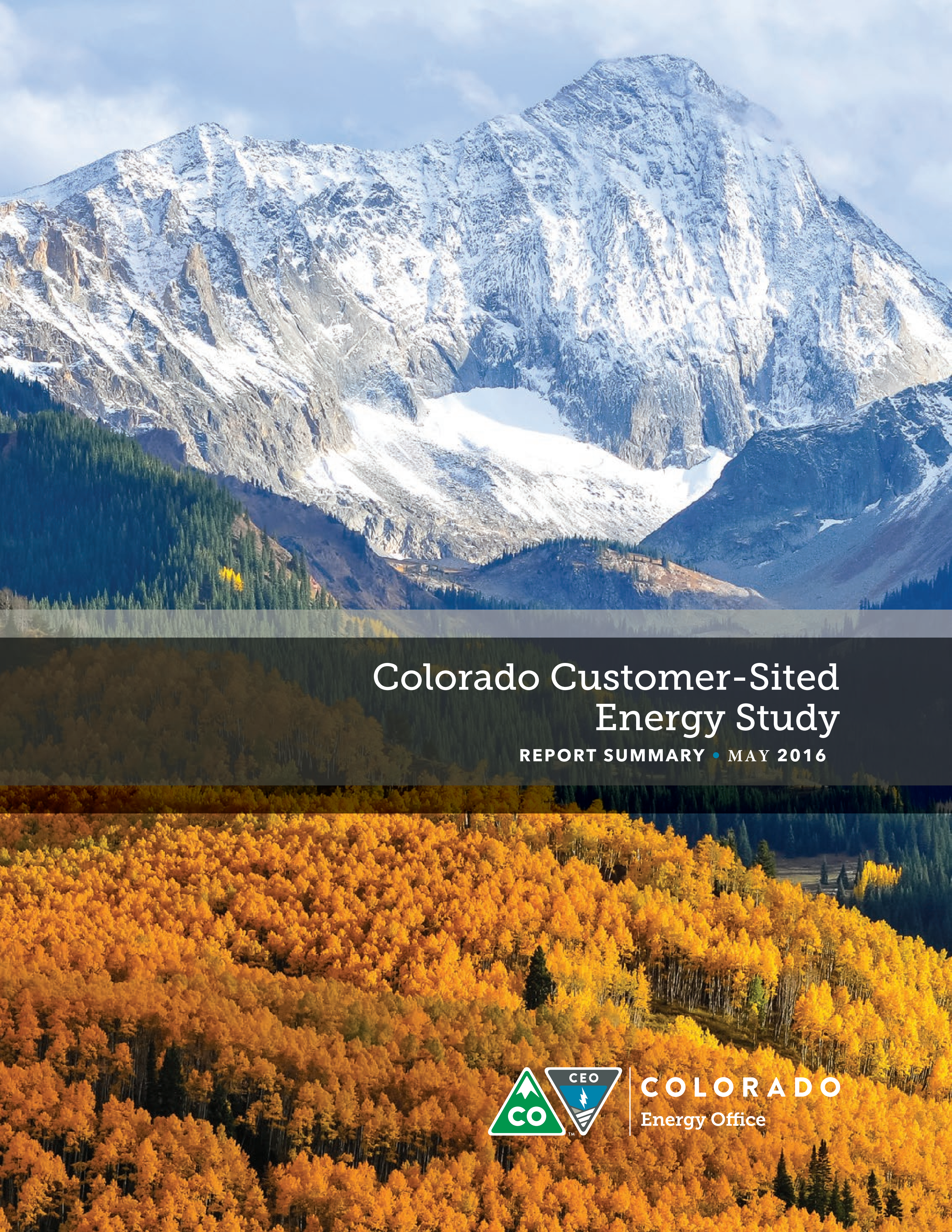

Colorado Customer-Sited Energy Study

REPORT SUMMARY • MAY 2016

COLORADO
Energy Office

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CEO

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1 | Introduction

The Colorado Energy Office (CEO) contracted with ANTARES Group, Inc. (ANTARES) to conduct a study to determine the size and characteristics of the market for customer-sited energy systems in Colorado. The study primarily targeted energy technologies that are eligible under Colorado's renewable energy standard (RES), including solar photovoltaics (PV), small wind turbines, small and micro-hydropower, waste heat recovery, solar thermal heating, ground source heat pumps (GSHP), and energy storage. The analysis focused on systems installed between 2007 and 2015—a time frame that covers nearly all of the RES-compliant system installations in the state. Installation data on these systems is not currently collected or tracked at the state level and the adoption of these technologies is not well understood.

The objectives of the study were to: 1) improve CEO's understanding of customer-sited energy market trends and the extent to which these systems contribute to Colorado's energy supply, 2) identify gaps in energy system data and potential solutions to address gaps, and 3) identify best practices in permitting that could enable jurisdictions to streamline their processes and standardize reporting of energy system data.

To perform the study, ANTARES partnered with the Colorado Solar Energy Industries Association (COSEIA) to provide strategic guidance, interface with industry stakeholders, and characterize the permitting process for key jurisdictions in Colorado. ANTARES also enlisted the support of Energy Intersections, LLC to provide policy and strategic planning support.

To accomplish the project objectives, the team collected and organized data on residential and commercial energy technologies installed in Colorado using a telephone and email survey of all of the permitting jurisdictions in the state, as well as county assessors' offices, electric service providers, industry associations and other stakeholders. Permitting jurisdictions provided summary permit data for all customer-sited energy systems that could be identified based on the available permit data. The project team endeavored to collect a wide range of information about the systems, including but not limited to: number of systems, installed capacity, installation address, county, and utility service territory. The project team also secured information from federal agencies, including the Federal Energy Regulatory Commission (FERC), the U.S. Department of Energy (DOE) Pacific Northwest National Laboratory, and the DOE Federal Energy Management Program (FEMP).

The data gathered from the permitting agencies and other stakeholders was compiled into a database and subjected to a battery of quality control tests to remove duplicate records, correct erroneous information, and ensure that the information assembled provided as complete a record of system installations as possible based on the available data. However, there were significant gaps in the data, resulting in a dataset that is not comprehensive, but represents the lower bounds of the actual total installations in the state. The project team performed a gaps analysis to identify specific data gaps and inform the next steps for CEO's work related to customer-sited energy technologies. The team also analyzed the data to show trends in installations over time and geographic distribution of system installations.

Lastly, the project team conducted an evaluation of permitting requirements and processes across the different local jurisdictions, which provided insight into how processes could be improved to facilitate future tracking of customer-sited energy system installations.

2 | Study Methodology

2.1 Data Sources

The ANTARES team reviewed and classified information resources as primary data sources, secondary data sources and data verification sources. This classification was based on an evaluation of the types of information available from each source and a ranking of sources that took into account the likelihood of securing the data in a practical timeframe, the effort required to secure the data and the completeness and usefulness of the data.

Primary data sources were those that were expected to provide the bulk of specific system information. Secondary data sources were those that yielded useful information but either were limited in geographic coverage, represented a relatively small number of technologies or systems, or required an extraordinary effort to obtain data relative to the amount and quality of information available. Data verification sources were those that did not provide specific system locational information, but did provide a valuable means to cross-check estimates of total system capacity and number of systems established by this project. **Exhibit 1** illustrates the hierarchy of data sources that the team used.

EXHIBIT 1. HIERARCHY OF DATA SOURCES

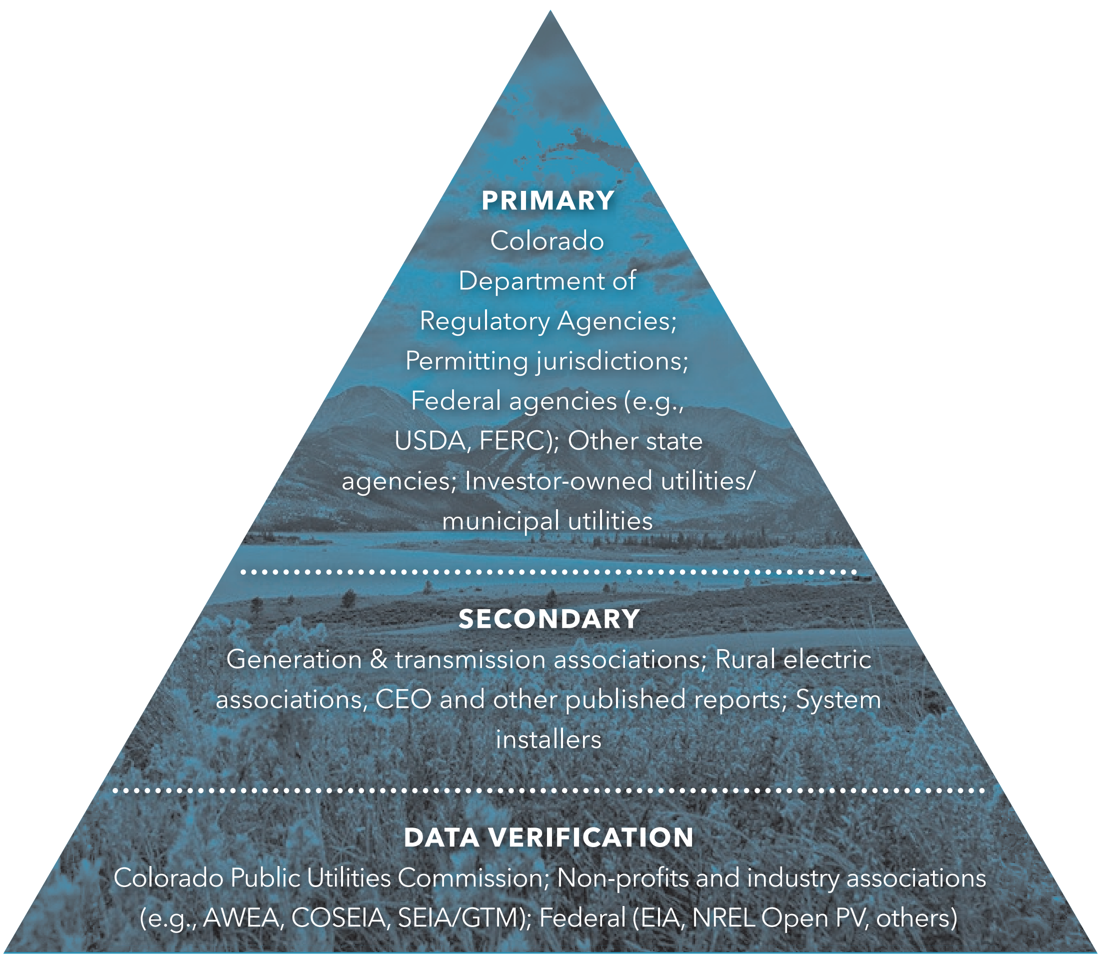


EXHIBIT 2. DATA ACQUISITION APPROACH BY TECHNOLOGY

Technology	Primary data collection strategy and data resources
Solar photovoltaics	Conducted telephone interviews with permitting jurisdictions and followed up via email, phone and on-site meetings to secure database queries and review other digital and hard-copy records
Solar thermal	Worked with installers representing most recent installations in Colorado
GSHP	Worked with industry association to obtain historical data, coupled with state drilling permits
Small wind	Reviewed data from NREL, CEO, DORA permits, USDA, industry associations and other published sources
Small hydroelectric	Reviewed data from FERC, NREL, CEO, DORA, USDA, NRCS and other published sources
Waste heat recovery and energy storage	Gathered from university case studies and vendors

2.2 Data Acquisition Approach

For nearly all technology types and data sources, the project team relied heavily on telephone surveys and email communications to gather permit data and other information about customer-sited energy system installations in the state. Survey efforts focused first on sources of data that were readily available and had broad geographic coverage. Within the primary data category, the strategy for collecting data differed by technology type and is summarized in **Exhibit 2**.

2.3 Survey Methodology

The DORA Electrical Board permits solar PV, wind, and small hydroelectric systems in the state of Colorado and has permit data for systems installed since the mid-1990s. The staff at DORA queried their permit database to obtain permit data for these systems. While DORA manages the permitting process for several counties across the state, there are a few municipalities it does not cover. ANTARES team members worked with those municipalities separately to obtain information on permits.

The strategy the ANTARES team used to collect the remaining data on customer-sited energy systems relied mainly on telephone and email contact with permitting jurisdictions in the state. ANTARES used a tailored survey approach that was designed to ensure a high response rate. Contact information for permitting jurisdictions statewide was obtained with the assistance of COSEIA, Colorado Counties, Inc., and professional groups such as the Colorado Assessors Association. Key elements of the survey approach included:

- A **pre-survey letter** sent on CEO letterhead to the permitting jurisdiction contact to explain the purpose and need for the project, describe the parties involved, list the types of information sought, request assistance through participation in a phone interview and records research, and thank the respondent in advance for their participation.
- A **telephone interview** with contacts at the jurisdictions to discuss their permitting practices, evaluate data availability and work out the details of how to obtain the data. The team designed an interview process to help agencies respond more easily, quickly identify hurdles to securing data, and provide solutions for overcoming them.
- **Follow-up contacts** by email to confirm the types and format of data sought in a formal data request and provide examples of the data.
- **Telephone follow-up calls** to thank the respondent for their participation and if the requested information had not yet been received, express hope that it would be sent soon.

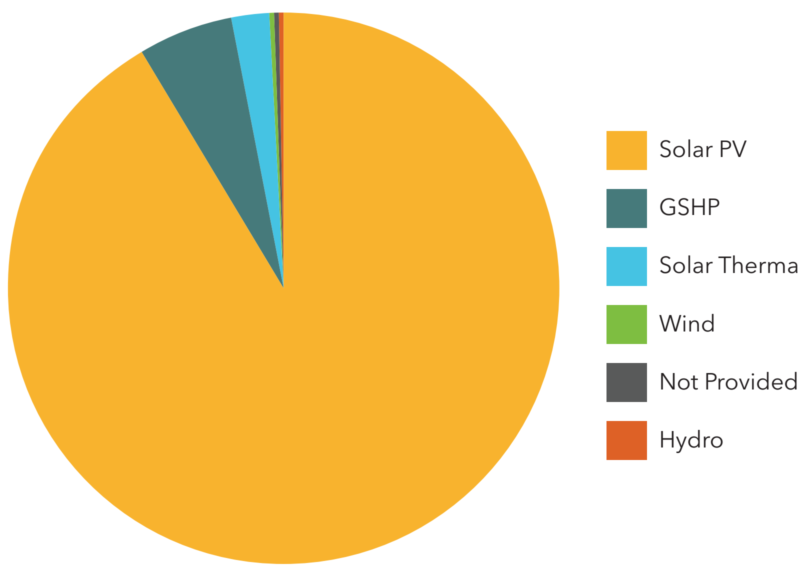
3 | Customer-Sited Energy Data

3.1 Aggregated Data on Customer-Sited Energy Technologies

Due to gaps in the available data, the estimates put forth in this study can be interpreted as lower bounds on the actual total installations in the state. For this reason, the estimates determined herein may not match those publicized by industry organizations.

The data gathering effort identified over 32,000 customer-sited systems installed in Colorado. **Exhibit 3** shows a breakdown of installed systems by technology type. Solar PV makes up the largest percentage of installations, at 92 percent.

EXHIBIT 3. SUMMARY COUNT OF SYSTEMS INSTALLED BY TECHNOLOGY TYPE

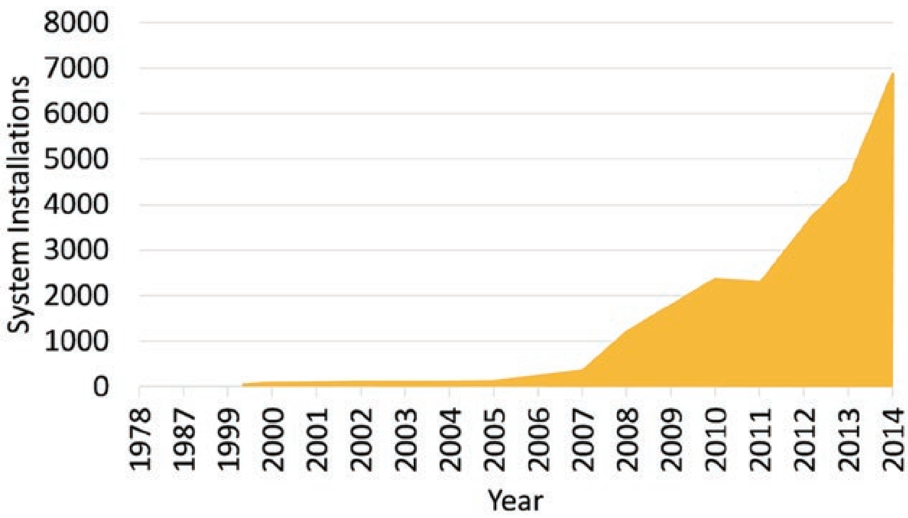


Technology	Count	Percentage (%)
Solar PV	29,363	91.6%
Ground Source Heat Pumps (GSHP)	1,718	5.4%
Solar Thermal	690	2.2%
Wind	142	0.4%
Not Provided	105	0.3%
Hydro	19	0.1%
Total	**32,037**	**100.0%**

3.2 Solar PV

More than 29,000 customer-sited solar PV installations were identified through this study. **Exhibit 4** shows that solar PV installations grew rapidly following the implementation of Colorado's RES in 2007. Estimating total installed solar PV capacity in Colorado was not possible using the data collected because capacity data was not reported for almost half of the systems installed. However, it is assumed that the trend in installed capacity would follow a similar path to that of the total number of installations.

EXHIBIT 4. ANNUAL SOLAR PV SYSTEM INSTALLATION IN COLORADO FROM 1978–2014[1]



Year	System installations	Cumulative number of systems[2]
Prior to 2007	793	793
2007	352	1,145
2008	1,185	2,330
2009	1,785	4,115
2010	2,361	6,476
2011	2,289	8,765
2012	3,531	12,296
2013	4,531	16,827
2014	6,828	23,655
2015 partial	4,722	28,377

1. 2015 data not graphed as it was incomplete for many jurisdictions.

2. Data in table represents 97 percent of the systems identified.

EXHIBIT 5. GEOGRAPHIC DISTRIBUTION OF SOLAR PV INSTALLATIONS

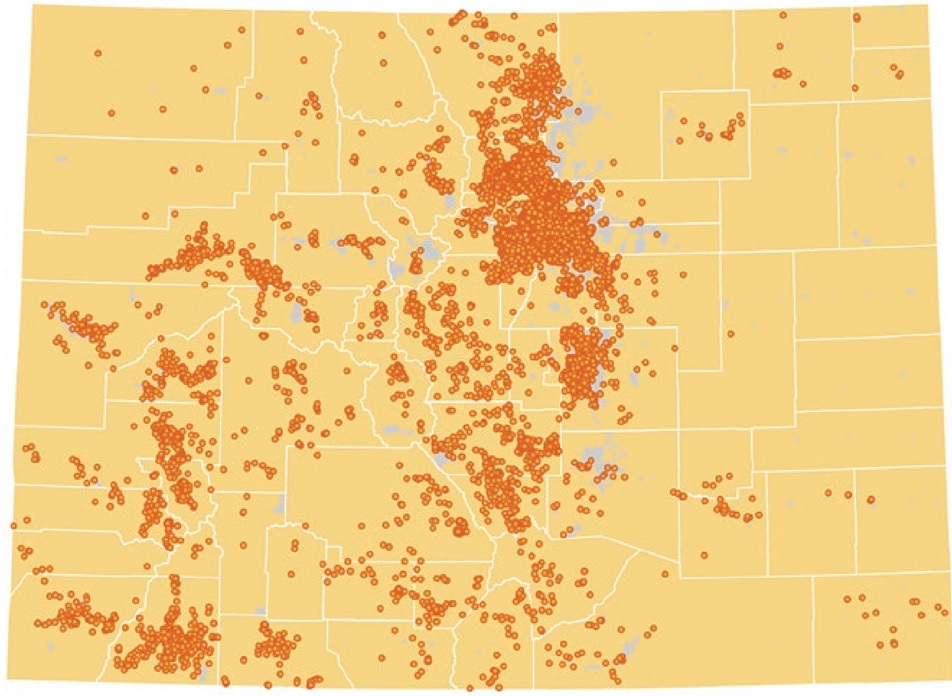


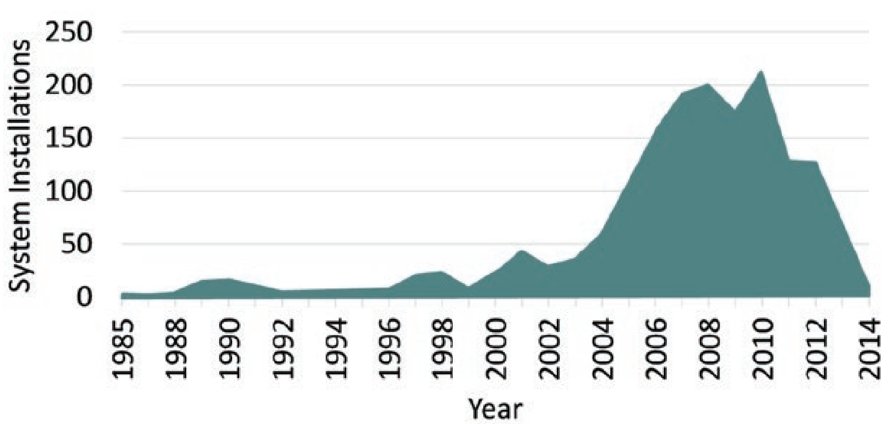
Exhibit 5 shows the geographic distribution of solar PV systems installed in the state. System installation is concentrated in larger metropolitan areas in the Front Range but many systems also have been installed in Western Slope cities such as Durango and Grand Junction.

The data for solar PV systems was the most complete and provided the best opportunity for analysis of installation trends in Colorado. The total estimated number of solar PV systems identified through this effort closely align with trends reported by electric service providers to the U.S. DOE Energy Information Administration (EIA) via Form 861, although the total number of systems identified in the current study is somewhat lower than the number provided by EIA.

3.3 Ground Source Heat Pumps

A total of more than 1,700 installed GSHPs were identified in this study. However, in contrast with solar PV, installations of GSHPs in Colorado (**Exhibit 6**) have declined in recent years. Low natural gas prices are one of the main factors contributing to the recent decline in GSHP adoption.

EXHIBIT 6. ANNUAL GSHP SYSTEM INSTALLATION IN COLORADO FROM 1985–2014[3]



3. 2015 data not reported as it was incomplete for many jurisdictions.

EXHIBIT 7. GEOGRAPHIC DISTRIBUTION OF GSHP INSTALLATIONS BY COUNTY

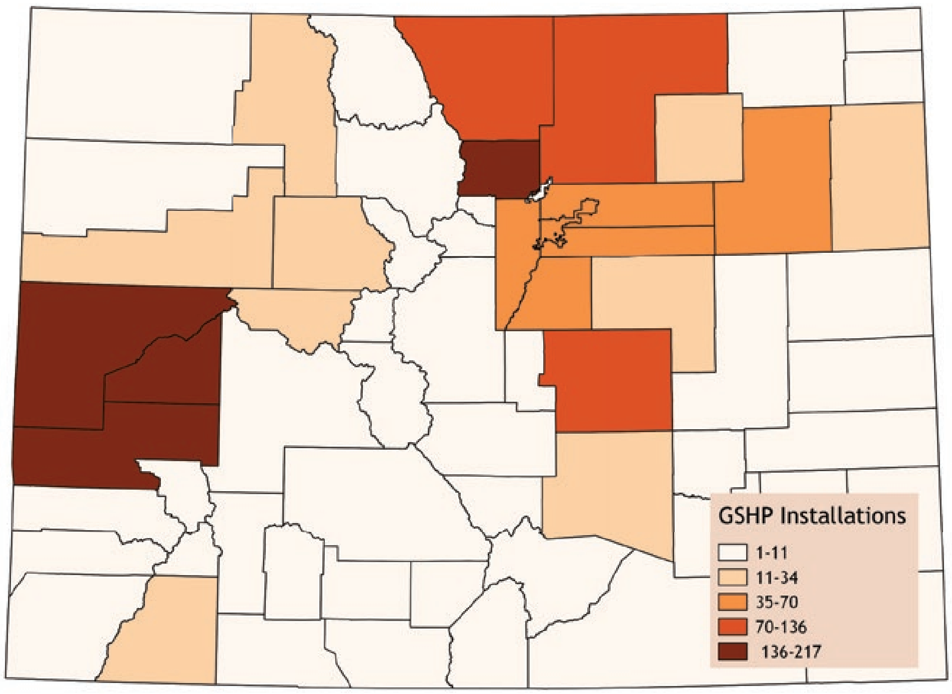


Exhibit 7 shows the geographic distribution of GSHP installations, aggregated by zip code.

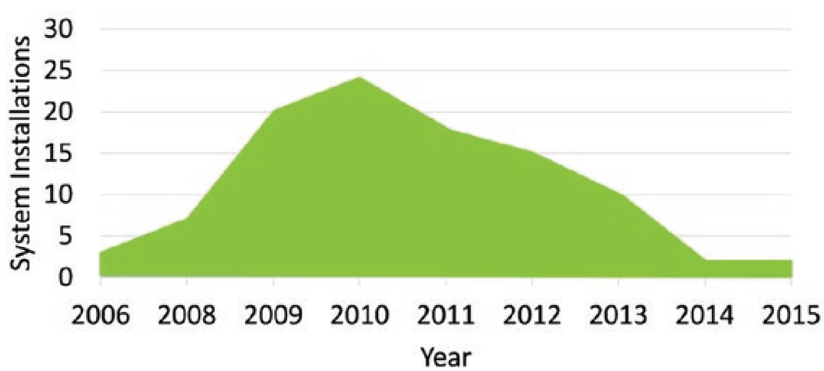
3.4 Solar Thermal

The number of installed solar thermal systems identified in this study was nearly 700. While this number is significant, other data suggests that this represents only a small fraction of the total number of systems. This disparity primarily is due to a lack of differentiating information in permit data that would allow for a more complete system count. Most permitting jurisdictions do not have a separate permit for solar thermal or even a permit data field that allows them to distinguish solar thermal systems from other mechanical equipment.

3.5 Small Wind

There were a total of 142 customer-sited small wind systems identified in the state. Several larger systems included turbines used for testing at the National Wind Technology Center, the 8 MW Huerfano River Wind project in the Walsenburg area servicing the San Isabel Electric Association, and the 1.8 MW turbine installed in the Pueblo area. One relatively unique turbine is the 900 kW turbine installed at the Wray Public School, which is a large system for any customer-sited system and is particularly large for a school-based project. **Exhibit 8** shows the number of small wind installations over time.

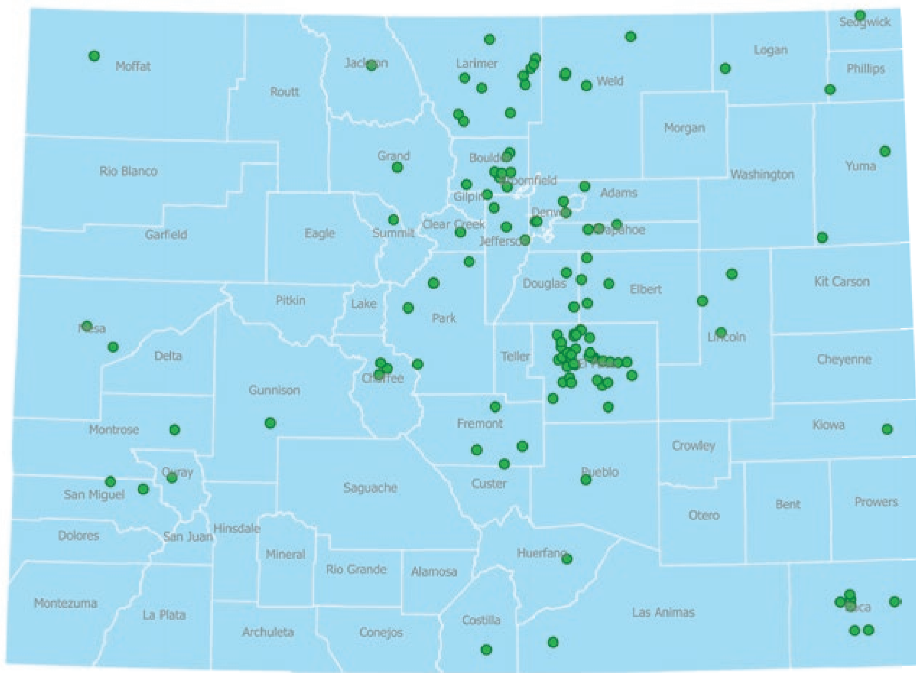
EXHIBIT 8. ANNUAL SMALL WIND SYSTEM INSTALLATIONS IN COLORADO[4]



4. Chart shows 70 percent of 144 total systems—install year not reported for the remainder.

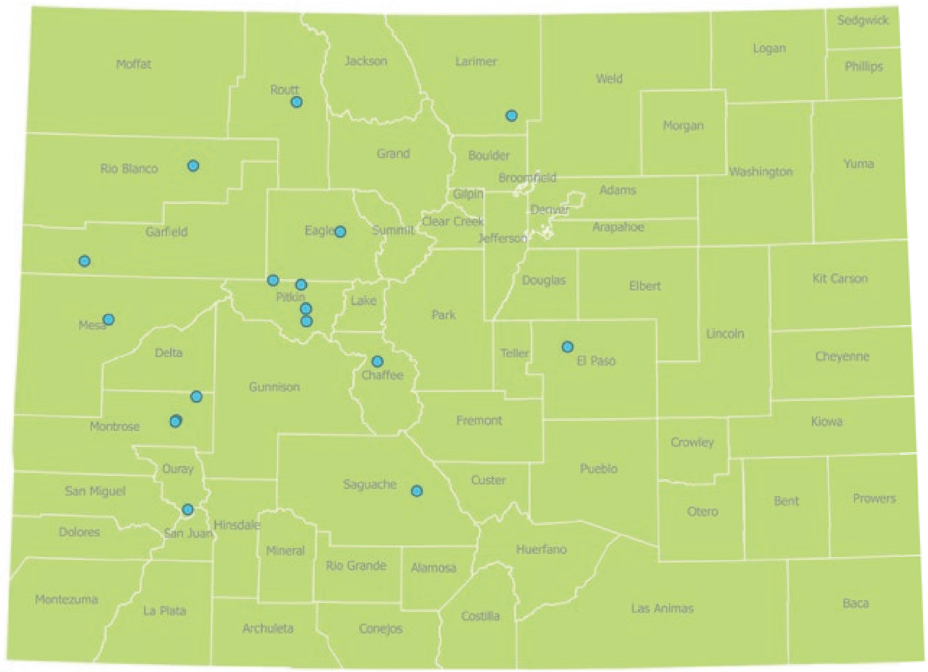
While the number of customer-sited wind systems identified is not large compared to some other technologies, wind turbine technology is interesting because it includes a wide array of system sizes installed over a wide geographic area (**Exhibit 9**).

EXHIBIT 9. GEOGRAPHIC DISTRIBUTION OF CUSTOMER-SITED WIND TURBINE INSTALLATIONS[5]



5. Map shows 83 percent of total systems.

EXHIBIT 10. GEOGRAPHIC DISTRIBUTION OF CUSTOMER-SITED HYDROELECTRIC INSTALLATIONS IN COLORADO



3.6 Small Hydropower

There were 19 small hydropower systems identified in the state through this study. These included systems that directly serve municipal utility power systems, but did not include small hydropower systems that sell power to an electric utility or electric cooperative. The small hydropower systems installed in Colorado range in size from a 5 kW system installed at a ranch in Steamboat Springs in 2012 to the 5,052 kW hydropower system installed at Ruedi Dam that serves the power needs of the City of Aspen Utilities Department. Several hydropower projects were installed at irrigation districts and municipal water and wastewater systems.

Exhibit 10 shows the geographic distribution of the small hydropower systems identified. It should be noted that some of the points on the map represent multiple systems in the same location, so not all of the systems are visible.

3.7 Data Gaps Analysis

ANTARES identified several data and information gaps and corresponding limitations to the use of the data collected. Some of these issues could be resolved through additional cleaning of the data already collected, but others require broader changes in the permitting process, such as collection of additional data points and standardization of the data collected.

Exhibit 11 shows the types of information gaps that were encountered during this project and could pose issues for future data collection and analysis.

EXHIBIT 11. CATEGORIES OF DATA AND INFORMATION GAPS ENCOUNTERED

Data Field	Not consistently available	Not reported	Erroneous information	Approximate percentage of records affected
Project value	✔	✔	✔	20%
Address/Location	✔	✔	✔	20%
System Capacity	✔	✔		65%
Residential/Commercial	✔		✔	40%
Installation date	✔			10%

Some data sources simply did not have data available for certain fields. For others, data was available for some records but not for others. Both of these situations were encountered for system capacity, project value and address fields. The inconsistent availability of capacity data in particular made it challenging to estimate total installed capacity for different technologies across the state.

Address information for systems was often incomplete, formatting was inconsistent, and typographic errors were common. A significant amount of data processing was necessary to obtain sufficient locational information to map systems with a reasonable level of accuracy.

The project value field was, for all system data derived from permits, an estimate of the labor, equipment and materials costs to install the permitted system. The value did not include overhead costs such as insurance or profits. These costs can add significantly to the installed cost of a system. Therefore, the project value field should not be construed as an estimate of the installed cost of a system paid by a customer. Similarly, the installation dates derived from permits were most frequently the date that the permit was approved, not the actual commissioning date of the system. This, however, is as close a proxy as possible for the date that the system began operating.

There was limited data available to accurately distinguish residential from commercial systems, due to the lack of a consistent definition of the terms residential and commercial. In some cases, this resulted in some very large systems for multi-family residential dwellings being listed as residential. This made it difficult to assess permitting fees or examine issues related to how these systems may be treated differently by electric service providers.

The permit data did not, in many cases, allow permitting jurisdictions to easily identify solar thermal, ground source heat pumps or wind turbine technologies. Solar thermal and ground source heat pump systems are not distinguishable from other residential or commercial plumbing permits for most jurisdictions. Boulder County, which has a separate solar thermal permit, is one of the few exceptions.

There are few commercial applications of energy storage systems other than temporary backup power or waste heat utilization for power generation in Colorado. Therefore, there has been no impetus to develop permitting processes specific to these systems. Any existing systems are likely permitted under rules for other electrical and plumbing projects. As the systems become more commercially available, there may be a need to evaluate how best to accommodate the needs of manufacturers, installers and end users for these systems. Energy storage systems in particular have the potential, when prices become more competitive, to facilitate increased use of renewable energy technologies.

4 | Permitting Requirements Overview for Customer-Sited Energy Systems

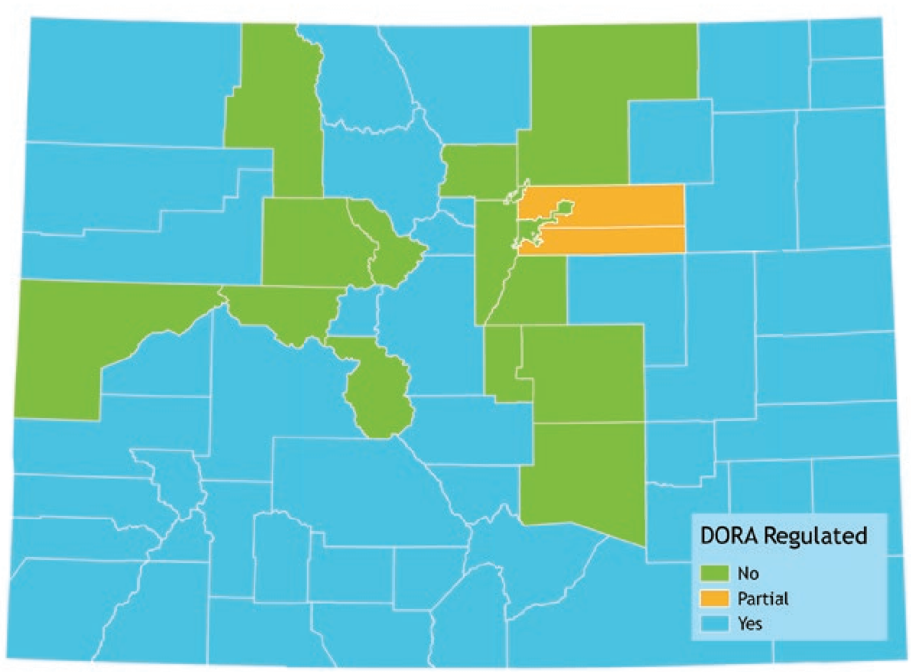
Permitting for energy projects in Colorado is regulated at the municipal and county level, as well as by the Colorado Department of Regulatory Agencies (DORA), Division of Professions and Occupations. DORA regulates more than 50 professions in the state, including electrical and plumbing licensing and permitting. DORA jurisdictions cover approximately two-thirds of the state geographically (see **Exhibit 12**), although DORA's service territory represents a smaller proportion of the state's population because it serves many rural locations.

4.1 DORA–Submittal Guidelines for Alternate Power Sources

DORA's Submittal Guidelines for Alternate Power Sources[6] include the items that must be supplied to the inspector, and apply to solar PV, wind, and small hydroelectric systems. The required items include permit numbers, site address, a site diagram that shows all major system components, an electrical one-line diagram, system specifications and manufacturer cut sheets, and details on the mounting configuration. The guidelines also specify that all systems and equipment must be listed and labeled by a recognized testing laboratory, and that outdoor equipment must be rated suitable for use in wet locations.

In addition to the general requirements above, DORA also has a specific solar PV permitting process. Typically the solar PV permit covers installation of roof- or ground-mounted panels. This permit is often twinned with an electrical permit that covers the interconnection process. DORA's solar permit application includes information such as site plans, one-line electrical diagrams, equipment lists, manufacturer cut-sheets, and structural load calculations.

EXHIBIT 12. COLORADO DORA ELECTRICAL BOARD TERRITORY



6. Colorado DORA, ***Submittal Guidelines for Alternate Power Sources***, Retrieved from https://drive.google.com/file/d/0B5zAmhRg5tCiMkhNUk1oVnVUZ1E/view

4.2 Municipal & County Regulations for Alternate Power Sources

At the county and municipal level, customer-sited renewable energy projects can be permitted using a variety of different processes including utilizing electrical permits, building permits, dedicated solar permits, or in the case of certain technologies, Special Exception Permits for projects that exceed sizing limitations or other criteria. A summary of the types of permits and associated requirement is provided below by technology.

Solar PV

In 2011, the Vote Solar Initiative and COSEIA surveyed the permitting requirements of several counties and municipalities in Colorado, comparing the results with industry best practices.[7] The data from the surveyed municipalities was compiled and updated for use in this study.

Of the 19 jurisdictions falling outside of DORA jurisdiction that were included in the COSEIA study, seven currently use a dedicated solar permit, 11 use the jurisdiction's building permit, and one (Colorado Springs) defers permitting to the county. When changes to the electrical panel are necessary for installation of the solar PV project, an electrical permit also is required.

Whether they require a building permit or a solar permit, some jurisdictions provide detailed guidelines, lists of requirements, or checklists to aid the process of submitting an application for installing solar panels. Many others do not offer any guidance at all. The permitting requirements and fees within a jurisdiction often differ for residential and non-residential systems, regardless of their size. In these cases, the non-residential systems require more detail, additional inspections, and higher fees. Requirements within a jurisdiction also may differ for systems based on configuration. Finally, some jurisdictions allow for electronic submittal of permits and associated documents via web portal or email, while some still require multiple paper copies.

Since the COSEIA report was released in 2011, several jurisdictions have adjusted their processes to be more in line with the best-practice recommendations, including lower permitting fees and allowing for online transactions. However, at the time of this draft, the process remains far from standardized, with each jurisdiction following its own process to some extent.

Solar thermal

Several jurisdictions reviewed utilize a permitting process for solar thermal similar to that of solar PV, with the key difference being the requirement for piping layout drawings that are not present in solar PV systems. In these municipalities, permits usually require a plan showing the location of wiring and piping, and inspections usually include rough and final plumbing and electrical inspections. However, in most jurisdictions, solar thermal system permitting for the HVAC component is not substantially different from a water heater or boiler installation and there is no separate permit for solar thermal systems. In these jurisdictions, there is no data field or other way to distinguish a solar thermal system from any other water heating or HVAC installation.

7. Vote Solar Initiative, ***Survey of Solar Permitting Practices in Colorado Local Jurisdictions***, 2011.

Ground Source Heat Pumps

Permitting requirements for ground source heat pumps are informed by the Colorado Geothermal Resource Act and the Federal Underground Injection Control Program and summarized in the Colorado Geothermal Rules.[8] At the state level, a Storm Water Permit and Dust Control Permit could be required during the construction phase, and a Colorado Electrical Permit from the State Electrical Board and a Well Water Permit from the Office of the State Engineer (SEO) could also be required. At the municipal or county level, geothermal projects could require Conditional or Special Use Permits, Building Permits, or Septic System Permits.

The Colorado Geothermal Rules define Type A geothermal wells as having a total depth of less than or equal to 2,500 feet, and utilizing geothermal fluids of less than or equal to 212°F. Type A wells can be either open-loop (Type A-OS) or closed-loop. Closed-loop wells can utilize either horizontal (Type A-CLH) or vertical (Type A-CLV) piping. Type A wells may be used in open-loop geoexchange systems, but this is not as common as closed-loop systems. Permitting and legal issues are significantly more complex for open-loop systems than for closed-loop systems.

Most ground source heat pump systems in Colorado use closed-loop systems (either Type A-CLV or Type A-CLH), which must be installed in accordance with manufacturer specifications, and installation must be performed by a certified individual.

8. Colorado Division of Water Resources, ***Rules and Regulations for Permitting the Development of Geothermal Resources through the Use of Wells*** (aka ***Geothermal Rules***), September 2004.

Wind

Most local permitting jurisdictions in Colorado do not have permits specific to wind turbine installation. Instead, local permitting is often handled using existing electrical and/or building permitting procedures. In addition to local electrical and building permitting requirements, many jurisdictions have small wind ordinances, which regulate the installation of wind energy conversion systems up to a certain size.

Many small wind ordinances are based on a national model ordinance and are, therefore, very similar across most jurisdictions. Typical small wind ordinances include specifications for the elements to include in a site plan, minimum parcel size, maximum allowable tower height, required setbacks from property lines, minimum allowable height above ground level, fencing or other anti-climb measures, and provisions for ensuring that the project does not adversely impact neighboring properties with noise or electromagnetic interference.

The permitting process typically includes provisions that applicants first obtain a signed "letter of intent to interconnect" from the utility company, demonstrating that the project is in compliance with requirements of the Public Utilities Commission or utility itself. Local building permit requirements typically require a letter of certification from a registered structural engineer stating that the support tower is in compliance with the Uniform Building Code.

Small Hydropower

As shown in **Exhibit 13**, small hydropower projects can be subject to licensing and permitting requirements from several different jurisdictions, depending upon the specifics of the site and the facility.

EXHIBIT 13. SMALL HYDROPOWER REQUIREMENTS

Jurisdiction	Requirement
Federal	FERC licensing
	Army Corps of Engineers Section 404 Permit
	Bureau of Land Management
	U.S. Forest Service Special Use Permit
	Bureau of Reclamation
	U.S. Fish and Wildlife Threatened and Endangered Species Consultation
State of Colorado	Department of Public Health and Environment Water Quality Control Section 401 Permit
	State Engineers Office (dams and water rights)
	Department of Regulatory Affairs State Electrical Board Permit
	1041 Powers (allows local government input on activities of state interest)
Local Government	Planning and Zoning Permits
	Commissioner Approval
	City/Town Council Approval

The Colorado Small Hydropower Handbook,[9] revised in 2015, provides a comprehensive review of the permitting requirements at each of these levels of jurisdiction.

Importantly, small hydropower projects enjoy exemption routes for FERC permitting, assuming the project does not occupy federal lands. These exemptions were expanded under the Hydropower Regulatory Efficiency Act of 2013[10]:

1. Small hydropower projects that meet the overall requirements and have a capacity of up to 10 MW may be exempted from FERC licensing.
2. Conduit exemptions apply to hydrological structures that have a maximum capacity of 40 MW that utilize existing man-made hydrological structures.

This act to streamline permitting processes for small hydropower projects also put in place requirements for expedited decisions on the part of FERC in response to these projects filing an intent to develop, thereby also compressing the time frame for small hydropower approval in addition to reducing the administrative burden.

9. Colorado Energy Office and Colorado Department of Agriculture. October 2015. *The Small Hydropower Handbook*. Available at https://www.colorado.gov/pacific/sites/default/files/atoms/files/CO%20Small%20Hydro%20Handbook_0.pdf

10. Federal Energy Regulatory Commission, Hydropower Regulatory Efficiency Act of 2013.

Electric Energy Storage

There are few commercial energy storage systems currently installed in Colorado. Colorado State University has some energy storage systems that it uses on an intermittent basis for research systems at its Large Engine Lab, but they do not operate for any significant period of time. As a result, there is no established permitting process for either energy storage systems. As with any new or emerging technology, permitting these projects requires working closely with local and/or state permitting officials to ensure that they fully understand how the technology works.

Waste Heat Recovery and Use for Electricity Generation

Waste heat recovery technologies used for power generation have few commercial installations in Colorado. As with energy storage systems, permitting these types of waste heat recovery systems will require working closely with state and local permitting officials as permitting engineers may not have experience with them.

5 | Recommendations

There are a wide range of permitting practice and policy changes that could facilitate the collection of customer-sited energy system data for compilation in a statewide database. A complete and continuously updated database would provide benefits for a variety of stakeholders, including providing the state and other interested parties the opportunity to gain a better understanding of market trends, allowing local governments access to accurate data to help inform climate action activities, and providing appraisers and other real estate professionals access to energy system data.

5.1 Permitting Best Practices

Moving forward, if CEO decides to track installation of these systems to better understand how customer-sited energy systems are contributing to Colorado's energy supply, it should work with permitting jurisdictions by providing technical assistance and possibly financial assistance to support changes in the permitting processes. Some specific steps are listed below.

- Work with DORA and other major permitting jurisdictions to see how permit applications and tracking databases might be changed to make it

easier to query data on a regular basis to support data collection. For DORA this may require coordinating with OIT and could require negotiation and training permitting staff to ensure that any additional data burden can also improve outcomes related to their core mission. It is demonstrable that better data collection processes will provide data processing efficiencies and improved accuracy, which are important to any agency.

- System type and capacity information need to be available as separate fields in permitting documents and address standardization needs to be adopted. The U.S. Postal Service provides address standards that have been widely adopted and are available online.[11]
- Consistent definitions of terms such as residential and commercial need to be developed and applied in the system data. The City of Fort Collins permitting form[12] is one example that provides a good model by collecting relevant information about the type of structure that needs a permit.
- Communities that have developed comprehensive methods for electronically tracking on-site energy development can be models for other communities, and they should be encouraged to share their best practices. Examples of some communities that have done this well in Colorado include the City of Aurora, the City of Arvada, Boulder County, the City of Boulder, the City of Fort Collins, the City of Westminster, and the Pikes Peak Regional Building District.
- Develop standardized permitting forms that exemplify best practices for permitting jurisdictions but that could be customized to meet the diverse needs of communities in Colorado. Model forms for solar PV systems have been developed and are available from COSEIA's Solar Friendly Communities website at **www.solarcommunities.org**. These can be adapted to meet the needs of different permitting jurisdictions and technologies other than solar PV such as solar thermal and GSHP.

The data collected through this project shows the rapid growth of customer-sited energy systems and the resulting need to streamline permitting and standardize procedures across the state to allow for efficient operations of both permitting offices and energy system installers. These are some of the key ways that permitting procedures could be streamlined for standard rooftop solar PV arrays, which make up the majority of customer-sited energy systems in Colorado:

- Develop a standard list of permitting requirements that can be shared with jurisdictions and posted on websites.
- Promote electronic permitting for larger jurisdictions, or at a minimum, electronic submittal of permitting documents, which increases efficiency, transparency, and accessibility.
- While Colorado's Fair Permit Act caps permit costs for solar PV permits at $500 and many jurisdictions have adopted best practices of significantly lower permit caps, others regularly add on many additional fees (often called "use taxes"), driving up the cost of permitting. Jurisdictions should charge actual costs for permits and not use them to subsidize other operations.
- Generally, one inspection should be sufficient for a standard solar PV system. Jurisdictions should be able to decide if a rough or final is more valuable.
- Rather than require a separate engineering review of each system, jurisdictions should allow systems that meet standard engineering calculations based on its wind and snow loads to be exempt from providing a separate professional engineering stamp on each system.

5.2 Coordination with Energy Service Providers

Electric service providers have demonstrated that they are willing to provide data to support this effort with the caveat that some data fields may not be released in order to preserve customer confidentiality and comply with applicable regulations and laws. CEO should continue to coordinate with electric service providers in the following ways:

- Continue to work with utilities to provide zip code level data, while reporting any potentially sensitive information in an aggregate form to preserve confidentiality. Most electric service providers that have this data demonstrated that they are willing to assist with this.
- Use utility data to fill in gaps in system capacity values for solar PV systems as an interim step while data acquisition processes are improved.

Using utility data could be a lower-cost alternative to using permit data. However, utility data privacy rules may limit how data may be used and publicly disclosed.

11. U.S. Postal Service, Postal Addressing Standards, http://pe.usps.gov/text/pub28/welcome.htm

12. Available on-line from the Solar Friendly Communities website: http://solarcommunities.org/12-best-practices/use-a-standard-permit/

5.3 Long-Term Process Improvements

It should be recognized that some of the data quality issues involve changes to permitting processes that would require mid- to long-term education and outreach efforts. However, the resources required to make some of these changes may not be that substantial, and the investment could help reduce administrative burdens on smaller building departments.

- As one example of a mid- to long-range initiative, CEO (with other stakeholders) could evaluate the possibility of securing additional resources or funding for solutions to reduce the burden of collecting energy system data alongside other information for systems in smaller permitting jurisdictions. Helping jurisdictions modernize their permitting systems would improve their ability to generate data in the format needed for this purpose. That data then could easily be pulled into a statewide web-based portal, or portals at the county level where systems could be listed as they are permitted.
- For larger and medium-sized permitting entities, we recommend a mid- to long-term transition to digital permitting systems that facilitate the use of "master" and "sub" permits so that permits that are part of a related project can be viewed as such, and changes to existing projects can be distinguished from new projects. This could assist with reducing permit processing time, tracking permit history, and performing other permitting functions more effectively.

6 | Conclusion

We believe this project marks the beginning of a more comprehensive and coordinated effort to collect customer-sited energy system data on a continuous basis—an effort that will become increasingly important for numerous reasons:

- As markets for distributed energy resources grow, it becomes more apparent that a coordinated public planning process involving a range of stakeholders including land and housing developers, local governments, energy developers and utilities is necessary. This process will necessitate more accessible, accurate and transparent information than currently exists for much of the state.
- As Colorado seeks to move toward a low-carbon future, the ability to quantify the amount of distributed resources will become more important. Currently, the state lacks the ability to say with certainty how much distributed energy is deployed in Colorado.
- Local governments and regions are increasingly interested in understanding more about the deployment of renewable energy technology in their areas. Developing a more consistent and complete way of accounting for these resources will help them with their own climate action plans. We also have seen through COSEIA's Solar Friendly Communities program the power of friendly competition between local governments. A statewide way to account for these systems would allow such competitions to hold more meaning.
- Tying on-site energy resources to sales prices of homes is still in its infancy but will become increasingly important as energy codes tighten and energy prices continue to rise. The ability to value a home's on-site renewable resources should be as standard as valuing a home's other attributes.

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