid and on a political level aims to increase its grid resiliency. This is also in part driven by Texans who have recently experience flooding and power outages after the recent hurricane season. The need to refurbish or build new infrastructure is in higher demand post hurricane Harvey. Well-funded private organizations /groups in Texas are interested in driving initiatives to increase resiliency and are becoming important stakeholders in smart grid and smart city projects.

As mentioned above, the Public Utility Commission of Texas (PUCT) operates with a hands-off approach. PUCT does not maintain a list of active solicitations, but they do offer a list of standard tasks required to work directly with them[115]. Despite the *laissez-faire* nature of PUCT, Swedish providers should still seek out a relationship with the entity. As regulatory overseers of the state's grid, the commission maintains excellent top-level knowledge fundamental to a successful entry into the state market.

As an alternative to the states deregulated market, there are many munis[116] and coops present in the state, each of which offers something closer to a regulated energy provision. Austin Energy is one of the largest of the munis, serving the state capital. They offer a portal to register your company in order to receive updates whenever solicitations occur[117]. Another interesting muni is Denton Municipal Electric. The city of Denton is currently on track to become a 100% renewably fueled city, the second city in Texas to do so. This transition will likely require substantial support from 3rd-party providers, and a list of active solicitations is available[118]. Access to the state's coops is best achieved via Texas Electric Cooperatives, an overarching cooperative containing most of the state's smaller generation, transmission, and distribution cooperatives.

As a result of the nearly fully deregulated nature of the state's electricity provision, there are *many* independent providers to consider. Choosing one over another for outreach will ultimately come down to the individual Swedish provider's technology offering. That said, it is possible to narrow down some of the stakeholder types of interest based on the likelihood that they will be amenable to 3rd-party smart grid opportunities.

First, Power Generation Companies[119] are entities that generate electricity that is intended to be sold at wholesale and may provide opportunities for Swedish providers within the renewable generation space. Examples include Luminant Generation Company[120], NRG Energy[121], and E.ON[122]. Next, Retail

[115] *http://www.puc.texas.gov/agency/about/procurement/Default.aspx*
[116] http://www.tppa.com/
[117] *https://savings.austinenergy.com/rebates/contractors*
[118] https://dentoncounty.com/Departments/Purchasing/Bid-RFP-Specifications.aspx
[119] https://www.puc.texas.gov/industry/electric/directories/pgc/alpha_pgc.aspx
[120] https://www.vistraenergy.com/supply-chain/
[121] https://www.nrg.com/suppliers/registration-process.html
[122] https://www.puc.texas.gov/industry/electric/directories/pgc/report_pgc.aspx?ID=PGSQL01DB1245458100150

Electric Providers (REP) are those entities that sell electricity to retail customers. They will likely be attractive for Swedish providers within the customer-side system space. There are a large number of REPs available in the state – however, it is possible to be efficient during outreach by targeting companies that share parent companies with other value chain participants. For example, TXU Energy is an REP that is owned by Vistra Energy, the same owner of Luminant Generation Company.

Finally, there are the state's five IOUs, also known as Transmission and Distribution Service Providers (TDSP); these are entities that function as the middleman between power generation companies, REPs, and retail customers.

The other major market participants are Power Marketers (entities that buy or sell electricity at the wholesale level) and Aggregators (entities that join two or more customers into a purchasing unit to negotiate the purchase of electricity service in Texas from retail electric providers). Neither of these entities will likely have opportunities relevant for Swedish providers.

Beyond the traditional market players, Texas is also home to a limited number of clean energy focused lobbying groups and industry associations. Of particular note is the Texas Clean Energy Coalition, a non-profit that promotes clean energy development as a complement to the state's strong oil & gas industry.

Texas, via the PUCT, has maintained a renewable portfolio standard since 1999[123]. The RPS has a stated goal of 10,000MW total renewable generation by 2025; however, the state has already met this target, thanks in large part to the state's substantial wind power generation. In fact, Texas' ability to become such a large wind producer (4th largest in the *world*, if it were a country[124]) stemmed from policies to support grid integration over the last decade[125].

The Texas Renewable Energy Industries Alliance offers a number of useful resources for renewables-related providers[126]. It is recommended that Swedish providers consider connecting directly with this resource.

MISO, an RTO serving a small slice of Eastern Texas, has recently approved a large investment into transmission improvement[127]. An active solicitation is currently ongoing at the time of writing, with proposals due by 20th July, 2018.

[123] http://programs.dsireusa.org/system/program/detail/182
[124] https://www.npr.org/2017/03/08/518988840/wind-energy-takes-flight-in-the-heart-of-texas-oil-country
[125] https://www.texastribune.org/2013/10/14/7-billion-crez-project-nears-finish-aiding-wind-po/
[126] http://www.treia.org/
[127] https://www.misoenergy.org/about/media-center/new-pagemiso-board-approves-texas-transmission-investment/

Many of Texas' coops and munis have begun purchasing "distribution-scale" solar installations at or nearby the distribution grid[128]. This trend emerged in popularity as a mechanism to minimize transmission-level costs, as well as control generation and distribution in a localized manner. Munis and coops in Texas function, essentially, as regulated & vertically integrated electrical utilities. These munis and coops will likely require third-party support in the implementation, integration, and management of this infrastructure.

Texas was one of the pioneers in implementing advanced metering infrastructure, creating PUC requirements as early as 2008 and achieving nearly full implementation by 2012[129]. As of today, Texas residents in applicable service areas have full access to their AMI data, and through a national program called Green Button, can easily share their data with 3rd-party providers for integration in various demand-side infrastructure. A recent settlement agreement between utilities and 3rd-party providers would provide even easier access to and sharing of this data, pending PUCT approval in April, 2018[130].

Texas has numerous incentives in place surrounding electric vehicles, including vehicle purchase rebates[131], charging station installation rebates, and charging rates targeting benefitting EV charging. Texas has the second most public charging stations installed in the U.S.[132].

In-depth data regarding the state of the charging infrastructure within the state is available via NREL and its Alternative Fuels Data Center[133].

As mentioned above, most Texans currently have access to Green Button AMI data sharing infrastructure. In addition, Pecan Street is a research institute focused on understanding customer behavior around water and energy[134]. They are involved in numerous initiatives with 3rd-party providers to improve consumer-side electricity usage.

Since Texas is the epicenter of traditional oil & gas companies within the U.S., it is also the home of most of the largest, wealthiest, and R&D-driven electricity companies in the States. A nearly pure free-market approach to smart grid developments provides open access and opportunities for all interested parties. Swedish providers have access to the cream of the crop for private collaboration within the state and is unlike many other states in the U.S.

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[128] https://www.rmi.org/news/distribution-scale-solar-goes-big-texas/
[129] https://www.texasmonthly.com/energy/exactly-smart-smart-meter/
[130] https://www.greentechmedia.com/articles/read/texas-smart-meter-data-access
[131] https://www.chron.com/business/energy/article/Gov-Greg-Abbott-signs-electric-car-rebates-into-11216575.php
[132] https://environmentamerica.org/sites/environment/files/reports/AME%20Renewables%20on%20the%20Rise%20July%2017.pdf
[133] https://www.afdc.energy.gov/states/tx
[134] http://www.pecanstreet.org/

The deregulated market provides opportunities, but it is important to remember that the lacking governmental policy engagement provides little top-level structure for smart grid programs. As such, much of the development relies entirely on private-driven initiatives. However, Texas is home to many of the traditional oil and gas companies whose interests may be challenged by some smart grid initiatives – indeed, many of these companies are the parent organizations of the very utilities within Texas that would be implementing these initiatives. Swedish providers will need to consider the disincentives inherent to many of the state's most attractive potential partners.

5 Smart grid developments

Investments in smart grid development were initiated during the Obama administration and overseen by the Department of Energy. Under the American Recovery and Reinvestment Act of 2009, the Federal government invested $4.5 billion over a period of 5 years to modernize the U.S. power grid beginning in 2009. $3.3 billion dollars of that investment was dedicated to smart grid technology deployment, with an additional $685 million in smart grid regional and energy storage demonstration projects. While the DoE continues to work on these efforts, today it is on a more limited basis, mainly through workshops and interacting with various stakeholders and there is no clear road map for smart grids in the U.S.

Even so, smart grids are on the agenda for many cities and states, as it is recognized that smart grids are an important part of increasing resiliency and modernizing the grid. Smart grids are also relevant for states facing an increase of distributed generation and needing to reduce carbon emissions while increasing efficiency. The speed at which smart grids are implemented are influenced by for example political will, citizen interest, geographical location and financial capabilities.

From a top-level perspective three areas of successful smart grid development can be highlighted. One area of strength across most states is the current and ongoing implementation of commercial- and residential-scale renewable generation like rooftop solar. In large part thanks to the Solar Investment Tax Credit, which was implemented in 2006, solar growth has averaged more than 50% growth annually for the last decade[135]. Another is smart meters which have been successfully rolled out to almost 50% of the population across the U.S., thanks to state-driven programs. Finally, zero-emission vehicles have also increased in amount, with 2017 sales reaching 25% year-over-year growth[136]. These sales have been supported by various state-level rebates and federal tax rebates.

With these strengths comes some pressing needs. As a direct result of the implementation of behind-the-meter renewable generation, utilities are struggling to manage the diverse and disparate load. DER management tools will play a pivotal role in grid development over the coming years, especially as several major states like New York and California look to shift their utility model to better support a microgrid approach. In addition, although smart meter implementation has been relatively successful, many customers still lack access to the diverse tools these platforms enable, such as demand response adjustments, full appliance integration, and smart home monitoring

[135] https://www.seia.org/solar-industry-research-data
[136] https://arstechnica.com/cars/2018/01/2017-was-the-best-year-ever-for-electric-vehicle-sales-in-the-us/

solutions. Finally, as ZEVs continue their adoption across the U.S., the need for widespread charging infrastructure becomes a pressing need. In particular, models for how to integrate this infrastructure into the broader grid and with DERs are actively being discussed by utility commissions across the country.

A few additional technology trends developing in the US energy market worth mentioning, as it may increase the number of Swedish SMEs interested, has been identified:

- *Smart home technologies*. Smart homes have appliances which are connected to each other and to a local network. The connectivity between the smart grid and home appliances can provide additional ancillary services such as demand response, frequency regulation and energy arbitrage.

  Smart home technologies are getting very popular across the country. Large companies like Amazon and Google are pushing this trend forward. Utilities are becoming aware of this trend and trying to come up with incentives for customers to participate in their programs. These programs are directed to provide utilities with ancillary services. So, there is an equal opportunity in all these five states for Swedish companies to provide services in this sector.

- *High Voltage Direct Current (HVDC) technology*. This is not a new technology but it is becoming more useful now as it can improve reliability, stability and transmission capacity in select applications. There are not many companies with expertise in HVDC technology in the US, opening an opportunity for Swedish SMEs to enter.

  Though HVDC technology has not been adopted heavily in the US, there are few projects in California and New York. Massachusetts is another possible state who adopts this technology because of their off-shore wind power adoption.

- *DC microgrids.* DC microgrids are gaining attention because of the increase in renewable microgrids. DC microgrids are more energy efficient. Hence, it can play an important role in the Net Zero Energy building (NZEB) program. California, Massachusetts and New York have several completed and ongoing projects for NZEB.

  In the DC microgrid market, California is leading by far. This is mainly because of the high energy costs in the state. Microgrids are growing throughout the country but notable states are California, Minnesota and Texas. A summary of the status for development within above described technology areas is shown in the table below.

	California	Massachusetts	New York	Minnesota	Texas
Smart Home	+	+	+	+	+
HVDC	+		+		
Micro-grids	+++			++	+

Along with these product based trends, a regulatory trend has developed around Clean Peak Standards (CPS). CPS requires a certain amount of energy during peak demand hours to be supplied by renewable energy resources, and is being implemented by several states. Energy storage is expected to play a major role in these efforts. Massachusetts and California are leading with CPS implementation.

5.1 Smart grid development in the five focus states

5.1.1 California

California's ZEV Action Plan calls for 1.5 million ZEVs in California by 2025 and is a multi-agency, multi-stakeholder initiative with many opportunities for external providers. This is one of the greatest opportunities for Swedish SMEs to enter the EV space. there are three state trends that deserve further investigation. First, the existing over-supply of DERs presents a clear opportunity for 3rd-party support in mitigating the grid issues resulting from it. In addition, Southern California is facing a mini-crisis regarding energy availability, due to the unplanned closure of the San Onofre Nuclear Power Plant. Finally, the state's many CCAs are aggressively expanding their operational capacity, both in generation and other supporting services.

5.1.2 New York

This state is encouraging microgrid space through 'NY Prize Microgrid Competition' which is a USD $40 million competition. Swedish participants can help NY communities win this competition by providing microgrid solutions. Finally, the Value of Distributed Energy Resources initiative aims to accurately understand the proper structure for a DER-intensive energy grid[137]. In 2018, activities will address demand management, demand response, and energy efficiency technologies. New York also has the 'Strengthen Cybersecurity' initiative which combines 3rd-party providers with state utilities in an attempt to formulate a system of common security protocols. No specific information exists about the program outside of the Energy Plan. Swedish cyber security companies can explore this space for upcoming opportunities.

[137] http://www3.dps.ny.gov/W/PSCWeb.nsf/All/8A5F3592472A270C8525808800517BDD?OpenDocument

5.1.3 Massachusetts

Overall, Massachusetts presents several interesting opportunities for Swedish providers. Underlined by Governor Baker's continued push for renewable energy adoption and grid modernization, the commonwealth's utilities' Grid Modernization Plans are continuing to clarify and incentivize the implementation of new grid technology. There are two major areas of opportunity driven by broad policy initiatives. First, the commonwealth's RPS actively seeks off-shore wind technology, a niche sector with a strong basis in Scandinavia. Additionally, the ZEV Adoption Act creates clear opportunities for 3rd-party involvement in ZEV charging infrastructure. More narrowly, Eversource (a major utility) has actively lobbied for the increased implementation of 3rd-party support within the commonwealth's grid modernization initiative. Swedish providers should consider working directly with Eversource to provide feasible, tangible opportunities to achieve this goal. Finally, the impending closure of the Pilgrim nuclear power plant is creating opportunities for supply providers across the commonwealth.

5.1.4 Minnesota

Minnesota is an interesting state in that it holds a lot of promise for 3rd-party implementation, despite major structural differences compared to the other states identified in this analysis. There is ample and evident government interest in supporting grid modernization procedures. The existing research on grid modernization is supported through a multi-stakeholder process, indicating an openness to collaboration. In addition, the state's 2025 Action Plan and Staff Report on Grid Modernization are clear signals of a top-level interest in improving the state's grid.

5.1.5 Texas

Texas's recent successes in creating and integrating massive-scale wind generation/transmission facilities point to a red-tape-free opportunity for similar improvements within the state moving forward. Further opportunities exist within grid storage of EV integration of this wind generation. In a related large-scale development, the states' munis and coops are moving toward a localized "distribution-scale" approach to solar generation, providing many opportunities for 3rd-party providers within this area. In addition, a long history of being an early adopter of new technology (e.g. AMI) indicates a forward-looking perspective by the local market. Further development on this front is expected, and frankly, required, given the slightly out-of-date nature of the existing infrastructure.

Georgetown, a small city in Texas, made the switch to 100% renewable energy sourcing in 2012, a possibility primarily because of the very low level cost of energy (LCOE) of wind energy. Similarly, Denton, TX, is considering a commitment to consuming 100% renewable energy. These examples highlight another opportunity in this highly deregulated market – Swedish companies can provide services which will enable small cities make transition to 100% renewable energy.

6 Challenges

6.1 Competition

The competition within the smart grid space is highly competitive in the U.S. U.S. companies excel at pitching and selling solutions which is a hurdle to overcome for non-U.S. companies. Within the smart grid space, Swedish SMEs are most likely to be competing against U.S. based entities that are larger in size, have existing reference cases, and can tap into an established network of potential customers, clients and experts. Examples of U.S. competitors in five technology areas of interest for Swedish SMEs are outlined below.

Technology Area	Examples of Competitors
Smart Homes	NEST, Amazon, Phillips, Belkin, EcoBEE
Smart Metering	Itron, Elster Group, General Electric, Schneider Electric
Electric Vehicles	Tesla, PlugShare, ChargePoint, EVgo
HVDC	General Electric
Microgrids	Enbala Power Networks, Duke Energy, Microgrid Institute, Dynapower, Princeton Power Systems, Veolia North America

Smart grid development is usually conducted in one of two ways: public-private partnerships via solicitation processes and private-private partnerships via contract development. Within each state, public-private solicitations come from a variety of sources, including the state's energy commission, the state's public utility commission, and directly from public utilities. For private-private opportunities there is a need to build relationships directly with the private providers. Utilities or other potential customers are sometimes constrained by whom they can work with, and preference is frequently given to local vendors. Furthermore, smart grid customers usually like to see that a vendor has successfully implemented its solution in a scaled environment, preferably in the U.S. Swedish SMEs are unlikely to be able to provide a U.S.-based reference case, further limiting their ability to engage in talks with a utility.

Therefore, for SMEs, partnering is an important factor for success, as it allows the Swedish solution to be represented by a U.S. company and take advantage of their local expertise on of how to do business with the above-mentioned models. Partnering also allows the SMEs to partake in larger projects, further expanding the types of opportunities than can be bid on.

Whether or not the Swedish SME is approaching a partner to discuss an idea or a company to pitch a solution, it is important to understand that these organizations are constantly being targeted by vendors and it can be tough to get their attention. Engaging them in a “neutral” location such as conference or tradeshow can ease introductions. Regardless of the method, it is important that the Swedish SME be prepared to dedicate resources, both time and financial, to establishing its first client in the U.S.

Partnerships are also very useful for overcoming the multitude of challenges around project financing within the U.S. Companies can take advantage of a limited number of state programs that provide guarantees for risk-heavy development. These incentives are typically not smart grid specific, however, and are available for broad high-tech investments. There are constraints on funding opportunities for non-U.S. entities and working together with a partner can help with issues regarding financing.

Venture capital (VC) firms may also be viable sources for company financing. These VC firms are predominantly based on either coast, with a large majority of funding coming from California. However, VC firms have expressed hesitancy about investing in energy technology over past few years, due to the large up-front capital requirements and high project risk. In their place, several project-based financing organizations have stepped in to fill the gap. Look to companies like PRIME Coalition, Activate Capital, or Generate Capital as alternatives to both banks and traditional VCs.

6.2 Challenges to be solved in order to increase export

A survey of Swedish smart grid SMEs highlighted cost, the regulatory environment and establishing a local network as some of the challenges new entrants can expect to face in the U.S. In general, barriers to entry are on a national level – e.g. trade barriers and immigration issues (work visas) – but there are also state level barriers, including state regulations on the environment or on specific products.

- A challenge for doing business in the U.S. for a Swedish SME is the distance to the market. Distance makes it more difficult to identify and interact with potential customers. U.S. smart grid customers are also generally not aware of the Swedish expertise within smart grids (policies, innovation and companies). Customers are usually also looking for proof of concept, preferring to see a U.S.-based reference case. While Swedish reference cases are good, a U.S. reference case shows the customer that the product is adapted and ready for U.S. deployment.
- The regulatory environment can vary on the state level, causing confusion and difficulty for Swedish SMEs looking to export to the U.S. Regulations can affect anything from data protection and security

to how a pricing strategy can be implemented. While it is not always easy to understand the regulatory requirements, it is possible to engage directly with the customer (typically utilities) to get a better understanding of what is required. In heavily regulated[138] states, such as CA and NY, the state's regulatory agencies are open to explaining the details of the regulation.

- Competition varies significantly from state to state. Large, enticing markets like CA and NY attract international attention from 3rd-party providers, while smaller states, like MN have less competition from outside providers. However, smaller states may offer less opportunities. Careful consideration should be paid to the level of competition within the target state, especially along specific technology lines, and SMEs will need to adjust their pitch accordingly.

It is important that Swedish SMEs consider the abovementioned hurdles and prepare their business for export before considering entering the U.S. One of the key factors is identifying a partner and building a local network. Partners are closer to customers and can incorporate the Swedish product in an overall solution. It is recommended to attend conferences and tradeshows and meet partners in a more informal environment. The partner can also increase credibility, which is important as U.S. customers in the smart grid space are usually much larger than those in Sweden.

[138] Regulated here meaning "characterized as having many regulations related to the energy grid," rather than the meaning described previously, "separation of generation, transmission, and distribution"

7 Opportunities for collaboration and key stakeholders

Because the U.S. has such a fragmented structure, it is important to understand the various stakeholder types that operate throughout the country in order to begin to delineate actors and their typical functions. It is then possible to pick a specific state/region and reexamine each stakeholder type based on their specific responsibilities within that state/region.

On a Federal level, the Department of Energy is an agency that provides legislative and regulatory support for the energy, environmental, and nuclear sectors in the U.S.[139] Other than acting as a resource for some national solicitation opportunities, most Swedish providers will have little to no direct interaction with the DOE. Instead, these agencies would potentially provide the basis for specific technical or environmental requirements once a project has been scoped and approved.

The various national laboratories such as NREL and universities support research and advancement of smart grid technology, making them important stakeholders to follow to better understand future smart grid trends. While there are limited partnership possibilities, these labs and research centers can act as incubators for interesting innovations and provide connections to local opportunities.

Another group of stakeholders that should be considered are the independent system operator (ISO), organizations which coordinate, control, and monitors the operation of the electrical power system within one or more states. For example, of the 5 states considered in this report, New York, California and Texas are controlled and monitored by their own ISO entity independently. In contrast, Minnesota is in an ISO territory that covers portions of 15 states, and likewise Massachusetts is in an ISO territory that controls 6 states. This means for Swedish SMEs, targeting ISO territories that cover more than one state could potentially increase and/or complicate the number of stakeholders involved in regulatory approval processes, and ISO-specific considerations may need further attention. For reference, the ISO's corresponded to the 5 states proposed are listed below:

- NY – New York ISO
- CA – California ISO
- TX – Electric Reliability Council of Texas
- Massachusetts – ISO New England

[139] https://energy.gov/mission

- Minnesota – Midwest ISO

Stakeholders on the state level are more important than those on a federal level as states have the largest influence on the regulation of the energy industry. Regulation is driven by three primary bodies on the state level.

1) First, there are state governmental organizations focused on energy. These are called a variety of names, such as Departments of Energy or Energy Commissions. These governmental bodies are generally in charge of policy development for and oversight over energy-related matters. In addition, these bodies forecast energy needs, support research into new technologies, and develop energy-related programs, amongst many other tasks.
2) Second, there are Public Service Commissions (aka Public Utilities Commissions; Corporation Commissions). These regulatory bodies work in tandem with state governmental organizations to oversee the state's energy sector.
3) Finally, the other major state agency, State Departments of Environmental Protection/Quality provide regulatory control over the physical environment surrounding electricity transmission – that is, air, land, & sea resources.

Swedish providers looking to enter a state's market should anticipate working very closely with that state's Public Utilities Commission. These two bodies are the primary stakeholders for identifying potential opportunities, making decisions about infrastructure projects, and providing introductions to other relevant players. Once a target state has been selected, it is advised to initiate a relationship with relevant employees of that state's DoE and PUC. These relationships are typically easy to initiate and can be facilitated directly through the appropriate agency website.

Along with state DoEs and PUCs, utilities are the primary stakeholder Swedish providers should anticipate engaging with. A good place to start is with the utility's "integrated resource plan" (IRP). These are documents that, depending on the state, are filed every 2-5 years. Each plan contains a detailed breakdown of the utility's current state, desired future state, and required steps to achieve this state. Typically, this focuses on generation commissioning or decommissioning, but it may also cover introduction of new technologies, particularly supporting grid modernization. From here, Swedish providers can access the utility's solicitation portal (when available) and/or initiate relationships with key, relevant internal stakeholders. The specific individual to connect with will depend on the project, but most utilities are receptive to new business opportunities.

Projects are often initiated by the utilities, and the extent of their power is determined in large part by two factors: first, if they are in a regulated or deregulated region; and second, if they fall within the territory of an ISO, an RTO, or neither.

- Utilities in regulated environments are (typically) fully vertically integrated – that is, they own and operate generation, transmission, and distribution[140,141]. Conversely, deregulated utilities are responsible for *distribution only*, with end consumers purchasing electricity via a competitive wholesale market.
- Utilities that are *not* located within the territory of an ISO or RTO are responsible for the development of local transmission plans, whereas ISOs and RTOs cover this responsibility for utilities within their service areas[142]

Furthermore, the utilities are either private or public which affects the way they evaluate renewables, smart grid solutions or programs that increase their value add. As a result, it is important to understand who to approach and what kind of pitch can have the best effect.

There are a number of other foundations or organizations that are also relevant stakeholders. GridWise Alliance is an advocacy group focused on supporting grid modernization across the U.S.[143]. Smart Electric Power Alliance (SEPA) is a non-profit entity, working primarily with major utilities that aims to provide education, research, and collaboration on distributed energy resources[144]. Smart Energy Consumer Collaborative is another utility-driven non-profit, this time aimed at understanding commercial demand for smart grid technologies[145]. There are also a number of private consulting companies dedicated to the smart grid, including but not limited to: EQL Energy[146], Cadmus Group[147], CLEAResult[148], and EnergySec[149]. These entities should be high priority targets for Swedish providers, as they can facilitate connections to existing projects and share experiences from the market.

A summary of these and other stakeholders and their relevance for Swedish SMEs are summarized below.

[140] https://www.ferc.gov/market-oversight/mkt-electric/overview.asp
[141] https://www.energysmart.enernoc.com/regulated-and-deregulated-energy-markets-explained
[142] https://www.energy.gov/sites/prod/files/2015/12/f28/united-states-electricity-industry-primer.pdf
[143] http://www.gridwise.org/
[144] https://sepapower.org/
[145] https://smartenergycc.org/
[146] https://www.eqlenergy.com/
[147] http://www.cadmusgroup.com/
[148] https://www.clearesult.com/
[149] https://www.energysec.org/

Stakeholder Type	Relevance for Swedish Providers	Usefulness as Information Resource	Form Relationship?
Federal DoE	Medium	Medium	No
Federal DHS	Low	Low	No
FERC	Medium	High	No
NERC	Low	Medium	No
State DoE	High	High	Yes
State PUC	High	High	Yes
State Dept. of Env't	Low	Low	No
RTOs/ISOs	Low	Medium	No
Utilities	High	High	Yes
Advocacy Groups	Medium	High	No
Private Consultancies	High	High	Yes

7.1 Existing Swedish Footprint

There is an existing Swedish footprint in the U.S. consisting of both smart grid solution providers and support organizations. The support companies can be leveraged to ease the transition in to the U.S. and help with a soft landing. Swedish organizations such as the Swedish Energy Agency (SEA), Swedish American Chamber of Commerce, Business Sweden and others are ready to facilitate SMEs growth in the U.S.

The Cleantech Hub in San Francisco is a combined effort by the SEA and Business Sweden that supports SMEs from Sweden in the areas of business development and growth. This initiative has been active for almost two years and a handful of companies have utilized its offering. Another interesting initiative is the Nordic Innovation House in San Francisco and in New York City. These initiatives provide mentoring support for all types of companies.

Within the area of smart cities, a Nordic collaboration is currently in the early stages and will be launched in Q2, 2018. The Nordic Sustainable City Solutions platform aims to connect Nordic companies with business opportunities and local partners to facilitate export. The platform partners have meet with 10+ cities to discuss sustainable city solutions and will narrow down the partner cities. Examples of cities included are New York City, Houston and Minneapolis. Through the Nordic initiative, Swedish companies may also gain access to a network of other Nordic companies, who may support each other as they venture to the U.S.

In addition to the Swedish initiatives and platforms, there are many Swedish companies active in the U.S. While the total number is unclear, estimates put the total at around 3,000 – 4,000 companies. These companies are spread across the U.S., mainly operating in states close to their customers or where

manufacturing is favorable. There are many large companies but also many SMEs, indicating that size is not always important. However, key learnings for a successful entry by SMEs include the need to be local, the need to network with customers and stakeholders, and the need to identify relevant partnerships. Developing strong partnerships is especially key for SMEs who do not establish in the U.S. in order to tap in to the partner's network.

There are several large Swedish companies active in the U.S. smart grid space including ABB and Ericsson. ABB has a Smart Grid Center of Excellence located on Centennial Campus of North Carolina State University in Raleigh, North Carolina. This new state-of-the-art Smart Grid Center of Excellence (COE) was created to demonstrate ABB's technology and investment in the smart grid industry. The COE has functional systems which display the end-to-end solution where information technologies (IT) and operational technologies (OT) converge to close the loop of automation, control and data acquisition[150]. ABB works with large utility companies across the U.S. and with grid modernization projects in cities such as New York City. Ericsson on the other hand has worked with IoT on microgrid projects and rolling out smart metering solutions. Electrolux has a line of connected appliances to be utilized in smart homes.

[150] http://new.abb.com/us/abb-smart-grid-center-of-excellence

8 Conclusions

In a large country like the U.S., the smart grid market varies largely between states. Swedish smart grid SMEs are therefore highly recommended to select a few states for market entry. California, New York, Massachusetts, Minnesota and Texas have been highlighted as particularly promising in this report after considering state level legislation promoting/supporting smart grid development, existing grid modernization plans, large potential market share from smart grids, and signaled intentions for continued development.

Unlike other countries, the U.S. does not have a roadmap or clear federal goals regarding smart grid development. There are however state-level regulations affecting the opportunities for market entry by Swedish SMEs. Swedish SMEs should be aware of the regulated/deregulated nature of the state they hope to enter, since it has clear implications for the key influence points and which stakeholders to approach.

Of the five states of focus in this report, each state offers different opportunities. Conclusions for each state is outlined below.

California

California is a massive energy market, full of opportunities for aggressive and dedicated new entrants. The attractiveness of the market brings high levels of competition, so foreign entrants should be prepared to challenge well-entrenched players with extensive local connections.

The top identified opportunities for Swedish providers are the Zero-Emission Vehicle Action Plan and the states rapidly growing number of community choice aggregators.

California is known for being in the forefront of development within the smart grid sector. Therefore California may be of interest for Swedish SMEs not only for doing business but for connecting with partners to establish cooperation and share knowledge.

New York

New York is often the go-to choice for Swedish entities looking to enter the U.S., due to the maturity and richness of its market, along with its relative proximity to Scandinavia. Like California, New York's attractiveness can make entry a challenge; however, the state has a large number of clearly defined programs and initiatives to help newcomers formulate a viable strategy. The top identified opportunities for Swedish providers are the states current work of redefining the utility role, upcoming large storage project opportunities and a competition for demonstration of smart grid technology.

Massachusetts

Massachusetts is an east coast market that doesn't attract the same buzz that New York does, while providing many of the same benefits that it's more famous neighbor offers. There is a robust network of high technology research hubs within the state supporting innovative pushes forward within the smart grid space, all without the hyper-intense competition of the New York market. The top identified opportunities for Swedish providers are the Zero Emission Vehicle Adoption act and offshore wind opportunities.

Minnesota

Minnesota offers interesting opportunities for Swedish providers looking to enter into a somewhat overlooked state with clear indicators of strong grid integration moving forward. Although state legislation has yet to formalize clear smart grid initiatives, the various action plans all call for the implementation of various smart grid projects, ranging from renewable energy integration, zero-emission vehicle adoption, and customer-side systems like advanced metering infrastructure. Large stakeholders engaged in smart grid operations and that are interesting partners in the state are Minnesota Power, Otter Tail Power Company, and Xcel Energy for implementation partnerships as well as Great River Energy for direct access to key energy providers.

Texas

Texas operates a very large, nearly totally free energy market. The state's system invites participation from collaborators of any kind, but requires that successes be achieved with little to no support from state entities. The top identified opportunities for smart grid providers are grid integration and storage opportunities.

Municipal areas with interesting opportunities include Georgetown and Denton, and approaches should be made through their local utilities.

9 Appendix 1 – Regional Selection Criteria

Five states have been highlighted in this report after considering four primary factors that impact the level of opportunities for smart grid providers. These factors are state level legislation promoting/supporting smart grid development, states with existing grid modernization plans, states with large potential market share from smart grids, and signaled intentions for continued development

1 – State-Level Legislation Promoting or Supporting Smart Grid Development
States that have pending or active legislation supporting smart grids are obvious choices for a closer look. Smart grid legislation falls into four primary areas. First, there are policies that generically support smart grid development. Broadly speaking, Connecticut, Massachusetts, New York, New Jersey, North Carolina, and Washington stand out in this area for their policies that support smart grids.

Next, there are a number of states with legislation directly related to advanced metering infrastructure (AMI; aka Smart Meters). There are 19 states that have greater than 50% adoption of advanced metering infrastructure, a strong indicator of both regulatory and consumer readiness for smart grid adoption. Of these 19, Maryland, Massachusetts, Ohio, Pennsylvania, and Texas stand out for their legislation allowing customers to opt out of smart meter implementation, a warning sign for widespread adoption of other smart grid apparatus. Additionally, 16 states have implemented "Green Button" connectivity to their smart meter infrastructure, a system that indicates forward thinking policies surrounding customer-side system integration, cybersecurity, and broad smart grid development.

Next, many states have implemented some degree of regulation surrounding net metering & virtual metering policies. 38 states have existing net metering policies in place, plus voluntary implementation in Idaho and Texas. 9 of these states actively disallow net metering, a negative indicator of the state's willingness and readiness to adopt smart grid infrastructure.

Relatedly, a number of states have drafted legislation concerning power purchase agreements (PPAs). 23 states have legislation in place allowing for 3rd-party solar PPAs, the most common type of PPA, and a good indicator of pro-smart grid financial development structures. 9 states actively disallow these 3rd-party solar PPAs, a clear discrediting factor.

With regard to renewable energy generation, many states have implemented what are called Renewable Portfolio Standards (RPS). These standards establish clear goals for the total amount of energy generated within the state that should come from renewable energy sources. They are accompanied with clear end-year targets and enforcement by the state's public utility

commission. 25 states have RPS targets in place, encouraging utility-side investment into private sector development of renewable generation infrastructure. 7 of these states have additional RPS legislation specifically provisioning for the implementation of distributed generation infrastructure.

Finally, many states have taken an active role in encouraging the use of electric vehicles. Utilities and/or public utility commissions (PUC) providing services across 19 states have introduced rate structures that incentivize the usage of electric vehicles. Additionally, utilities and/or PUCs in 25 states have introduced incentives directly supporting EV charging infrastructure development.

2 – States with Existing Grid Modernization Efforts

States with active existing modernization projects are also an obvious choice for future development. Highlights include California, Massachusetts, Minnesota, New York, and Rhode Island[151]. These states were selected for having concrete legislation in place detailing state-supported pathways for improving electricity generation sources, transmission networks, customer-side technology, zero-emission vehicle integration, or other smart grid components. The identified legislation typically takes the form of "energy plans" written by each state's Department of Energy or Governor's Office. These are roadmaps that contain identified needs, existing programs, and intended investment on the preceding smart grid factors.

3 – States with Largest Potential Market Share from Smart Grid Projects

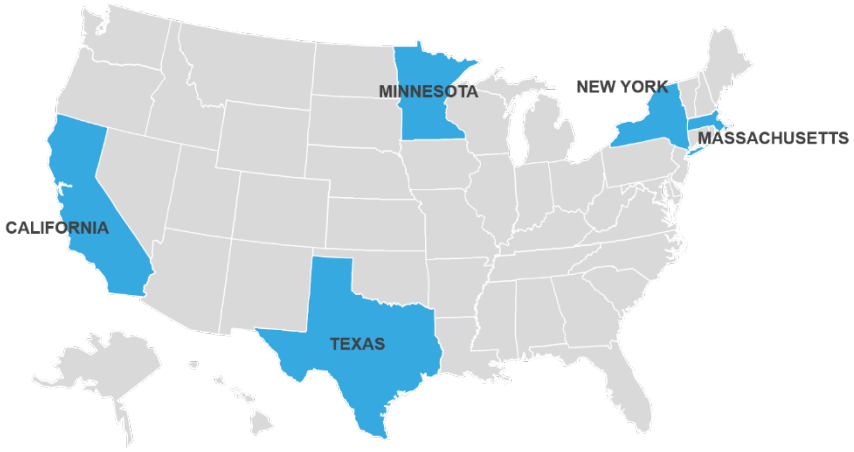
By examining existing tenders and planning phase documents, it is possible to decipher likely market potential within the states. Key performers on this metric include Texas, California, and Colorado[152]. These states are those with the largest number of pending solicitations for support across operations technology, information technology, and grid edge technologies.

4 – Signaled Intentions for Continued Development

There are other, non-legislative signals of a state's willingness and ability to tackle grid modernization projects. One of these signals, the Governors' Accord for a New Energy Future, is a signatory initiative that provides a verbal commitment for smart grid development. 17 state governors have signed this initiative.

Using the criteria within the four factors described above, the states can be evaluated based on a weighted ranking procedure to determine the highest priority states for Swedish SMEs. In the end, California, Massachusetts, New York, Minnesota, and Texas emerged as the top five states.

[151] https://www.utilitydive.com/news/the-top-5-states-for-utility-grid-modernization-and-business-model-reform/439550/
[152] https://www.energyacuity.com/blog/smart-grid-market-forecast



+/-	Weight	Factor	California	Colorado	Delaware	Illinois	Massachusetts	Michigan	Minnesota	New York	Texas	Vermont
+	1	Legislation - Broad Smart Grid Dev	0	0	0	0	1	0	0	1	0	0
+	0.5	>50% AMI Installation	1	0	1	1	0	1	0	0	1	1
-	0.25	Legislation - AMI Opt Out	0	0	0	0	1	0	0	0	1	0
-	0.5	Legislation - No Net Metering Allowed	0	0	0	0	0	0	0	0	0	0
+	0.5	Legislation - 3rd Party Solar PPAs Allowed	1	1	1	1	1	1	0	1	1	1
-	1	Legislation - 3rd Party Solar PPAs Actively Disallowed	0	0	0	0	0	0	0	0	0	0
+	0.5	Legislation - Green Button Implemented	1	1	0	1	1	0	0	1	1	0
+	1	Legislation - Renewable Portfolio Standards (RPS)	1	1	1	0	1	1	1	0	1	1
+	0.5	Legislation - RPS Distributed Generation Provision	0	1	0	1	0	0	1	0	0	1
+	0.5	Incentives - EV Charging Rates	1	0	1	1	0	1	1	1	1	0
+	1	Incentives - EV Charging Infrastructure	1	1	1	1	1	1	1	1	1	1
+	1	Existing Grid Modernization	1	0	0	1	1	0	1	1	0	0
+	1	Largest Potential Market Share	1	1	0	0	0	0	0	0	1	0
+	1	Governors' Accord	1	0	1	0	1	1	1	1	0	1
=		**TOTAL**	7	4.5	4.5	4.5	5.75	4.5	5	5.5	4.75	4.5
		RANK	1st	6th	6th	6th	2nd	6th	4th	3rd	5th	6th