County Land-Use Regulations for Solar Energy Development in Colorado

Allison Jackson,[1] Kate Doubleday,[2] Brittany Staie,[2] Allison Perna,[2] Mariel Sabraw,[1] Liz Voss,[1] Apolonia Alvarez,[2] Byron Kominek,[1] and Jordan Macknick[2]

1 Colorado Agrivoltaics Learning Center
2 National Renewable Energy Laboratory

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NREL/TP-6A20-88556
April 2024

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List of Acronyms

CALC	Colorado Agrivoltaic Learning Center
CRS	Colorado Revised Statutes
CSG	community solar garden
EIA	U.S. Energy Information Administration
ft	foot
GWac	gigawatts alternating current
GWdc	gigawatts direct current
kW	kilowatt
kWh	kilowatt-hour
MWac	megawatts alternating current
MWdc	megawatts direct current
NREL	National Renewable Energy Laboratory
PV	photovoltaic
SEIA	Solar Energy Industries Association
USDA	U.S. Department of Agriculture

Executive Summary

The United States is experiencing rapid growth in ground-mounted solar, including in Colorado where utility-scale (≥1 MW nameplate capacity) solar photovoltaic (PV) plants have been deployed in 28 of 64 counties (U.S. Energy Information Administration [EIA] 2023a). Ground-mounted or free-standing solar uses an array of PV modules mounted on a racking system on the ground. It includes both large, utility-scale plants as well as smaller applications, such as customer-sited arrays at commercial or industrial facilities and community solar gardens. As solar deployment has increased, so have community concerns about impacts to the visual landscape, property values, community character, and the development of agricultural land (Nilson, Hoen, and Rand 2024). Agrivoltaics, a dual land use combining agriculture and ground-mounted PV on the same land, is one possible solution to some of these challenges (Macknick et al. 2022). Agrivoltaics can include cultivating crops, beekeeping, and grazing livestock underneath and/or in between solar panels and can provide diversified income, water savings, and other synergistic benefits (Hernandez et al. 2019; Macknick et al. 2022; Nilson, Hoen, and Rand 2024). There is recent interest in agrivoltaics in Colorado, including successful commercial deployments as well as state-level grants and tax incentives for more demonstration sites (Jaffe 2022b; Colorado General Assembly 2023a).

Additionally, Colorado has a goal of achieving a 100% reduction in economy-wide greenhouse gas pollution by 2050, and the state's largest electricity provider, Xcel Energy, is targeting 100% carbon-free electricity by 2050 (Colorado General Assembly 2023b; Xcel Energy 2023). Since permitting authority for solar plants in Colorado lies with local governments, county land use codes and permitting processes play an important role in solar deployment (Lerner 2022; Lopez et al. 2023; Pascaris 2021). Counties commonly define zoning districts with different allowable uses and permitting processes for land-use changes, varying in their oversight and requirement complexity. Requirements can include maximum structure height; setbacks from property lines, roads, and structures; fencing or screening for safety or visual appeal; and other visual impact and vegetation management requirements, which can impact the design and viability of solar arrays (Daniels and Wagner 2022). In addition, agrivoltaic systems are a dual land use that might not fit neatly within existing zoning definitions or solar regulations that assume single land use. Each county generally adopts unique land use codes, causing high variability in solar regulations, which is a challenge for interested stakeholders, such as policymakers, solar developers, and researchers. In addition, county-level codes may be publicly available online in a document form such as a pdf, or they may not be available at all.

In this report, we present a comprehensive review of county-level policies across Colorado that regulate ground-mounted or free-standing solar, as opposed to rooftop or building-integrated solar, for both utility-scale and distributed applications. This review includes both solar-specific ordinances as well as general land-use code that might be applicable in counties without solar-specific policies. This report provides an accessible reference for stakeholders interested in identifying counties with particular regulations or in analyzing the diversity of regulations across Colorado. We defined a set of search criteria to find information on solar definitions and classifications, permitting processes, and use-specific requirements in each of Colorado's 64 counties. We reviewed relevant ordinances, land-use code, and comprehensive and master plans conforming to those criteria from March to November 2023. If any uncertainties were identified, we contacted county officials for clarification. The findings were categorized and mapped to

illustrate the distribution of key policies adopted across Colorado's counties on the following topics: solar definitions, solar siting policy documentation, categorization of PV systems for permitting, 1041 permitting, solar on agricultural land, panel height restrictions, fencing requirements, vegetation management, visual impacts, and plans and financial assurance for decommissioning**.** Additional topics relevant to solar permitting, such as wildlife impact mitigation, road impact fees, lot coverage restrictions, and setbacks are left for future work or are addressed elsewhere (e.g., Lopez et al. 2023). Appendix A lists the documents reviewed for each county, and other county-level results are available in the appendices.

As of November 2023, 39 of Colorado's 64 counties had documented solar land-use regulations that contain some or all of the information in the search criteria (Figure ES-1). Nineteen counties have no land-use code specific to ground-mounted solar. However, this landscape is continually evolving—the remaining six counties had moratoriums on large-scale solar applications in effect during the review and report preparation periods. Five of these moratoriums were instituted to provide sufficient time for land-use code revisions soon after large solar power plants were permitted or announced to the public, and county officials determined that existing regulations did not sufficiently address solar as a land use or sought to proactively address other community concerns (Witowski 2022; Bunton 2023; Turner 2023a; McDermott 2023; Sida 2023).

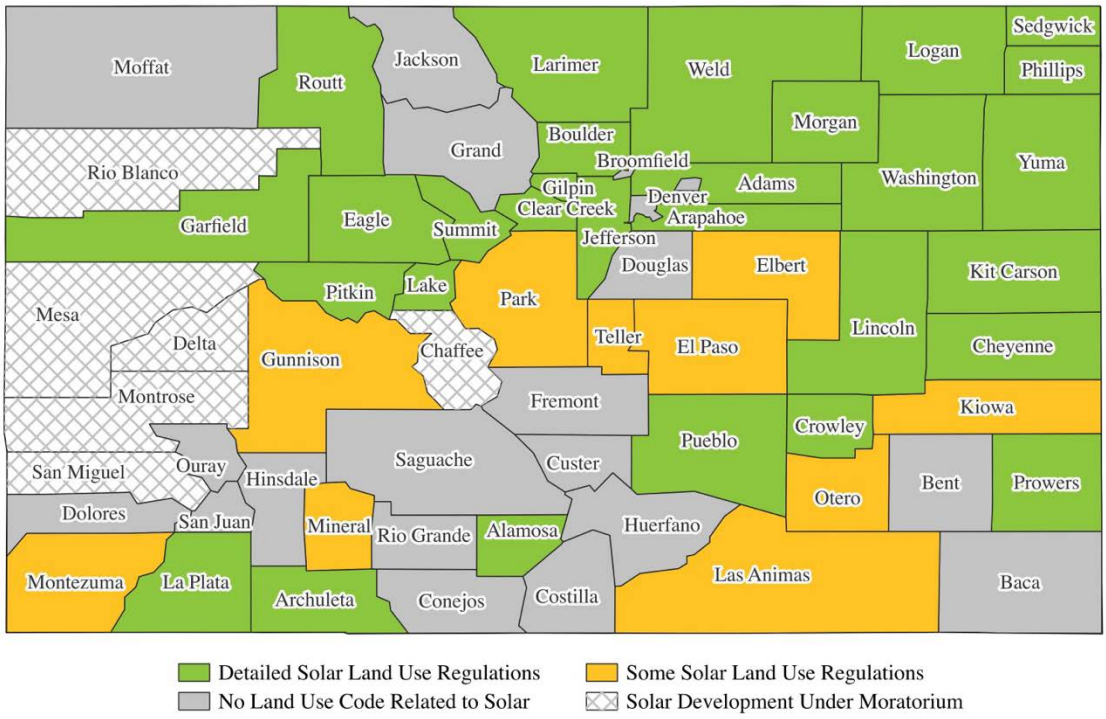

Figure ES-1. Status of solar land use regulations in Colorado counties (2023).

Counties with "Detailed Solar Land Use Regulations" have documentation on all the policies listed in the review's search criteria, and counties with "Some Solar Land Use Regulations" have documentation on some but not all.

While a few counties have adopted language similar to that of their neighbors, most counties have adopted their own definitions of solar energy systems and their own land-use requirements. The cumulative effect is a wide variety of potential regulations for utility-scale solar in Colorado, as summarized in Figure ES-2. When considering both solar-specific ordinances and general

land-use codes, the most common requirements regulate fencing and visual impacts, closely followed by required plans and financial assurance for decommissioning after the system's useful life. Particularly relevant for agrivoltaic installations, several counties have specific restrictions regarding solar or general development on irrigated land, and many counties have restrictions on the maximum panel height, although most restrictions are currently high enough for common agrivoltaic configurations. Unique to Colorado, many counties also have "1041" permit requirements that might apply to solar; 1041 powers refer to delegated powers from the state to local jurisdictions to regulate certain matters of statewide concern, and 1041 permits are generally more expensive, rigorous, and have a higher level of scrutiny than other permit types.

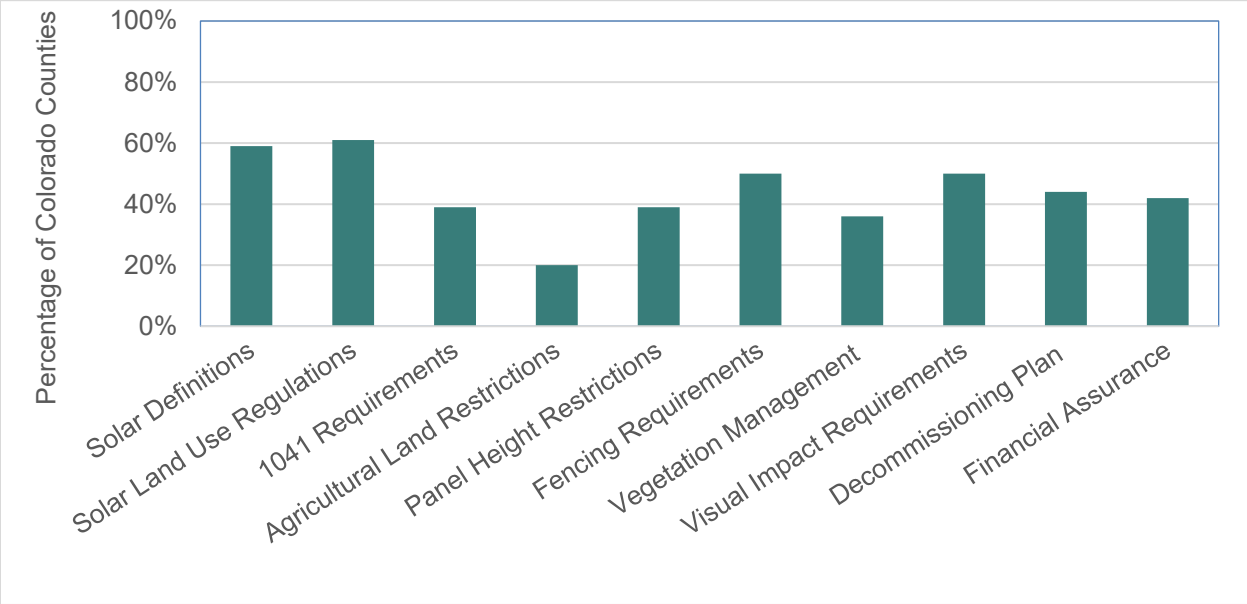

Figure ES-2. Summary of land-use policies and requirements that might apply to utility-scale solar across Colorado's counties

From the review results, we found the following key takeaways:

- **Solar plant permitting requirements across Colorado are county-specific and highly variable.** Counties often varied permitting requirements for PV systems based on their installed capacity, land area, and/or electricity end use. These groupings might not be applied as intended for new and emerging solar configurations due to gaps or ambiguity in definitions. For example, there might be fewer requirements for large off-grid PV arrays for commercial uses than grid-tied systems in counties that differentiate based on electricity end use. There can also be overlap with legacy 1041 regulations, in some instances requiring developers to complete both a 1041 permit and a conditional use or special use permit (County of Elbert 2018). Relatedly, two counties require 1041 permits at a lower installed nameplate capacity threshold for solar and wind compared to fossil fuel, biofuel, or similar power generating facilities.
- **75% of Colorado's existing utility-scale solar power plants and 89% of its installed solar capacity are located in 45% of its counties, each of which has documentation for all of the policies in the review**. Once a county starts receiving applications for solar power plant permits, there appear to be two common drivers motivating the adoption of

solar-specific regulations: community response and clear gaps in the existing land-use code. The public processes required for land use code and zoning changes can help address community needs and concerns, and clearly documented policies lower risks for solar development.

- **Some county policies existing at the time of the review could limit agrivoltaic deployment**, including four counties restricting solar in some or all agricultural zones, several others considering agricultural impacts in the review process, four counties with 10–15-foot panel height limits, and six counties with higher permitting stringency for any development on irrigated land.

Table of Contents

Executive Summary ..... **v**
1 Introduction **1**
2 Background **4**
3 Methods **7**
3.1 Search Criteria 7
3.2 Document Search 8
3.3 Contact With Planning Departments or County Commissioners 9
3.4 Categorization and Mapping of the Data 9
4 Results **10**
4.1 Solar Definitions 10
4.2 Solar Siting Policy Documentation and Solar Deployment 11
4.3 Categorization of PV Systems 13
4.4 1041 Permitting (Areas and Activities of State Interest) 14
4.5 Solar on Agricultural Land 16
4.6 Panel Height Restrictions 18
4.7 Fencing Requirements 19
4.8 Vegetation Management 20
4.9 Visual Impacts 22
4.10 Decommissioning Plans 23
4.11 Financial Assurance for Decommissioning 24
5 Discussion **26**
5.1 Solar-Specific Ordinances, Deployment, and Community Response 26
5.2 Variability in Solar Permitting Across Colorado's Counties 29
5.3 Agrivoltaics and Solar Land-Use Code 31
5.4 Future Research 33
6 Conclusion **35**
Glossary **37**
References **38**
Appendix A. County Land-Use and Permitting References **48**
Appendix B. Solar Definitions by County **55**
Appendix C. 1041 Permit Thresholds by County **66**
Appendix D. Panel Height Restrictions by County **68**
Appendix E. Fencing **70**

List of Figures

Figure ES-1. Status of solar land use regulations in Colorado counties (2023)..... vi
Figure ES-2. Summary of land-use policies and requirements that might apply to utility-scale solar across Colorado's counties..... vii
Figure 1. Average solar resource and utility-scale (>1 megawatt [MW]) solar deployed by county as of October 2023 (EIA 2023b)..... 5
Figure 2. Policies and definitions reviewed for each Colorado county 8
Figure 3. Solar power or solar power zoning definitions in Colorado counties..... 11
Figure 4. Identification of which Colorado counties have implemented land-use policies regulating solar installations 12
Figure 5. Colorado counties' methods for categorizing solar power installations to determine which requirements to apply during the permitting process. 14
Figure 6. Solar power plants might trigger a 1041 permit requirement in some Colorado counties. 15
Figure 7. Regulation of solar power plants on agricultural land in Colorado counties..... 17
Figure 8. Maximum allowable height of solar panels in each Colorado county..... 18
Figure 9. Fencing requirements for solar power installations in Colorado counties..... 20
Figure 10. Vegetation management requirements for solar power installations in Colorado counties..... 21
Figure 11. Visual impact requirements applicable to solar power installations in Colorado counties 22
Figure 12. Decommissioning and reclamation requirements for solar power installations in Colorado counties 23
Figure 13. Financial assurance requirements for decommissioning solar power installations for Colorado counties 25
Figure 14. Timelines of solar deployment, adoption of solar-specific ordinances or definitions, and amendments to those ordinances for Colorado counties with high solar deployment to date. 27
Figure 15. Timelines of current county-level solar moratoriums in Colorado, including public announcement or permit approval of key solar power plants planned in each county. The planned capacity and/or acreage of each solar plant is indicated..... 28

List of Tables

Table 1. Number and Installed Capacity of Solar Power Plants Located in Counties With Different Levels of Solar Siting Policy Documentation 13
Table 2. County Policies Specifically Protecting Agricultural Lands From Solar Development 17
Table A-1. County Documents Referenced in the Review Results 48
Table B-1. Solar Siting Definitions by County 55
Table C-1. Colorado County Thresholds Potentially Triggering a 1041 Permitting Process for Solar Power Plants in Those Counties 66
Table D-1. Height Restrictions on Solar Panel Heights by County 68
Table E-1. Fencing Requirements by County 70

1 Introduction

The United States is currently undergoing a large-scale build-out of rooftop and ground-mounted solar photovoltaic (PV) projects, with total installed capacity projected to nearly double from 189 gigawatts alternating current (GWac) in 2024 to 352 GWac in 2030[1] (Gagnon et al. 2023). For utility-scale solar power plants and community solar gardens (CSGs) as well as for large commercial and industrial customers consuming their own solar-generated electricity on-site, these installations are typically ground-mounted and can cover tens or up to thousands of acres (Ong et al. 2013). When trying to identify locations for large ground-mounted solar plants, the most promising sites for solar developers are often on large, cleared parcels close to existing transmission lines with strong solar resource, stable soil, and minimal slope (Arán Carrión et al. 2008). Much of the land that meets these needs is current or former agricultural land (Adeh et al. 2019). While solar development is generally supported in the United States (Carlisle et al. 2015), there can be opposition to projects, particularly with projects developed on farm or forest lands (Gaur et al. 2022). Community resistance to solar development has occurred in rural areas, as communities attempt to balance prime farmland conservation, support new economic opportunities, maintain local rural character, and achieve renewable energy targets (Jaffe 2022b; Richardson, Kirk Hall, and Morgan 2022; Sungu 2011).

One possible opportunity to address these challenges is agrivoltaics, a dual land use that combines agriculture and ground-mounted PV on the same land (Bessette et al. 2024; Dinesh and Pearce 2016; Kumpanalaisatit et al 2022; Macknick et al. 2022; Mamun et al. 2022). These dual land uses can include cultivating crops, beekeeping, and grazing livestock underneath and around solar panels (Macknick et al. 2022; Kolbeck-Urlacher 2023). In the right conditions and with the right hybrid design, agrivoltaics can provide an additional income stream for landowners, maintain farmland or pastureland in production, and provide other synergistic benefits (Hernandez et al. 2019; Jaffe 2022b; Macknick et al. 2022). These benefits have the potential to address some of the major sources of community opposition, although some of the impacts are still unclear or mixed. The potential visual and aesthetic impacts of solar on the landscape is a common reason for community opposition (Carlisle et al. 2015; Nilson, Hoen, and Rand 2024), and current literature does not find clear community preferences for the aesthetics of agrivoltaic systems (Pascaris et al. 2022; Schröter, Püttschneide, and Mergenthaler 2023). However, other studies have also found that solar projects would be more likely to be supported with the addition of agrivoltaics, and solar developers have reported sometimes adding agrivoltaics in response to community feedback (Pascaris et al. 2022; Nilson, Hoen, and Rand 2024). Pascaris et al. (2022) found that 82% of survey respondents stated they would be more likely to accept solar projects in their community if agrivoltaics were integrated, even more so if they provided fair economic opportunities to farmers and the surrounding community.

While proposing an agrivoltaic rather than a single-use PV system can impact a community's response to a permit application, it can also change how the application is handled during the permitting process. Based on the selected dual-use activities, an agrivoltaic PV array might be configured differently from a single-use utility-scale system (Macknick et al. 2022). For example, the PV panels might be mounted higher above the ground or with wider spacing

[1] Based on NREL's Mid-case Standard Scenario with current policies (Gagnon et al. 2023).

between rows of panels to accommodate larger livestock, such as cattle, or agricultural equipment (Macknick et al. 2022). Due to these differences in use and configuration, agrivoltaic and single-use PV systems might also differ in where and how they can be successfully permitted for installation.

While national renewable energy policies focus on financial incentives, and state policies generally include a mix of incentives, land-use laws, and renewable portfolio standards, the final authority on whether solar is permitted for installation typically lies at the county or municipal level (Daniels and Wagner 2022; Kolbeck-Urlacher 2023; Pascaris 2021). Therefore, county zoning codes and permitting processes can have a significant impact on where and how ground-mounted solar and/or agrivoltaic installations could be built (Lerner 2022; Lopez et al. 2023; Pascaris 2021). Counties commonly define zoning districts, such as industrial or agricultural, with different allowable uses (Daniels and Wagner 2022). Further, some uses might be allowed as the primary land use, whereas other uses might only be permitted as an accessory that is incidental to the primary use (Dillemuth and White 2013). Agrivoltaic installations are a dual land use that might not clearly fit within the existing zoning definitions (Pascaris 2021). Each zone can have its own requirements, such as maximum structure height, fencing or screening for safety or visual appeal, and minimum distance that structures are set back from the road (Dillemuth and White 2013). These requirements can impact the design and economic viability of ground-mounted solar and agrivoltaic installations. There are other siting considerations as well, such as minimizing impacts on wildlife, scenic vistas, and sensitive historical, cultural, or archeological resources.

For each zoning district within a county, counties specify the type of permit required for each allowable use in that district, such as an accessory or use-by-right permit, conditional use permit, or special use permit. Use-by-right permits have minimal if any requirements, conditional use permits have requirements that must be reviewed by the county administrator or land-use department, and special use permits require extensive documentation and are reviewed by the Board of County Commissioners in a public hearing (Daniels and Wagner 2022). Zoning codes often allow large-scale ground-mounted solar plants within certain zones subject to a special use permit process (Daniels and Wagner 2022).

Information on county-level regulations is not centrally located and can be time-consuming to review, presenting a challenge for stakeholders such as policymakers, solar developers, and researchers interested in accessing and analyzing that information. Guarino and Swanson (2023) conducted a review of local-level agrivoltaic regulations in Illinois, which to the best of our knowledge is the only such resource for agrivoltaics in the United States. Lopez et al. (2023) reviewed county-level ordinances in the United States and analyzed the impacts of wind and solar setbacks on land available for renewable development. Owusu-Obeng, Mills, and Craig (2024) developed a database of local zoning ordinances for the Great Lakes region and quantified the expected impacts of these ordinances on solar deployment. This report expands that knowledge pool by reviewing and reporting county-level land-use codes impacting ground-mounted solar and agrivoltaic development across all counties in Colorado. While both Guarino and Swanson (2023) and Lopez et al. (2023) only reviewed solar-specific ordinances, this review includes both solar-specific ordinances and generally applicable zoning standards for those counties that have not adopted solar-specific ordinances, offering a more comprehensive review of solar siting requirements in Colorado.

This report reviews the state of ground-mounted solar regulations in each Colorado county's land-use code by reviewing relevant documents and directly contacting county land-use departments, administrators, or commissioners. We also discuss how these regulations might impact the deployment of agrivoltaic systems; impacts to large, utility-scale solar deployment are outside of the scope of this report. Note that land-use policies are rapidly evolving due to the high demand for solar power. Six of Colorado's 64 counties have temporary moratoriums on solar or all land-use applications while they develop their regulations and permitting processes. Most of these moratoriums are planned to last for 6 to 18 months, but there is potential for early resolution or extension. In the remainder of this report, Section 2 reviews background information on current developments impacting solar power deployment in Colorado. Section 3 presents the review method and key search topics. Section 4 reports the review results, which are discussed in Section 5, including variability in requirements found across Colorado counties and discussion of potential impacts on agrivoltaic deployment. Section 6 concludes. For more information on individual counties, detailed tables of the review results are available in the appendices.

2 Background

Colorado has multiple state, municipal, and corporate goals supporting the deployment of renewable resources to reduce greenhouse gas emissions and air pollution. Colorado previously established a renewable portfolio standard for 30% of electricity sold by investor-owned utilities to be produced from renewable resources by 2020 (U.S. Energy Information Administration [EIA] 2023a). Colorado has set a requirement for an 80% reduction in greenhouse gas emissions from electricity by 2030 and a goal of achieving a 100% reduction in statewide greenhouse gas emissions by 2050 (Colorado General Assembly 2019, Colorado General Assembly 2023b). The governor's office published a faster roadmap targeting 100% renewable energy by 2040 (Colorado Energy Office 2019). Colorado's two largest investor-owned utilities are on track to meet the 2030 target, and Xcel Energy has also set a corporate target of 100% carbon-free electricity by 2050 (Black Hills Energy 2023; Xcel Energy 2023). As of 2019, fourteen counties and towns[2] have also committed to their own 100% renewable goals (Colorado Energy Office 2019).

As Colorado moves toward these renewable energy targets, solar PV installation in the state is rapidly increasing. Colorado has strong solar resource, particularly in the southcentral San Luis Valley and the southeastern plains (Figure 1). While there is limited electrical transmission from some of these high-resource areas to Colorado's Front Range urban load centers, a new set of transmission lines are currently in development to alleviate this limitation in the eastern plains (Xcel Energy 2021). Regions with available transmission capacity and sufficient land availability, particularly on the eastern plains, have a growing utility-scale solar market.

[2] Denver, Pueblo, Boulder, Fort Collins, Summit County, Frisco, Aspen, Glenwood Springs, Breckenridge, Longmont, Lafayette, Nederland, and Golden

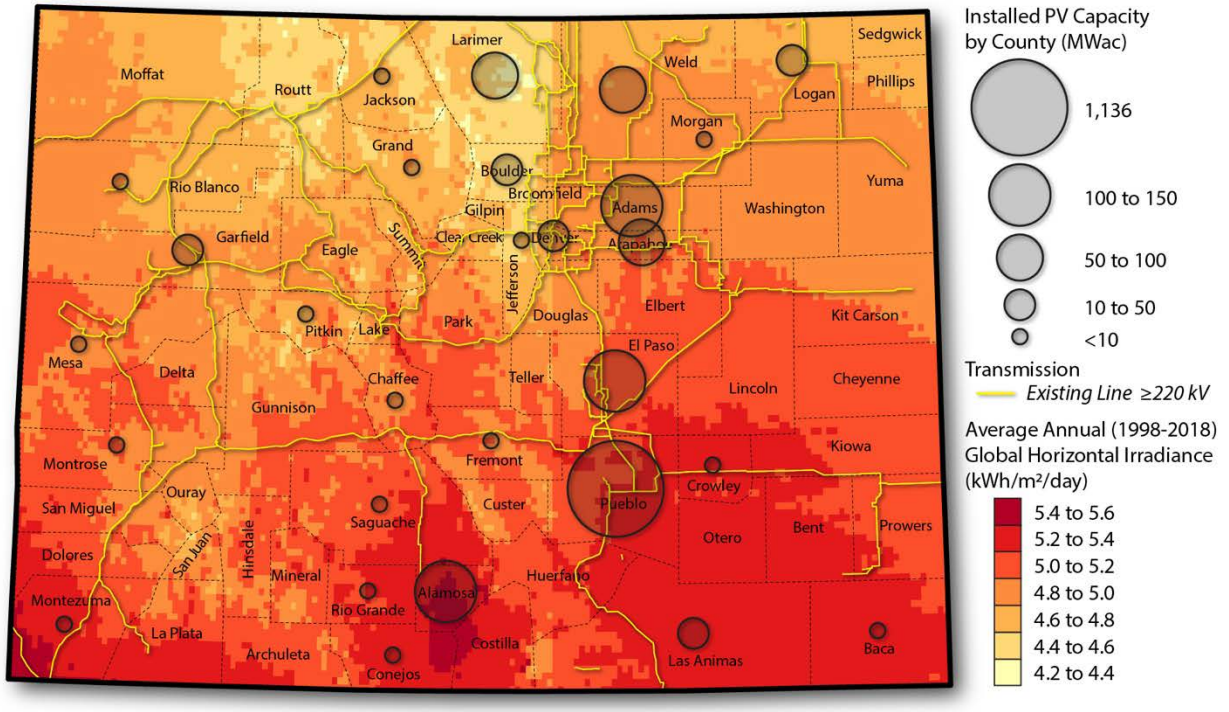

Figure 1. Average solar resource and utility-scale (>1 megawatt [MW]) solar deployed by county as of October 2023 (EIA 2023b).

Installed capacity bubbles are centered in each county and are not indicative of actual distances from the solar power plants to the transmission lines. *Illustration by NREL*

As of October 2023, 143 utility-scale (>1 megawatt alternating current [MWac]) solar projects have been deployed in 28 of Colorado's 64 counties (EIA 2023b). These plants have a combined capacity of almost 1.9 gigawatts alternating current (GWac), with another 1.3 GWac under construction or planned for installation by 2025 (EIA 2023b). Most of the existing capacity is concentrated in a few counties with very large solar power plants of tens to hundreds of MWac, with over half of the state's total solar capacity in Pueblo County alone (EIA 2023b, Figure 1). However, 43% of the total number of utility-scale plants are smaller CSGs with installed capacities of 1–4.8 MWac.

Agrivoltaic applications are being explored across this range of scales in Colorado, including both large, utility-scale solar plants and CSGs. One of the first agrivoltaic installations in Colorado was Jack's Solar Garden, a 5-acre, 1.2-megawatt direct current (MWdc) CSG in Boulder County that includes crop production, grazing, and pollinator habitat within the solar array (InSPIRE 2023; Jack's Solar Garden 2023). On the other end of the spectrum, Garnet Mesa Solar, a 383-acre, 80-MW utility-scale plant in Delta County, is in preconstruction and plans to support grazing of 1,000 head of sheep within its array (Jaffe 2022b; Garnet Mesa Solar 2023). Other current and planned deployments include three sheep-grazed CSGs, several small-scale agrivoltaic crop research sites operated by the National Renewable Energy Laboratory (NREL) and Colorado State University, and a community-supported agriculture program planned for a solar array at the Denver Botanic Gardens Chatfield Farm (InSPIRE 2023; Vickerman 2022).

On the policy front, Colorado passed Senate Bill 21-235 in 2021 allocating $150,000 to the "research, guidance, technical assistance, feasibility studies, and projects related to agrivoltaics" (Colorado General Assembly 2021). In 2023, Colorado passed another bill providing $500,000 in grants for more agrivoltaic demonstrations in the state and offering a personal property tax exemption for equipment used in agrivoltaic systems with novel designs (Colorado General Assembly 2023).

Within this context, this report offers additional information for solar developers and policymakers interested in understanding how county-level land-use codes in Colorado might impact future agrivoltaic project development and ground-mounted solar project development in general. In addition to the commonly used accessory, conditional use, and special use permit categories, counties in Colorado also regulate solar power by a "1041 permit" unique to the state (Colorado Department of Local Affairs n.d.). Passed in 1974, the Areas and Activities of State Interest Act in the Colorado Revised Statutes (CRS § 24-65.1) created "1041" powers, named after the original legislation, Colorado House Bill 74-1041. These 1041 powers give local governments control over certain development projects in their jurisdictions that have statewide impacts (FindLaw Staff 2022). The bill includes 13 different areas and activities of statewide interest that communities can opt to regulate by identifying the areas and activities of interest that apply to their locality and adopting guidelines for their administration. One of these 13 areas and activities is the site selection and construction of major facilities of a public utility, which can include solar power plants. Therefore, this report also identifies which counties are opting to use this permitting process for solar power development.

3 Methods

To understand Colorado's county-level solar siting ordinances and land-use policies, we conducted a review of relevant publicly available data for each of the 64 counties. We first defined the review search criteria, then carried out a review for each Colorado county through document searches and by contacting planning departments and county commissioners, and finally categorized and mapped the data. The following subsections outline details for each step. Maps of these results are shown in Section 4. County-level findings are available in the appendices, and each county's land-use codes and other documents are listed in Appendix A. The document search occurred between April 5 and Nov. 1, 2023. Land-use code changes and moratoriums on solar developments passed or lifted after Nov. 1, 2023, are not included in this report, with the exception of Mesa County, which implemented a moratorium on solar applications starting Jan. 9, 2024, between the review completion and report publication.

3.1 Search Criteria

We selected pertinent information to include in the Colorado county-based solar siting policy review through first reviewing available information from counties with recently enacted solar siting regulations. The first two counties selected were Boulder County, which revised its Land Use Code in 2018, and Weld County, which added new solar siting regulations in 2021. After reviewing each county's regulations, we drafted a list of relevant policies and policy categories. The list was iteratively revised throughout the data collection process based on other counties' regulations. Through this iteration, some counties were revisited to ensure all criteria in the final review list had been reviewed for all counties. The final list of policy review criteria is outlined in Figure 2 and includes categories regarding county-specific definitions and classifications, permitting processes, zone-specific requirements, and decommissioning requirements. Several of these criteria, including permitting, height, setback, decommissioning, and financial assurance requirements, were similarly reviewed in Guarino and Swanson's (2023) analysis of Illinois's county-level solar requirements.

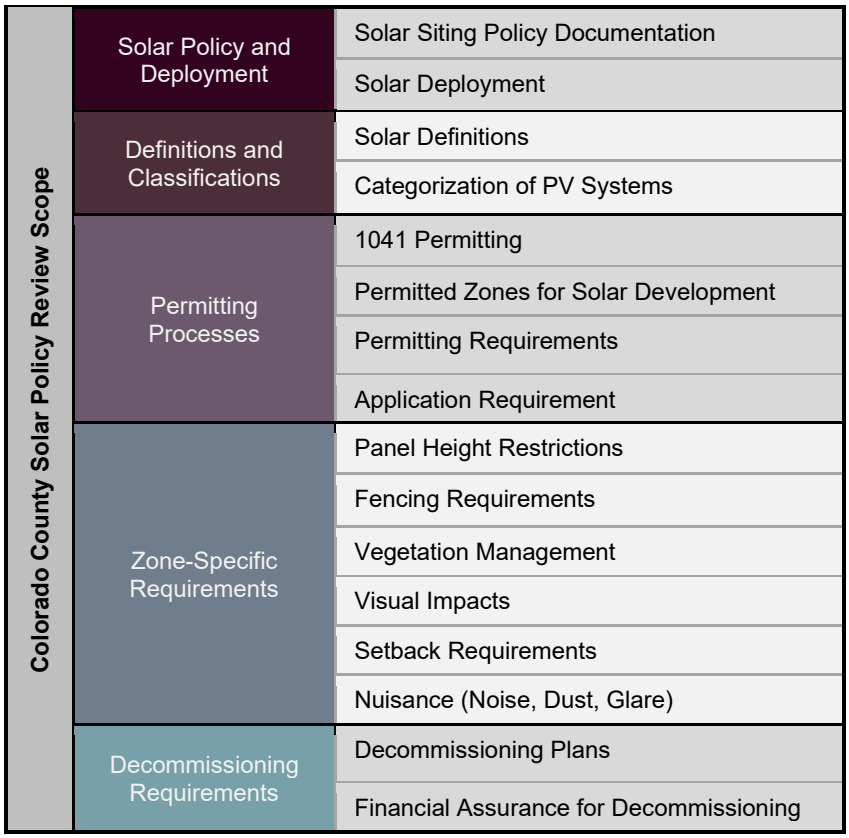

Figure 2. Policies and definitions reviewed for each Colorado county

3.2 Document Search

With the list of solar siting policies selected, we conducted Google searches for publicly available information for each Colorado county. We reviewed documents like zoning ordinances, land-use codes, and comprehensive and master plans. In some cases, building codes were also reviewed, but because this report focuses on ground-mounted rather than rooftop solar, they were only relevant for certain items, such as panel height restrictions. In general, policies that were clearly intended to regulate rooftop solar were excluded, while policies that were ambiguous or applicable to both rooftop and ground-mounted solar were included. Policies addressing each element of the selected list of solar siting evaluation criteria by county were collected from the aforementioned documents.

For counties with no solar-specific policies, we used a list of keywords to search for relevant policies that apply to solar development. Keywords included height, vegetation management, reclamation, decommissioning, setback, agriculture, glare, noise, erosion, dust, energy, utility, power plant, and 1041. For example, many counties have general nuisance regulations, such as a requirement that a "use does not create excessive or offensive noise, vibration, smoke, dust, odors, heat, glare or light noticeable or extending beyond the property." These regulations are not specific to solar but may have implications for construction and operation of solar arrays.

3.3 Contact With Planning Departments or County Commissioners

Following the review of publicly available documents, we identified a county contact, such as a county planner in the planning or land-use departments, a county administrator, or a county commissioner, based on the county's organization structure. If any uncertainties or missing information were identified in the document search, we followed up with this contact via phone or email to confirm the information and/or ask any questions that remained.

3.4 Categorization and Mapping of the Data

Once all the data were compiled, we focused on the following subset of topics from Figure 2 relevant to solar policy and development:

- Solar definitions
- Solar siting policy documentation and solar deployment
- Categorization of PV systems
- Solar on agricultural land
- 1041 permitting
- Panel height restrictions
- Fencing requirements
- Vegetation management
- Visual impacts
- Decommissioning plans
- Financial assurance for decommissioning.

We then mapped the data for each of these topics in QGIS (version 3.23.3) to visualize the range of solar policy across all 64 Colorado counties.

4 Results

Here, we present the key results of our solar siting policy review (Figure 2) to highlight common themes across Colorado's 64 counties. The land-use documents referenced for each county are listed in alphabetical order in Appendix A, and additional county-level details of the review findings are reported in the other appendices. Notably, six counties (9%) have passed temporary moratoriums on applications for solar energy systems and were revising their land-use codes at the time of the review and/or report preparation. Moratoriums are typically put in place to allow county officials time to revise statutes, usually with a target timeline (e.g., 6 to 18 months), although some are open-ended. For example, the moratorium in Montrose County was expected to be in place for 18 months, ending in October 2024. Chaffee County has had a moratorium on all land development applications since 2022 while they revise their land-use code. This includes most solar power plants with some exemptions, so for this analysis Chaffee County was classified as a moratorium. Mesa County implemented a 6-month moratorium on solar applications starting Jan. 9, 2024, after the review was completed; while no other land-use changes past Nov. 1, 2023, are reported, an exception was made to include Mesa here as under moratorium. For these six counties, we do not report any findings based on the previously adopted land-use codes, as we expect changes in the near future.

4.1 Solar Definitions

Establishing clear definitions for solar energy systems, which can have a variety of configurations and applications, creates a foundation for applying the appropriate permitting and planning requirements. The text of a definition determines what is and what is not regulated, or to what degree it is regulated. In some counties, land uses that are not explicitly defined are prohibited, while in others, undefined land uses are tacitly permitted, which can create uncertainty for solar developers (Pascaris 2021).

The review found solar-specific definitions in 38 Colorado counties (59%) (Figure 3). Most counties have unique definitions, which typically include a description of applicable technologies and/or a specification of what infrastructure is or is not included. For example, Pitkin County defines a Solar Energy Collector as "a device for the passive collection of solar energy for use in the heating of water or the generation of electricity, together with related wires and pipes necessary for operation." Many counties allow solar energy systems to include energy storage (e.g., Boulder, Chaffee, Crowley, Weld), although Arapahoe County specifically excludes battery storage from its Small Solar System Facility definition. There is one county, Morgan County, with both a solar-specific definition and a definition of an agrivoltaic system: "A system designed for the simultaneous use of areas of land for both groundmounted [sic] solar collectors and agriculture."

In 12 counties (19%), solar power plants are defined more broadly within the category of "facilities of a public utility." For example, Douglas County defines a power plant, which is one type of a major facility of a public utility, as "[a]ny electrical energy generating facility with an energy generation capacity of 50 megawatts or more, and Appurtenance(s)." Eight counties (13%) had no definitions relevant to solar siting. The full list of solar definitions is available in Appendix B.

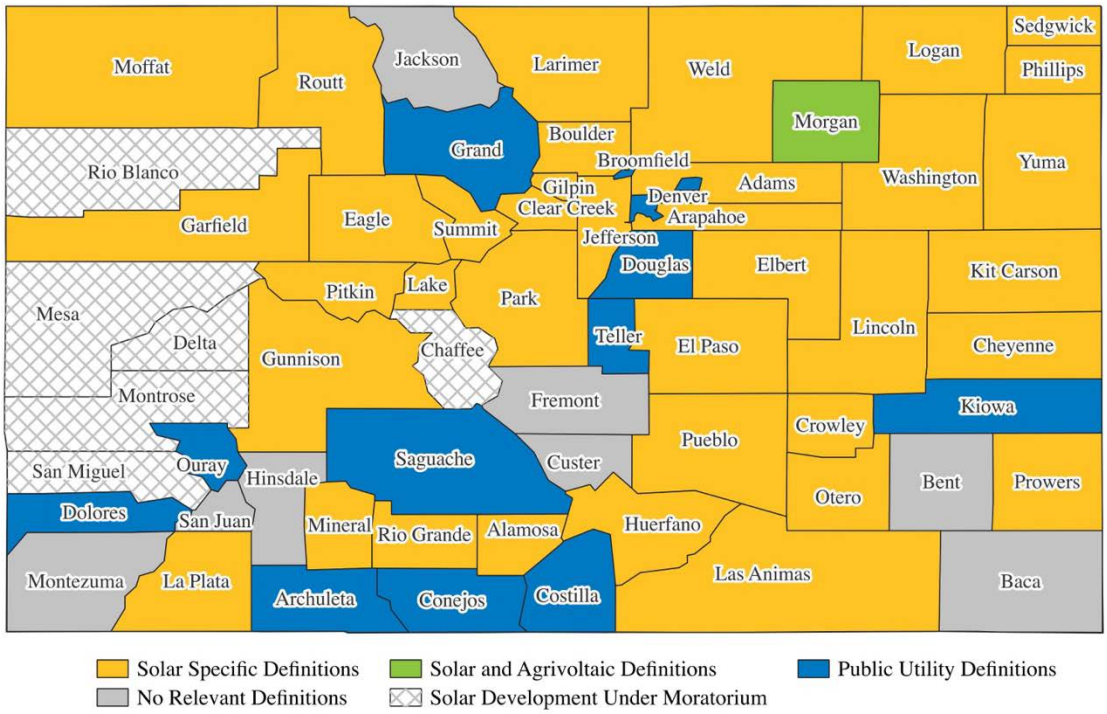

Figure 3. Solar power or solar power zoning definitions in Colorado counties

4.2 Solar Siting Policy Documentation and Solar Deployment

Comprehensive solar siting and permitting documentation sets clear expectations for all stakeholders and enables solar developers to manage risk regarding projects with substantial up-front investments and long development timelines. Additionally, higher solar deployment has been observed in localities with documented solar siting policies (Cook et al. 2016; Lopez et al. 2023; Lerner 2022). Here, we present which Colorado counties have adopted policies addressing some or all of the items listed in the review criteria (Figure 2), as well as the current level of solar deployment in those counties.

As shown in Figure 4, 29 counties (45%) have detailed solar land-use regulations that address all the policies in Figure 2. One county, Gilpin, did not provide definitions for accessory or principal solar systems, but otherwise had detailed solar siting regulations using those terms. Another 10 counties (16%) have some solar land-use regulations, which address some but not all the policies outlined in the solar siting review. Other counties, 19 in total (30%), have no land-use code specific to ground-mounted solar or renewable energy resources. However, some of these counties have more general public utility, power plant, or general development regulations that are potentially applicable to ground-mounted solar, which are included in the findings in subsequent sections.

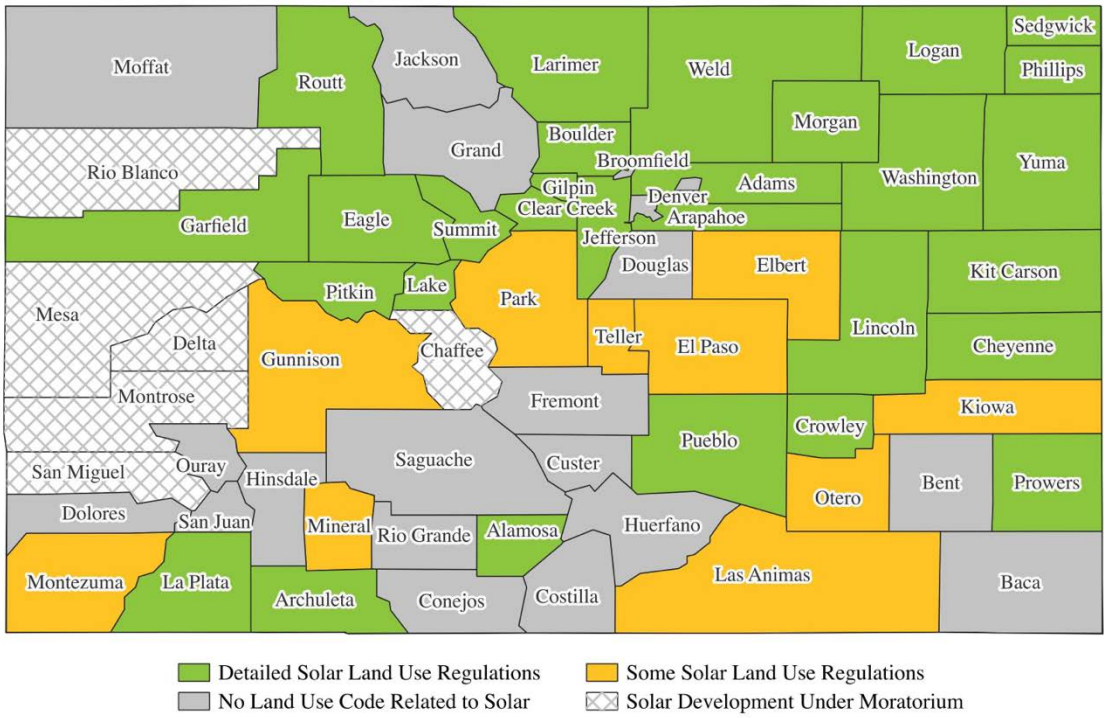

Figure 4. Identification of which Colorado counties have implemented land-use policies regulating solar installations

By cross-referencing this data with the EIA data on solar deployments (EIA 2023b) shown in Figure 1, we found that 107 (75%) of Colorado's 143 utility-scale solar power plants[3] are located in counties with detailed solar land-use regulations, accounting for 1,675 MWac or 89% of Colorado's utility-scale installed solar capacity (Table 1). Ten projects (154 MWac) are located in counties that had some solar land-use regulations, and 16 projects (40 MWac) are located in counties with no code related to ground-mounted solar. Finally, 10 projects (24 MWac) were sited in counties where the solar siting policies are currently under revision or a moratorium. These data only include projects that are currently operational and not those that are in the development pipeline.

[3] While ground-mounted systems can also include arrays of <1 MW nameplate capacity, the vast majority of ground-mounted solar is utility-scale and data on smaller systems is not readily available.

Table 1. Number and Installed Capacity of Solar Power Plants Located in Counties With Different Levels of Solar Siting Policy Documentation

County Documentation of Solar Siting Policies	Project Count	Project Count (% of Total)	Installed Capacity (MWac)	Installed Capacity (% of Total)
Detailed Solar Land-Use Regulations	107	75%	1,675	89%
Some Solar Land-Use Regulations	10	7%	154	8%
No Code Related to Ground-Mounted Solar	16	11%	40	2%
Under Development, Revision, or Moratorium	10	7%	24	1%
Total	**143**		**1,892**	

4.3 Categorization of PV Systems

Within their solar ordinances, many Colorado counties implement a variation of permitting requirements, based on the expected impact of a solar array. For example, "medium"-sized arrays might require an administrative or minor impact review, while "large" arrays might require a major impact or special use review,[4] including one or more public hearings and approval by the Board of County Commissioners. Many counties also have simplified permit requirements for "small" solar energy systems designated as accessory to the primary land use, which are likely targeting rooftop systems, although some counties specifically allow ground-mounted systems as accessory uses (e.g., Eagle and Larimer counties). We found large diversity in how these permitting categories are implemented across Colorado counties, resulting in variability of potential requirements for PV systems of similar scale and use cases.

Three distinct methods for categorizing arrays were found in the review of Colorado counties: categorizing based on the installed capacity of the array (megawatts), based on the land area of the array footprint (acres), and/or based on the intended end use[5] for the electricity produced by the array. This final method could include categories for PV arrays intended to export electricity to the power grid for profit or for on-site self-consumption. For some counties, these categories are designated by the number of end users (e.g., one or more). Counties that regulate solar PV plants through existing public utility regulations applicable to multiple electricity generation technologies, rather than solar-specific ordinances, typically specify requirements based on the plant's installed capacity (in megawatts).

Thirty-nine percent of Colorado counties categorize their permit requirements based on one of these three methods, including ten counties (16%) categorizing solar arrays based on installed

[4] The names of these permits differ by county, and include Modified Administrative Land Use Permit, Minor or Major Impact Project, Land Development Agreement, Major Impact Review, or Limited Impact Special Review.
[5] In this case, intended end-use refers to the interconnection method, such as behind-the-meter and front-of-the-meter solar systems.

capacity, eight counties (13%) categorizing based on the intended end use of the electricity, and seven counties (11%) categorizing based on the land area (Figure 5). In addition, 30% of counties apply two or more of these methods together.

The remaining 14 counties (22%) not under moratorium do not define different categories of PV systems. This group includes counties with no PV permitting information available as well as counties implementing a single permitting process regardless of the solar energy system dimensions and use case.

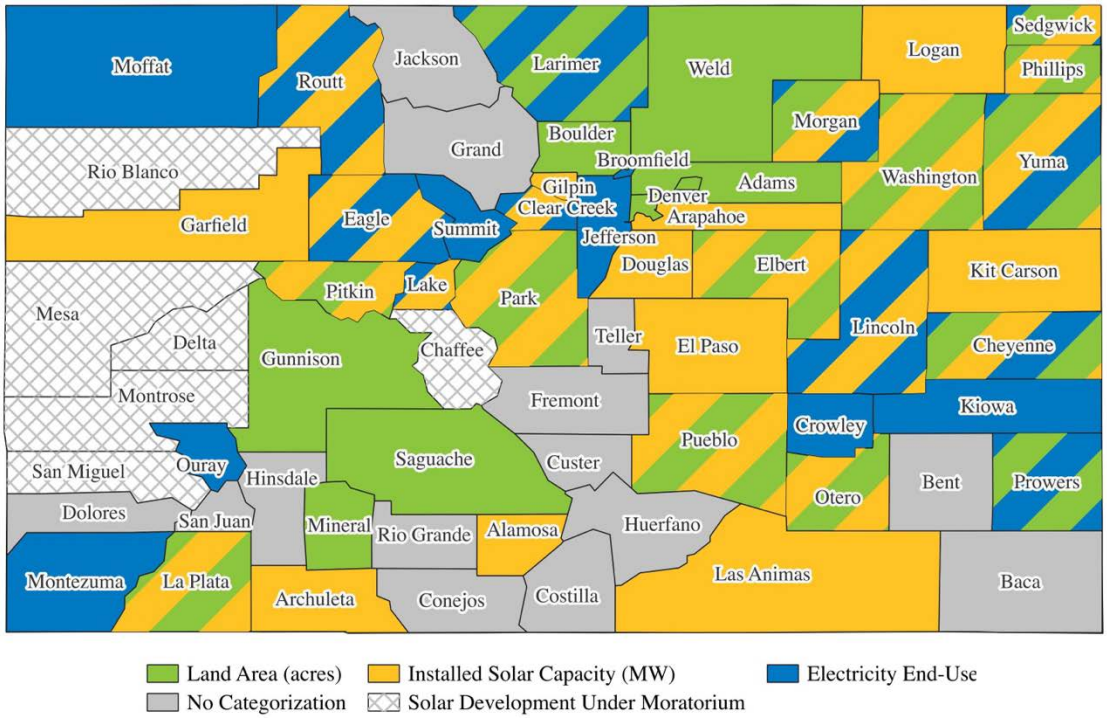

Figure 5. Colorado counties' methods for categorizing solar power installations to determine which requirements to apply during the permitting process.

Figure 5 includes some categorization methods that are ambiguous about whether they apply to both ground-mounted and rooftop solar systems. However, the figure might exclude some permit categories specifically for rooftop solar due to this review's focus on ground-mounted systems.

4.4 1041 Permitting (Areas and Activities of State Interest)

Some Colorado counties require certain solar development applicants to complete a 1041 permit rather than a more standard accessory use, conditional use, or special use permit. 1041 regulations are delegated powers from the state of Colorado to local jurisdictions to regulate matters of statewide concern, including utility infrastructure development. Additionally, these regulations serve as a means to safeguard particular geographical areas holding historical, cultural, or natural resources of statewide importance. Permitting processes per 1041 regulations are generally more expensive and rigorous and have a higher level of scrutiny than special review permitting processes, although requirements vary from county to county.

Our review found two ways that Colorado counties have implemented 1041 regulations that might apply to solar power plants. First, 1041 permits might be required for the site selection and

construction of a "major facility of a public utility," including power plants. Twenty-four counties (38%) in Colorado have adopted 1041 regulations for power plant siting that are or might be applied to ground-mounted solar power plants (Figure 6). Of these, 21 counties apply their 1041 regulations based on the power plant's generation capacity, acreage, or both, where power plants that exceed a threshold go through the 1041 permit process, and power plants under the threshold go through some other permit process. The threshold for power plant generation capacity varies from 0.5 MW to 50 MW,[6] and the threshold for land area varies from 0.25 acre to 320 acres. The remaining four counties (6%) have adopted 1041 regulations for siting of a major facility of a public utility, but do not specify what types or sizes of facilities would qualify. Some counties have explicitly integrated 1041 requirements into solar-specific permitting processes, while others have not, so there can be ambiguity about whether, in some instances, counties might choose to apply their 1041 regulations over a parallel solar permitting process.

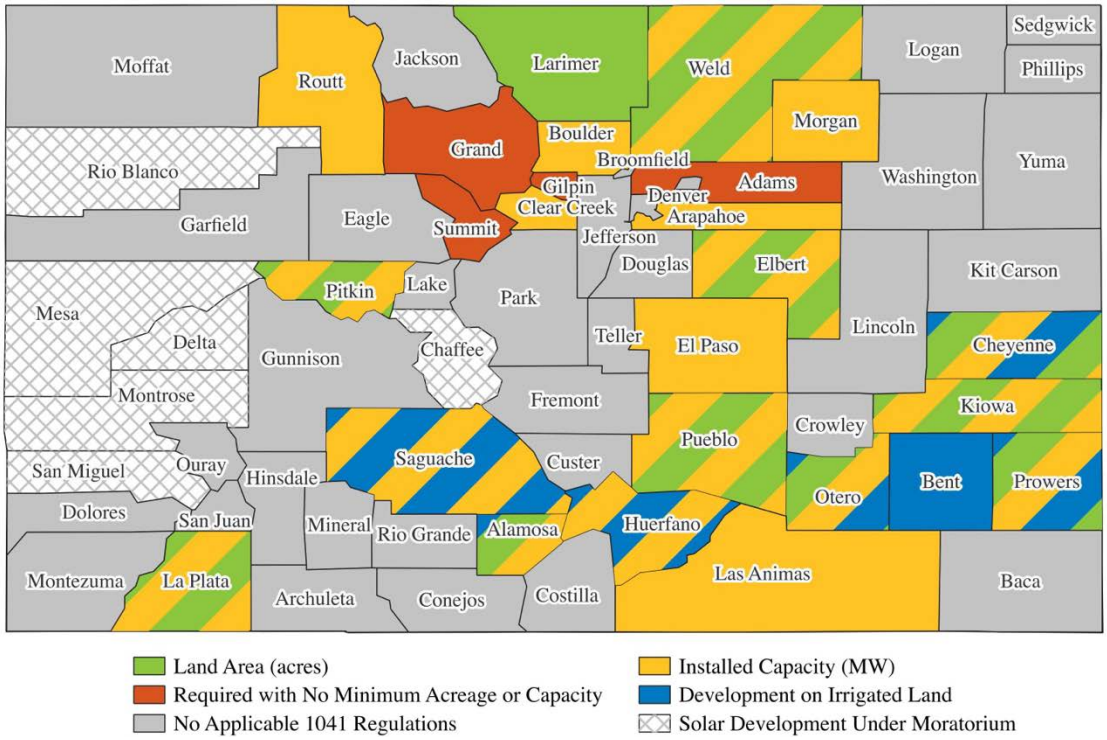

Figure 6. Solar power plants might trigger a 1041 permit requirement in some Colorado counties.

While green, yellow, and red all indicate counties that have implemented 1041 regulations for siting a power plant or major facility of a public utility that might apply to solar, counties in red have not adopted capacity or acreage minimums to define the size of the facilities that qualify for the requirements.

Separate from 1041 regulations on siting of a major facility of a public utility, our review found that some counties have implemented 1041 regulations that might apply to solar power plants specifically when sited on agricultural land. 1041 permits can be required for developments of any type on historically irrigated land that plan a partial or complete "dry-up" of the land or

[6] While some counties specify solar DC (or nameplate) capacity, many 1041 regulations are applied to power plants based on the "MW" capacity size, regardless of generation technology. This is a source of potential ambiguity in cases where DC vs. AC capacity has not been specified.

development of the land for any purpose other than irrigated agriculture, potentially impacting local water rights in the long term. Six counties (9%) require 1041 permits for any development on historically irrigated land, with minimum thresholds ranging from 3 acres to 10 acres of irrigated land. Five of these counties also have a power plant capacity and/or acreage threshold for 1041 permits, regardless of irrigation status. The full list of requirements for counties that have adopted specific capacity, acreage, and/or irrigated land development thresholds is available in Appendix C.

Not all counties or localities have adopted 1041 regulations. There are 33 counties (52%) that have either no 1041 regulations for any of the areas or activities of state interest, or no 1041 regulations specifically for site selection or the construction of major facilities of public utilities or development of irrigated land.

4.5 Solar on Agricultural Land

Current or former agricultural land has many of the conditions favorable to solar development, including large, cleared parcels with strong solar resource and flat, stable ground (Arán Carrión et al. 2008; Adeh et al. 2019). Renewable development offers many potential local benefits, including job and tax revenue growth (The Western Way 2022). However, there are also concerns about siting solar development on agricultural lands, including potential impacts on food production, irrigated prime farmland, water rights, and local community character (Hunter et al. 2022). Therefore, Colorado counties are balancing these competing needs in their land-use codes, and some have instituted specific restrictions regarding solar development on agricultural lands in addition to the 1041 requirements for development of irrigated land discussed in Section 4.4.

In 40 (63%) of Colorado's counties, a solar energy system is allowed on agriculturally zoned or designated land (Figure 7), provided that the appropriate permit process is completed based on the zone and categorization system in Section 4.3. In addition to the permitting process, 11 counties (17%) have implemented specific policies that protect farmland in relation to solar energy development, which are detailed in Table 2. Two counties (3%), Fremont and Kiowa, do not allow solar energy systems on agriculturally zoned lands. Five counties (8%) do not have agriculturally zoned or designated lands and similarly have no related stipulations.

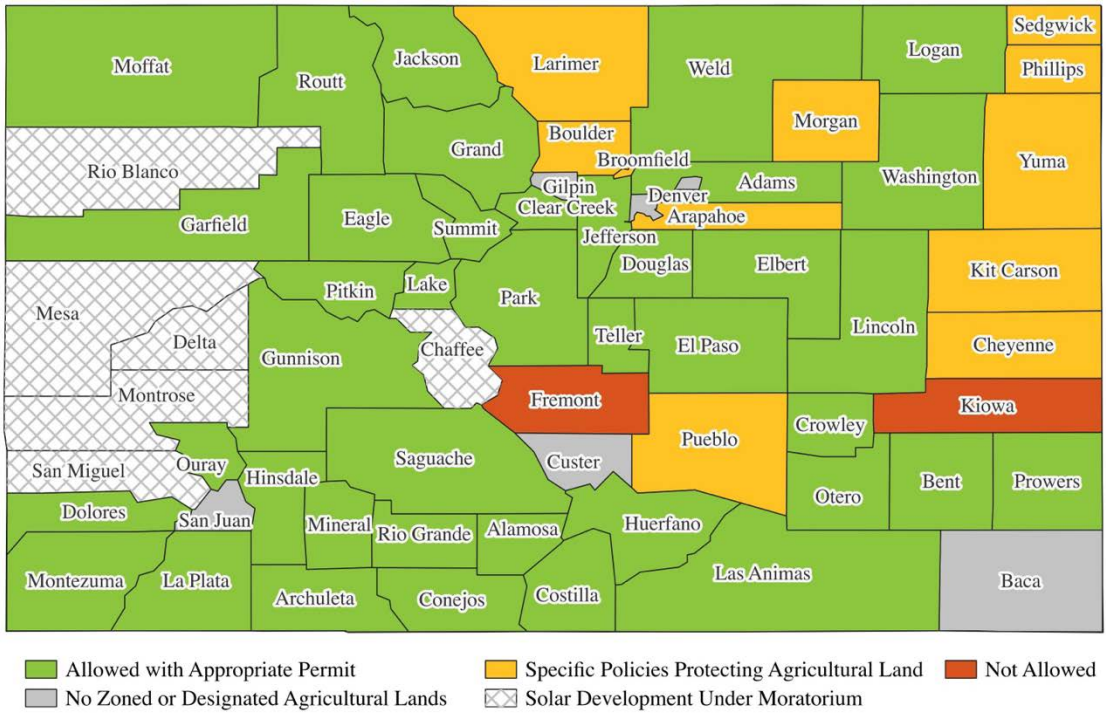

Figure 7. Regulation of solar power plants on agricultural land in Colorado counties

Table 2. County Policies Specifically Protecting Agricultural Lands From Solar Development

Counties	Policy or Statement
Arapahoe, Pueblo	Allow solar on some agriculturally zoned districts but not others.
Boulder	Restrict total disturbed areas associated with the ground-mounted PV system to 7 acres on parcels smaller than 70 acres in size, or 14 acres on parcels larger than 70 acres in size. Any application for a ground-mounted solar energy system with disturbed area greater than 0.5 acres on lands designated as Significant Agricultural Lands must include a Solar Energy System Development Report.
Broomfield, Larimer	Only allow solar on agricultural land as an accessory use for on-site consumption.
Cheyenne, Phillips, Sedgwick, Yuma	"Distributed and Utility-Scale Solar Energy Systems are encouraged to locate on predominantly (more than 60%) non-prime farmland."
Kit Carson, Morgan	"Protection of Agricultural Lands. The Wind or Solar Energy Facility shall not have a significant adverse impact on agricultural lands and agricultural operations above what is allowed for under landowner lease agreements."

4.6 Panel Height Restrictions

Some local authorities impose height restrictions on solar panels to maintain the visual harmony and aesthetics of a community and/or to ensure the safety of solar panel installations under high wind loading or extreme weather events. Restricting the height of solar panels can help mitigate these risks.

Restrictions on solar panel height vary across counties in Colorado (Figure 8). There are 33 counties (52%) that do not have specific height restrictions for solar panels. These include counties with no publicly available policies regarding height restrictions in general as well as counties where the height restriction for ground-mounted solar is determined by the general building height restriction for the underlying zoning district. For these counties, building and/or structure height restrictions range from 25 to 75 ft for principal use within the zone, which would typically not be a constraint for ground-mounted solar.

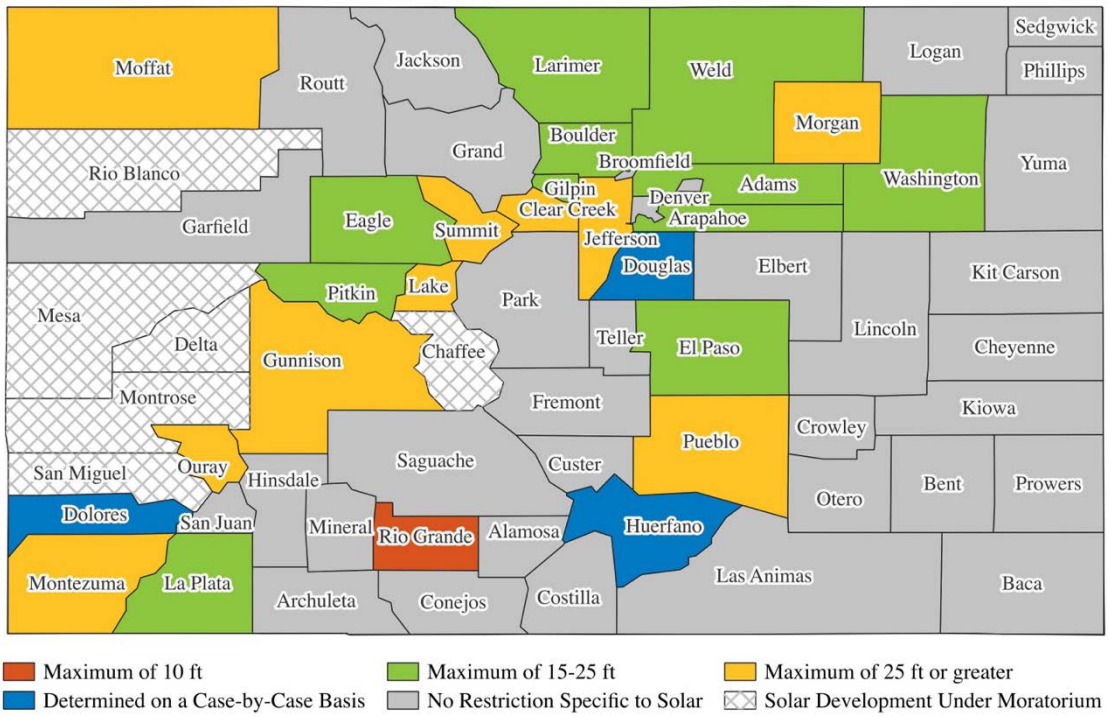

Figure 8. Maximum allowable height of solar panels in each Colorado county.

For counties with no restrictions specific to solar, the maximum allowable height typically defaults to the maximum building height in the underlying zoning district.

Ten counties (16%) have solar panel height restrictions of 25 ft or greater, typically in the range of 25 to 35 ft. Eleven counties (17%) have maximum allowable heights of 15 to 25 ft, and one county, Rio Grande County, restricts free-standing (i.e., ground-mounted) solar panels to 10 ft in height. Morgan County has different height restrictions for traditional solar projects (30 ft) and agrivoltaic projects (35 ft). There is also variability across the counties as to what aspect of the solar array is used to determined compliance with height restrictions. For example, Washington County measures the height from the equipment base to its highest point during operation, whereas Arapahoe County measures the height to the solar panel mounting point.

Three counties (Dolores, Douglas, and Huerfano) regulate panel height on a case-by-case basis. In Dolores County, the height restriction is determined during the land-use agreement process. Similarly, Douglas County determines maximum height during the use by special review process. Huerfano County's Board of Commissioners may exempt solar projects from maximum structure height restrictions on a case-by-case basis during the review process.

Panel height can also impact setback requirements in certain counties. In Boulder County, solar panels are restricted to 15 ft in height, unless a project has a site-specific need and has been approved through the review process. If taller panels are approved, setbacks are then increased by 75 ft from all property lines unless adequate vegetative screening can mitigate visual impacts. In Kiowa county, there are no height restrictions, but setbacks must be 1.2 times the height of the solar panels.

4.7 Fencing Requirements

Solar arrays are typically fenced for protection, both to protect people and animals from the electrical equipment and to protect the solar array from accidental or intentional damage. However, fencing can also have negative impacts on wildlife habitat and migration patterns (Lovich and Ennen 2011; Sadoti et al. 2017).

Fifteen counties (23%) have specific requirements for fencing around solar arrays (Figure 9). Of these, four counties (Adams, Gilpin, Las Animas, and Washington) provide specific information about height and type of fencing, while the other counties require a fence, but do not provide height specifications. Another 17 counties (27%) have fencing policies that might apply to ground-mounted solar arrays. The remaining 26 counties (41%) that are not under moratorium have no requirements for fencing.

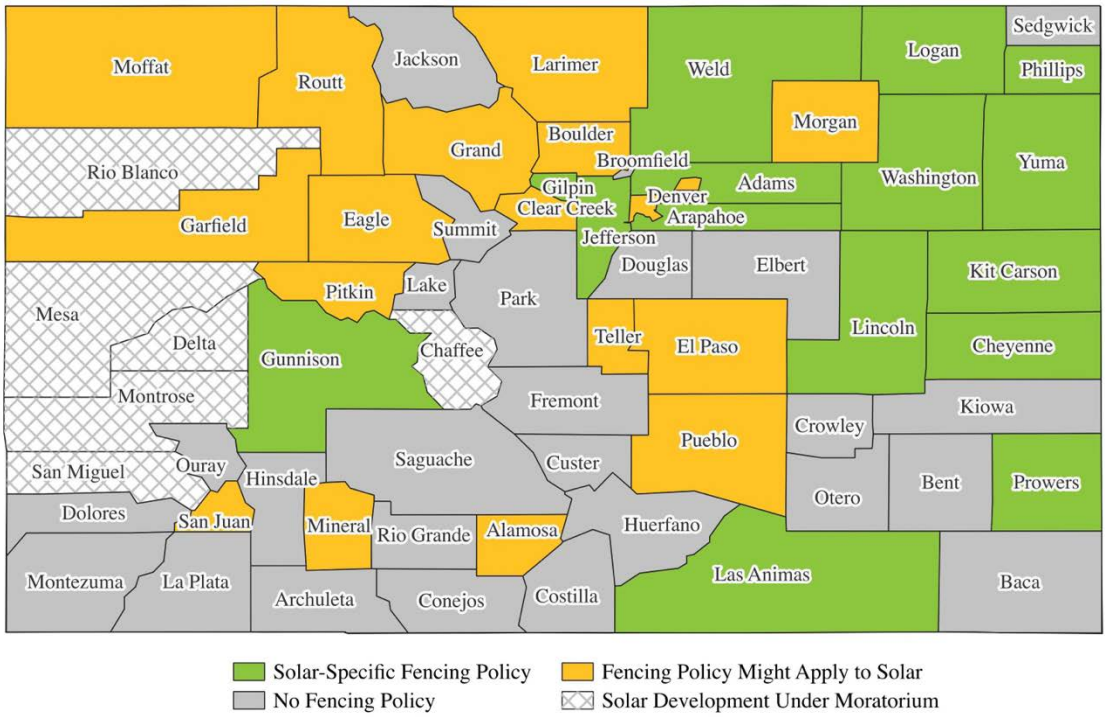

Figure 9. Fencing requirements for solar power installations in Colorado counties

4.8 Vegetation Management

Vegetation management policies describe how vegetation such as trees, shrubs, and other plant life should be managed and/or preserved during a change in land use or the development of a property. The specifics of vegetation management can vary widely depending on local land-use codes and zoning regulations, but the general goals are to balance the preservation of natural landscapes and ground cover with the needs of development, while also managing stormwater runoff effectively.

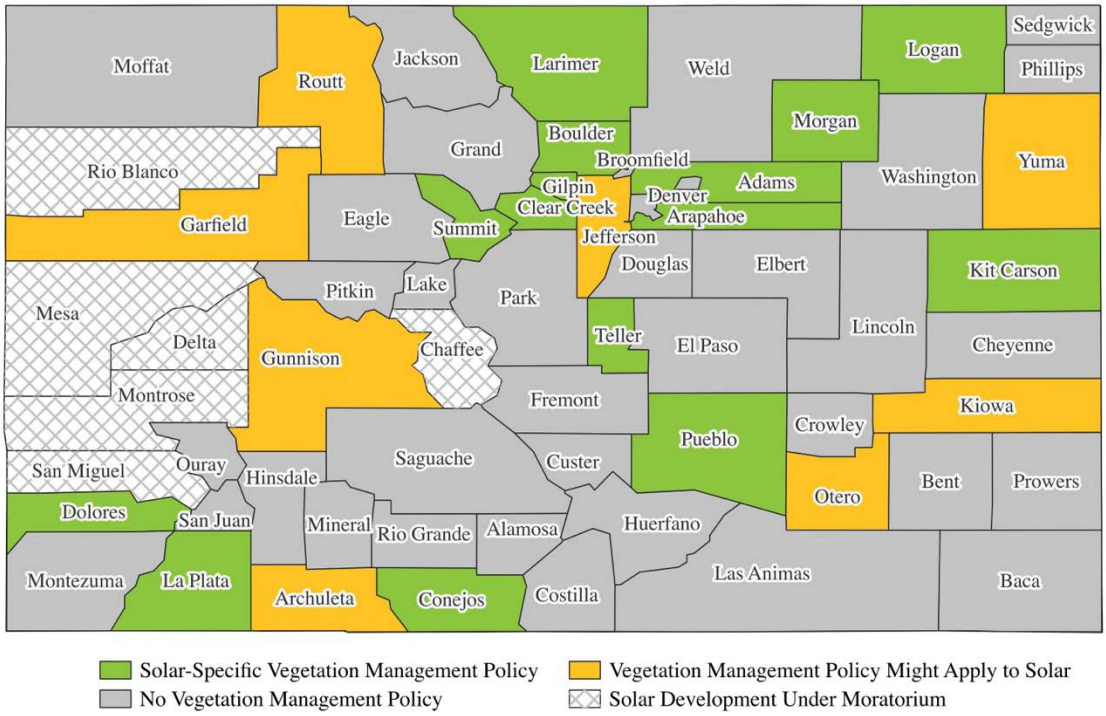

Figure 10. Vegetation management requirements for solar power installations in Colorado counties.

About a quarter of Colorado counties (15 out of 64) have specific requirements regarding vegetation management during or after the construction of solar arrays (Figure 10). Another 8 counties (13%) have general vegetation management regulations for specific permits or general development standards that could be applied to the construction of solar arrays. The other 35 counties not undergoing a moratorium do not have specific policies relating to vegetation management.

Most of these vegetation management policies (18 out of 22) relate to minimizing disturbances (like grading, soil compaction, or vegetation clearing), revegetation requirements after construction to minimize erosion, and noxious weed management. Examples include Boulder County's Solar Energy System Development Report, which has plans to maintain or improve soil quality and agricultural integrity, and Chaffee County's Restoration and Revegetation of Disturbed Areas policy, which requires revegetation within one season using a mix of native, adaptive, and drought-tolerant grasses and groundcovers to prevent soil erosion and weeds.

Five counties have specific policies relating to wildfire mitigation and fuel reduction caused by vegetation. For example, Adams County requires a plan to keep vegetation to minimal levels around the facility perimeter through treatment, mowing, or other fuel reduction methods.

Finally, two counties have requirements to retain existing trees and vegetation where possible. Archuleta County regulations state, "Significant vegetation, including dominant or mature trees and shrubs and endangered species, should be retained where possible and in accordance with Community Wildfire Protection Plan requirements."

4.9 Visual Impacts

Common community concerns about solar PV arrays include visual changes in the landscape and aesthetic concerns (Carlisle et al. 2015). Proper siting, design, and mitigation policies, including visual screening through fencing or vegetation, can help minimize the perceived negative visual impacts. There can also be concerns about glare from solar panels impacting neighbors, motorists, and aviation, although PV is typically coated in antireflective materials, and research addressing these concerns has demonstrated that solar PV has similar reflectivity to smooth water (Riley and Olson 2011; Day and Mow 2018).

Twenty counties (31%) across Colorado have policies regulating the visual impacts of solar arrays (Figure 11). An additional 16 counties (25%) have visual impact policies that might apply to solar arrays. Three counties may require visual impact plans and mitigation on a case-by-case basis for specific sensitive locations or the size of the solar array. Other counties have visual impact policies applicable to any development within their jurisdiction that are not specific to solar. The other 22 counties (34%) not under a moratorium did not have any requirements related to visual impacts of new developments.

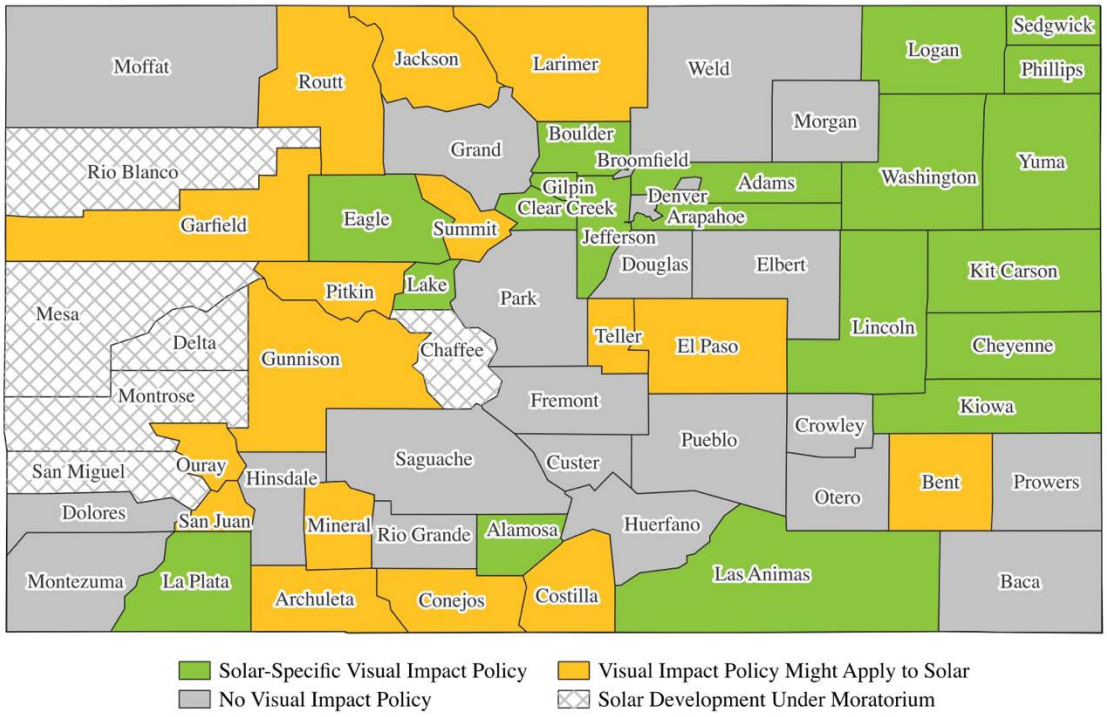

Figure 11. Visual impact requirements applicable to solar power installations in Colorado counties

Seven counties require a visual impact plan or report as part of their permitting process. Lincoln County has the most extensive requirements, including multiple visual simulations for developments in a sensitive viewshed or with structures taller than 30 ft, and projects may be denied if significant visual impacts cannot be sufficiently mitigated. Thirteen other counties have visual impact policies related to nearby properties or rights-of-way. For example, Yuma County's policies state: "All Solar Energy Systems shall not have an adverse visual impact on the natural features or character of the surrounding area and shall be located to minimize glare on

adjacent properties and roadways." This is typical for counties that state that the solar array should not impact nearby land use but do not prescribe specifically how that should be done.

4.10 Decommissioning Plans

Proper planning for decommissioning from the outset of a project can help mitigate potential environmental, financial, and regulatory challenges associated with the eventual end of the array's operations. Decommissioning plans state when and how solar array infrastructure is to be removed once it is no longer operational. Decommissioning plans can dictate how materials (steel, solar panels, wires, concrete, gravel, etc.) are to be handled upon removal (e.g., recycled, landfilled, or donated), expectations of the land's quality after decommissioning, and who is ultimately responsible for these costs (Curtis et al. 2021).

Twenty-seven counties across Colorado (42%) have policies related to solar array decommissioning and reclamation (Figure 12). Within this group, six counties mention decommissioning or reclamation in their solar specific policies, but do not have specific requirements and rely instead on the developer to formulate an adequate plan during application. The other 21 counties have specific requirements for decommissioning plans. Cheyenne, Yuma, and Sedgewick counties have the most extensive requirements for decommissioning, which include structure and cabling removal and soil and vegetation restoration. These policies also provide clear guidelines of the owner or operator's financial and legal obligations and the county's power to review and approve the decommissioning plan or, if necessary, complete the decommissioning if it does not proceed in compliance with the plan.

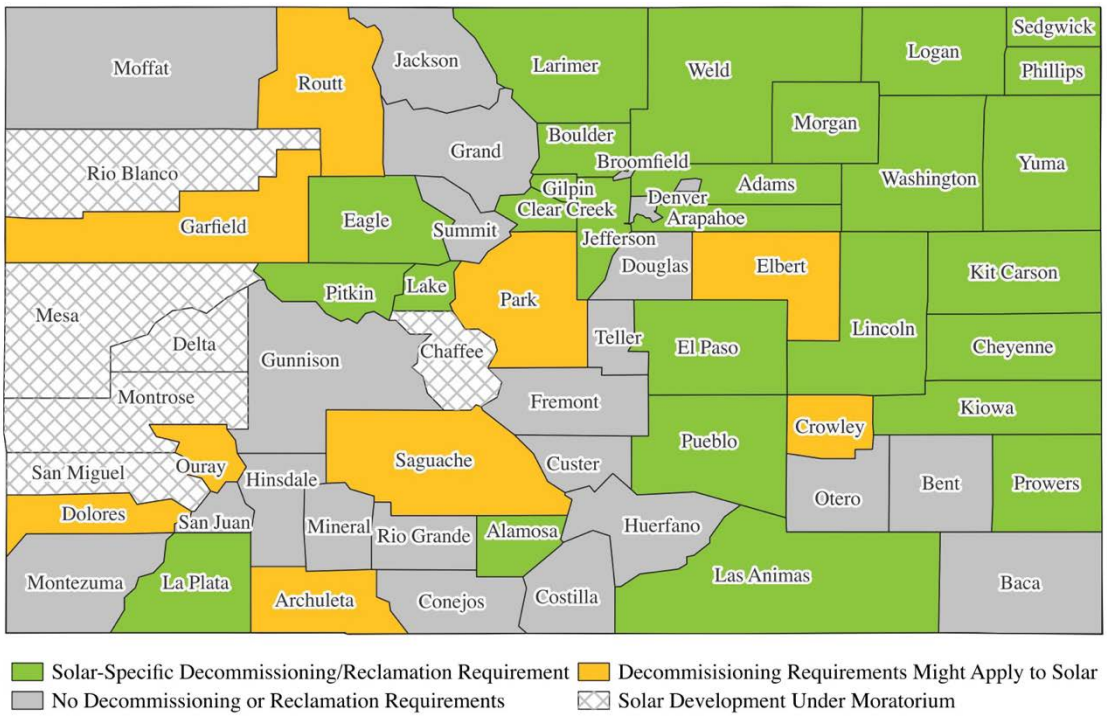

Figure 12. Decommissioning and reclamation requirements for solar power installations in Colorado counties

Nine other counties require a reclamation or decommissioning plan for any development within their jurisdiction, not just specific to solar energy systems. The other 22 counties not under moratorium did not have any decommissioning requirements relevant to solar arrays.

4.11 Financial Assurance for Decommissioning

In addition to a decommissioning plan, a form of financial assurance is often required to ensure for the removal of the solar array infrastructure at the end of its useful life, even if the plant operator faces financial hardship or bankruptcy in the interim. Financial assurance can take various forms like a self-bond, bond, federally insured certificate of deposit, government-backed securities, corporate guarantee, letter of credit, or cash. Financial assurance is usually a certain percentage of the total value of the project or a valuation of the funds needed to remove the solar equipment minus its salvage value. Several counties, including Cheyenne, Lincoln, and Sedgwick counties, require this value to be reevaluated every 3 to 5 years, starting either postconstruction or toward the middle of the project's lifespan after 10–15 years.

Financial assurance or decommissioning bonds are required for solar energy facilities in 18 Colorado counties (28%) (Figure 13). For example, El Paso County requires a financial assurance deemed acceptable to the county equal to the cost of decommissioning, as estimated by a professional engineer. Some counties require financial assurance from the outset, while other counties such as Kit Carson do not require the financial assurance until partway through the system's lifespan (e.g., 10 years), unless there is abandonment or decommissioning of the project prior to that time. An additional 19 counties (30%) have financial assurance in their land-use code that is not specific for solar energy facilities but may be applicable to them. Park County's policies are not specific to solar, but state: "The County may require monetary deposits, bonds, and/or written agreements to provide for a sufficient financial guarantee, as determined by the County, for restoration and cleanup of site access or other County property or interests." The remaining 21 counties (33%) not under moratorium do not have any requirements for financial assurance in their land-use codes.

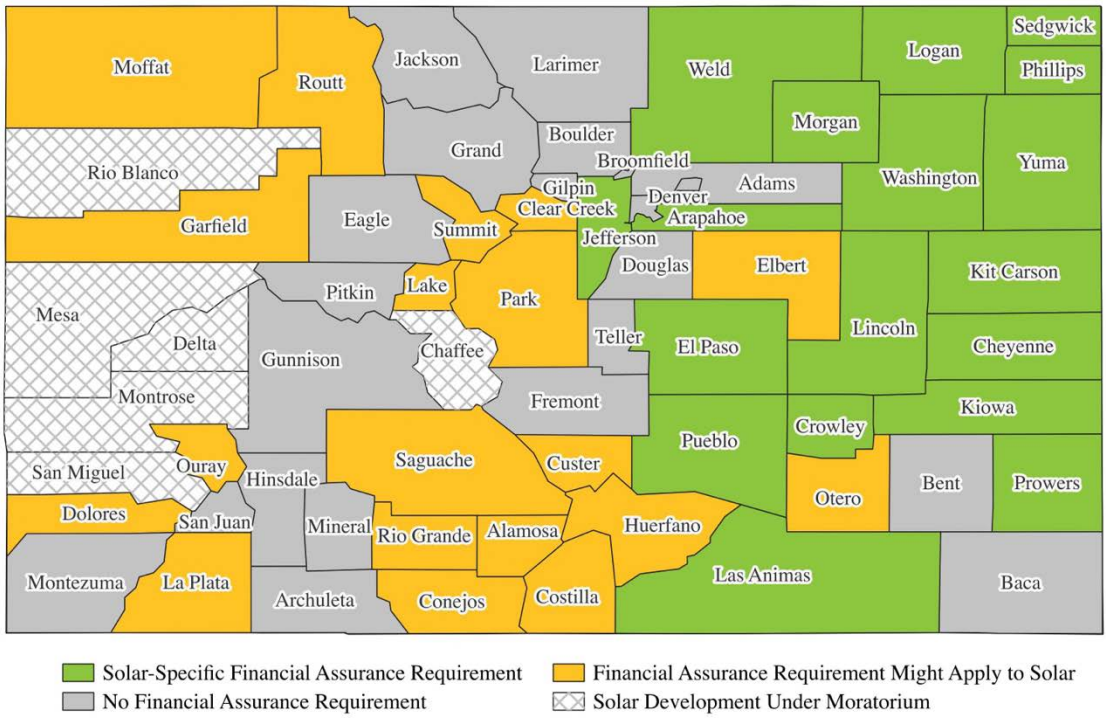

Figure 13. Financial assurance requirements for decommissioning solar power installations for Colorado counties

5 Discussion

Our review of Colorado's county-level solar ordinances and land-use codes illustrates that there is currently high variability in requirements and permitting rigor for ground-mounted solar across Colorado. Depending on the county, solar arrays of similar size, configuration, and application might be required to complete one of various permitting requirements up to and including 1041 permits (e.g., Prowers County) or might not require a permit at all (e.g., Baca County, which is Prowers County's neighbor). This regulatory landscape for ground-mounted solar is also continuously evolving, with six county moratoriums currently in effect, many of which were motivated in part by community concerns about solar. Counties that have already adopted solar-specific ordinances commonly include requirements addressing community concerns, including visual impacts, safety, and changes to agricultural land. Dual-use agrivoltaic systems are one approach to address community concerns about converting agricultural land to solar, and agrivoltaics have been deployed in multiple Colorado counties, although only Morgan County has codified a definition for agrivoltaics thus far. Our review of regulations finds that some county-level policies might impact the feasibility of agrivoltaic deployments, while other policies protecting irrigated land might be more compatible with agrivoltaic deployments than traditional utility-scale solar arrays that include a permanent dry-up.

In this section, we discuss some of these major findings, including the interactions between solar deployments and the adoption of solar-specific ordinances and moratoriums, variability in solar ordinances across Colorado, and potential impacts of county-level regulations on agrivoltaic deployments and state-level renewable energy targets.

5.1 Solar-Specific Ordinances, Deployment, and Community Response

We found that the majority of Colorado's utility-scale[7] solar power plants (75%) and installed capacity (89%) are located in counties with documentation on all of the policies we reviewed (Figure 2). This is consistent with other analyses that find correlation between localities with solar ordinances and where solar is being deployed (Day 2015; Cook et al. 2016; Lopez et al. 2023; Lerner 2022). Additionally, Lerner (2022) notes that counties tend to adopt renewable energy ordinances when their neighbors adopt ordinances or begin building renewable energy projects. There are potential interactions between solar ordinances and solar deployment, where the demand for solar deployment can motivate solar ordinance adoption, which can in turn enable further solar developments. Solar projects require substantial up-front investments and often have long development timelines. A typical utility-scale solar PV project can take up to 4–5 years from planning to the completion of an operational solar energy facility (SEIA 2013). Regulation changes or revisions can disrupt project planning and execution; therefore, documented permit and planning requirements enable interested landowners and solar developers to make informed decisions and manage project risk.

To investigate the interdependence of solar ordinances and adoption, we reviewed the timeline of solar ordinance adoption for the five counties with the highest number of utility-scale solar

[7] While ground-mounted systems can also include arrays of <1 MW nameplate capacity, the vast majority of ground-mounted solar is utility scale, and data on smaller systems are not readily available.

projects and the five counties with the highest installed capacity (Figure 14).[8] The dates of solar ordinance adoption and amendment are compared to the year that utility-scale solar capacity became *operational* in that county; note that the year of operation likely lags the year each solar power plant was first proposed to the community due to permitting and construction timelines. Figure 14 illustrates that these Colorado counties typically adopted solar-specific ordinances after one or more solar power plants were planned in their jurisdictions. Garfield, Alamosa, El Paso, and Arapahoe counties adopted regulations around the same time as their first few solar power plants were becoming operational and then implemented amendments a few years later as more and larger solar power plants were developed. Adams, Weld, and Pueblo counties allowed for the permitting and construction of several projects prior to the adoption of solar-specific regulations. While the regulatory certainty from documented solar siting policies might reduce permitting risk for future solar developments, this analysis does not address other factors influencing solar developers to target land in these counties, such as solar resource, available interconnection capacity, land prices and availability, or expectations about community response.

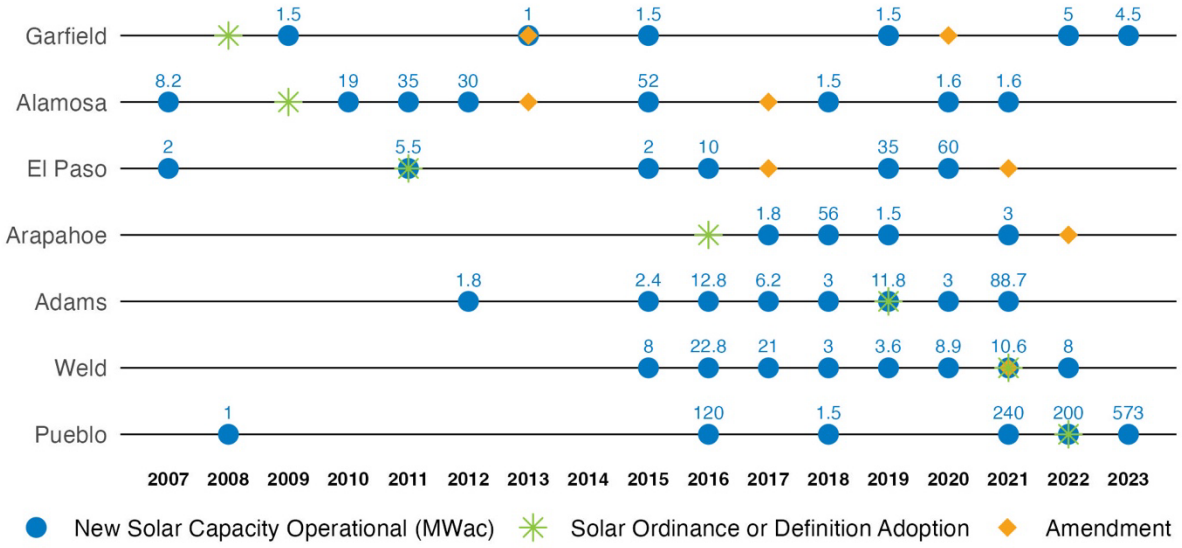

Figure 14. Timelines of solar deployment, adoption of solar-specific ordinances or definitions, and amendments to those ordinances for Colorado counties with high solar deployment to date.

Solar ordinance and amendment dates were determined by a review of county documents and personal communication with county officials. Blue dots show when a utility-scale solar power plant became operational according to the EIA (EIA 2023b), which lags the date that the project applied for county permitting. The top five counties in the EIA data in terms of number of projects (Adams, Weld, Alamosa, Arapahoe, Garfield) or installed capacity (Pueblo, Alamosa, Adams, El Paso, Weld) are shown.

Once a county starts receiving applications for solar power plant permits, there appear to be two common drivers motivating the adoption of solar-specific regulations: community response and clear gaps in the existing land-use code. More recently, from 2022 to 2023, several counties, including Morgan, Phillips, Washington, and Logan, have enacted and resolved temporary moratoriums on solar power plant applications to provide land-use departments with sufficient

[8] Three of the counties (Adams, Alamosa, and Weld) are included in top five counties for both number of projects and installed capacity, so only seven counties were reviewed.

time to draft suitable regulations for local needs. Current moratoriums are in effect for Chaffee, Delta, Montrose, San Miguel, Rio Blanco, and Mesa counties. Chaffee County has had an ongoing moratorium for multiple land-use categories while it completes broader updates to its land-use code (Ark Valley Voice Staff 2022; Chaffee County 2022); the other five counties instituted moratoriums soon after large solar power plants were announced for development or solar permit processes were resolved, as shown in Figure 15 (Chaffee County 2022; Montrose County 2022b; Delta County Board of Commissioners 2022; Tuttle 2023; Mesa County 2024; Turner 2023b; SolarGen 2022; McDermott 2023; Garnet Mesa Solar 2023; Bunton 2023; NextEra Energy 2023; Sida 2023).

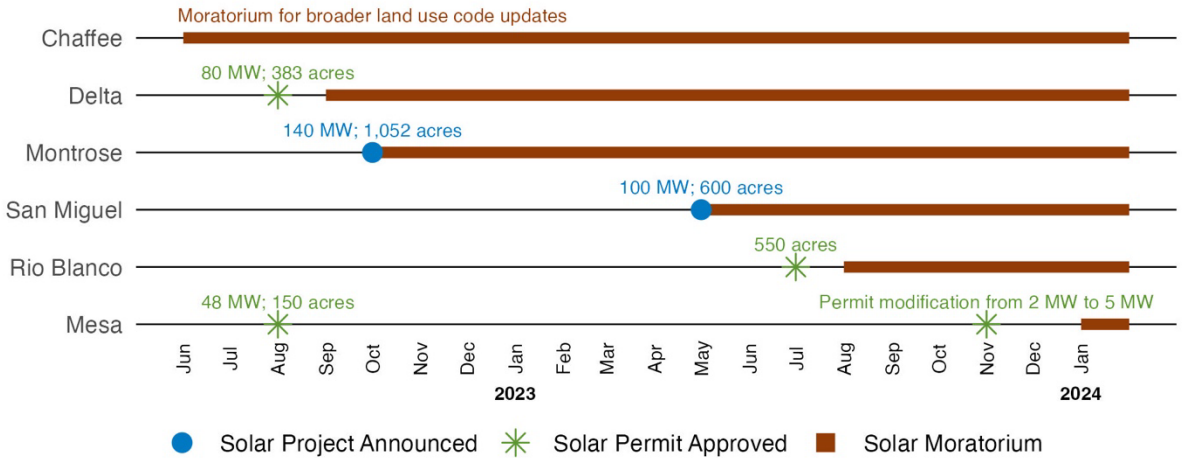

Figure 15. Timelines of current county-level solar moratoriums in Colorado, including public announcement or permit approval of key solar power plants planned in each county. The planned capacity and/or acreage of each solar plant is indicated.

This timeline focuses on key developments and is not intended to be a comprehensive review of solar developments in each county. Chaffee, Montrose, Rio Blanco, and Mesa also had relatively small (1–8 MWac) solar power plants developed in 2012–2020 (EIA 2023b) prior to this 18-month timeline.

Several of these solar projects elicited strong community response, both positive and negative, and county officials reported feeling that their existing land-use code was insufficient to address concerns (Witowski 2022; Bunton 2023; Turner 2023a; McDermott 2023; Sida 2023). In Delta County, an 80-MW solar project that was initially rejected by county commissioners for concerns of losing farmland was approved after the addition of sprinkler and drip irrigation to support agrivoltaic sheep grazing below the panels (Jaffe 2022a; Witowski 2022). Two weeks after the approval, the county commissioners implemented a moratorium on all utility-scale solar projects to develop relevant solar policy for future projects (Delta County Board of Commissioners 2022). Similarly, a few weeks after a large-scale solar project was proposed in Montrose County, county commissioners enacted a 6-month moratorium on all solar projects, or "until appropriate facility standards are incorporated into the Montrose County zoning regulation, whichever comes first" (McDermott 2023; Montrose County 2022b). In San Miguel County, a solar project proposal caused locals to raise concerns around visual impacts and impacts on recreation, hunting, and wildlife (Bunton 2023). Amid feelings at the county that the existing code is "lagging behind," San Miguel County commissioners approved a 6-month

moratorium 1 week later to make the application process fair and "to respond intelligently for both our citizens (and) also for future applicants" (Bunton 2023; Tuttle 2023).

In this ordinance development process, each county is balancing local needs, and many counties have implemented solar-specific policies to proactively address community concerns, such as visual impacts (31% of counties). However, a side effect of this county-by-county approach is that the solar permitting landscape across Colorado is varied, resulting in a regulatory variance that can present a challenge to solar developers and interested landowners where there are ambiguities and gaps in local ordinances.

5.2 Variability in Solar Permitting Across Colorado's Counties

Due to the county-by-county approach to developing ordinances, there is variability of permitting rigor for solar power plants across Colorado. Counties commonly apply varying permitting requirements for different types of PV systems, categorized based on installed capacity (MWdc, MWac, or MW), land area (acres), and/or electricity end use (self-consumption vs. grid export). Additionally, some counties have adopted 1041 regulations that are explicitly integrated into solar-specific permitting processes, while in other counties there is ambiguity about whether legacy 1041 regulations apply. For example, a few counties have adopted 1041 requirements without further definitions of what constitutes a "major facility of a public utility," while many other counties have defined specifications of which power plants qualify. In aggregate, this presents a variance of potential requirements across the state for landowners and solar developers interested in developing projects.

At the same time, the three commonly used permitting categorization methods have potential gaps or limitations that might inadvertently impact the types of solar deployments a county is intending to support. When considering the installed capacity, PV systems have two ratings to consider: the DC capacity (MWdc), which is the total capacity of the PV modules, and the AC capacity (MWac), which is the rating of the inverters that interface between the PV modules and the electric grid. Due to the higher relative cost of inverters, PV systems are commonly built with a DC-to-AC capacity ratio of 1.3 or more, although including energy storage can increase this ratio (Bolinger et al. 2023). Some counties specifically define which capacity they are referring to in their solar permitting regulations, such as Garfield and Lincoln counties, but other counties simply refer to the "MW" capacity without clarifying their definitions. While the DC installed capacity is commonly referenced by the solar industry, this ambiguity in definitions may be more prevalent for counties that use the same permitting processes across multiple types of power plant technologies, for which the AC capacity is the default rating under consideration.

When categorizing based on either land area or installed capacity, permitting requirements and land-use restrictions might not be applied as intended for new and emerging solar configurations. Currently, utility-scale solar arrays require an average of 5.75 acres per MWdc[9] of installed solar capacity, equating to a capacity density of 0.17 MWdc/acre (U.S. Department of Energy 2021). However, there is variability in this capacity density due to topography and technology choices; for example, optimized tracking systems can enable higher densities. In other cases, lower

[9] *Solar Futures Study* reports typical land use requirements of 7.5 acres/MWac and inverter loading ratios of 1.3, which are converted here into acres per MWdc.

densities are intended and desired, such as in agrivoltaics configurations with wider row spacing to prioritize use of arable land and improve access for labor and equipment (Macknick et al. 2022). In very widely spaced arrays, the system might include far fewer PV module rows and have a lower impact on the land compared to a traditionally configured array on the same area, leading to smaller energy generation per acre when compared to traditional utility-scale designs. Further, advances in PV technology, including module efficiency, layout, and tracking optimization, could continually impact the solar capacity density that is considered typical. Due to the variability in capacity density, establishing requirements based on either land area or installed capacity may result in situations that may or may not align with the original intention of the regulations. For example, a county that requires 1041 permits for any plant greater than 5 acres might require a 1041 permit for both a 1-MWdc (~5.75 acres) traditional utility-scale solar plant and a 0.5-MWdc agrivoltaic plant with twice the row spacing.

When categorizing PV systems based on the expected electricity end use, such as commercial vs. noncommercial use or self-consumption vs. electricity export to the grid, counties are potentially balancing private property rights and expected land impacts. While PV systems for noncommercial use or self-consumption might typically be expected to be small rooftop mounted systems, there are also emerging applications for large ground-mounted, off-grid PV systems. These include large commercial and industrial customers, such as data centers, mining operations, or indoor agricultural grow centers, powering their own on-site operations (Peacock 2021; Schoenberg 2020; Sandfire 2024). These applications could impact significant land areas but may or may not fall into the intended permit category based on an end-use categorization. Finally, many counties categorize PV systems based on some combination of these three methods, which might be a source of ambiguity or confusion, particularly as new PV configurations and use cases emerge, and counties might need to update their approaches to match their intended outcomes.

At the state level, this variance in local permitting regulations has raised concerns within the legislature about uneven deployment and the impact on broader statewide goals for renewable energy deployment, including Colorado's target to achieve 100% renewable energy by 2040 (Brasch 2024; Colorado Energy Office 2019). In response to concerns about the rate of deployment, Colorado lawmakers are currently drafting legislation that would establish a standardized process for local government reviews of renewable energy proposals, including limits on the durations of moratoriums and setback restrictions (Brasch 2024). With a similar approach, Illinois passed a law in 2023 mandating review procedures, timelines, and standards for county-level permitting of utility-scale wind and solar projects (Granholm, Antoniolli, and Montgomery 2023). Other states, including Connecticut, Maine, Michigan, Ohio, New Hampshire, New York, Oregon, and Vermont, have opted to establish state-level siting authorities for new energy-generating facilities over a certain capacity or acreage (Ellison and Orner 2023; State of Oregon 2024; Farm and Energy Initiative 2024; Ohio Power Siting Board n.d.). For example, New York has a state-level process for renewable projects larger than 25 MW, while Vermont's Public Utilities Commission has authority over all solar array siting (Farm and Energy Initiative 2024). In Oregon, large PV systems are subject to siting by the state, depending on the acreage and whether the proposed location is on farmland (State of Oregon

2024). It is likely too early to assess the efficacy of these state approaches compared to county-based approaches in meeting state goals for renewable deployment.

Separately from the development of state-level siting boards, other efforts have focused on developing model land-use codes and educating local officials on best practices in solar permitting regulations. These programs include the U.S. Department of Energy's SolSmart program, which provides no-cost technical assistance to local governments to implement best practices and offers Bronze through Platinum designations based on the locality's processes (SolSmart 2023), and International City/County Management Association's Solar@Scale program, which helps local governments overcome common barriers to utility-scale solar deployment (ICMA 2024). A variety of other organizations have developed model solar ordinances, which often target a particular state (Energy, Policy, and Innovation Center n.d.; Dillemuth and White 2013). While the Colorado Energy Code Board has published a Solar Ready Code package that targets rooftop solar, there is not currently a state-level model ordinance package for utility-scale solar in Colorado, although the Colorado Department of Local Affairs plans to release a Template Land Development Code in 2024 that includes some specifics on ground-mounted solar systems (personal communication). Additionally, the Colorado Solar & Storage Association has published a recommended guide of best practices from a solar developer's perspective (Colorado Energy Office 2024; Colorado Solar & Storage Association 2022). While each locality has unique circumstances to consider, there are many commonalities and standardized practices that can decrease the burden of code development for resource-limited local governments while also decreasing permitting uncertainty for solar developers.

5.3 Agrivoltaics and Solar Land-Use Code

Agricultural land is often well suited for solar development (Adeh et al. 2019), yet 5 out of the top 10 agricultural producing counties in Colorado currently have no deployed solar (Yuma, Kit Carson, Prowers, Washington, and Phillips counties) (Colorado Department of Agriculture n.d.; U.S. Department of Agriculture [USDA] NASS 2017; Figure 1). Demand for solar development in some of these counties may increase with the completion of the Colorado Power Pathway, which will expand transmission capacity to the southeastern corner of Colorado (Xcel Energy 2021). Solar development restrictions or challenges often arise from local land-use policy or lack of community acceptance (Carlisle et al. 2015; Kolbeck-Urlacher 2023; Lopez et al. 2023). To address these challenges, agrivoltaics has been proposed as a potential solution to keep agricultural land in production and increase local acceptance of solar projects (Pascaris et al. 2022). However, some Colorado county-level policies may unintentionally restrict agrivoltaics by limiting solar development on agricultural land and/or restricting panel height. These two topics are each discussed below, including considerations and potential impacts.

Solar Development on Agricultural Land

Agricultural land made up 48% (31.8 million acres) of Colorado's land in 2017 (USDA NASS 2017). Farm and ranchlands are abundant in Colorado and are often available at a lower cost than other land types. An average acre of commercial or residential land costs $11,600 in Colorado (Morris 2023) compared to $1,770/acre for agricultural land (USDA NASS 2022). This contributes to making farms and ranches attractive options for solar developers who require large

contiguous areas for their installations. However, converting agricultural land into solar arrays can have multiple trade-offs.

Communities across the state have debated the use of agriculturally zoned land for solar projects, as it could compete with food production, raise rental prices for farmers and ranchers, and increase development around rural communities (Hunter et al. 2022). Due to these concerns, some local governments have enacted policies that restrict the development of solar arrays on agriculturally zoned land. Such policies restrict the size/output of solar arrays, add permitting requirements, or ban solar energy systems on agricultural land altogether (e.g., Fremont and Kiowa counties). Counties that prohibit solar energy infrastructure on agricultural lands also prevent the addition of agrivoltaics.

Some counties do not ban solar development of farmland but restrict or discourage solar development on "prime"[10] or "significant"[11] agricultural lands (Cheyenne, Phillips, Sedgewick, Yuma, and Boulder counties). In 2017, Colorado had 1.4 million acres of prime farmland (National Resource Conservation Service 2017) and in 2016, the state had 5.6 million acres of nationally significant agricultural land (American Farmland Trust n.d.). Policies that limit solar development on prime farmland might also impact the deployment of agrivoltaic systems.

Further, six counties (Alamosa, Bent, Cheyenne, Otero, Prowers, and Sagauche) have irrigated land clauses in their 1041 regulations that may also impact agrivoltaic deployment. These clauses are intended to prevent the sale of water rights separately from the land and prevent the dry-up of irrigated agricultural land. However, the water redistribution and lower evaporation rates under solar panels could allow for decreased irrigation or the cessation of irrigation altogether. A recent study found that for semiarid C3 grassland growing beneath an agrivoltaic system in Colorado, the aboveground net primary productivity was reduced by only 6%–7% with no irrigation in the past 3 years (Kannenberg et al. 2023). Permitting that allows for the dry-up of land but continued agricultural production, such as grazing and hay production, would allow agrivoltaic systems to be developed on these lands.

In addition, agrivoltaics has shown to provide local community and farmer benefits. Solar panels redistribute moisture to the edges of their panels that can enable deeper soil moisture retention (Sturchio et al. 2023). Solar panels also provide shade to the ground, which can lower soil and plant temperatures while reducing evaporation rates from the soil (Barron-Gafford et al. 2019). These benefits are especially important in semiarid climates like Colorado because they can help lower irrigation requirements. The shade and lowered air temperatures may assist with lowering health-related illnesses in farmworkers (Ghosh 2023). However, solar panels may come with trade-offs, such as lowering the total amount of arable land to farming or impacting current farming practices due to the placement of the structures (Pascaris et al. 2020). Early collaboration with farmers during the project design phase can help mitigate these impacts (Macknick et al. 2022). Policies that forego any possibility of solar development on agricultural

[10] USDA designation of high-quality farmland of major importance in meeting national needs for food and fiber production, including cultivated land, pastureland, and forestland.
[11] Nationally significant agricultural land is the "land best-suited to long-term, intensive crop production" (American Farmland Trust n.d.).

land can inadvertently prevent landowners from accessing solar land leases for agrivoltaic systems that potentially allow for greater farm viability and more diversified income.

Panel Height

Agrivoltaic systems often require alternative configurations to traditional utility-scale PV designs to permit agricultural activities (Macknick et al. 2022). This can include various design changes, such as increasing the height of panels. In cropping systems, some agrivoltaic designs are elevated up to 12–15 ft to allow for maximum crop growth height, larger agricultural equipment (Marrou et al. 2013; Weselek et al. 2019), and optimal diffusion of sunlight for plant growth (Faizi et al. 2022). Some agrivoltaic orchards are built even higher, with panel heights up to 16.4 ft (Juillion et al. 2022). In orchards, elevated solar panels may offer the additional benefit of hail protection to the crops (Willockx et al. 2024).

For grazing systems, most solar arrays of traditional height will accommodate the integration of sheep, but panels often require higher elevation for the integration of cattle (Macknick et al. 2022). Cattle are an important market for Colorado farmers and ranchers, valued at $2 billion in 2020 (USDA NASS 2021). In 2021, Colorado had 2.7 million head of cattle but only 445,000 head of sheep (USDA NASS 2021), leading to a smaller agrivoltaic grazing market if panel height is restricted. The panels also offer potential benefits to cattle, such as access to shade, reduced radiant heat load (Maia et al. 2020), and lower respiration rates and body temperatures (Sharpe et al. 2021). In one study, cattle preferred the shade of the panels over a shade cloth (Maia et al. 2020).

Some Colorado counties limit the panel height of solar panels (e.g., a 10-ft restriction in Rio Blanco County and a 15-ft restriction in Pitkin, Arapahoe, and Larimer counties). This restriction could potentially limit the types of agrivoltaic systems that could be incorporated into the PV structure, such as taller cropping systems (e.g., fruit trees) and cattle grazing. All other county panel restriction heights are higher than 15 ft and would have a low probability of interfering with agrivoltaic systems. While allowing flexibility for solar designs can be important to the success of agrivoltaic projects, it is important to note that there can be trade-offs for alternative designs, such as increased costs (Horowitz et al. 2020) and increased risk in areas with high wind or snow loads (Macknick et al. 2022).

5.4 Future Research

Extensions to the Current Report on Colorado's County Policy Landscape

While this report focused on reviewing and summarizing the current county policies applicable to ground-mounted solar development, additional analyses quantifying the impacts of these local policies on land availability for solar development would be a valuable extension, similar to those in Lopez et al. (2023) and Owusu-Obeng, Mills, and Craig (2024). This review focused on many of the key policies of interest for siting and permitting ground-mounted solar, but there are additional policies that would be valuable to add, including lot coverage restrictions, impact fees for heavy machinery use on roadways during construction, and wildlife impact mitigation requirements, which can be a significant factor in the permitting process (e.g., Park County Board of County Commissioners 2021). Future research area could also include actual or expected impacts on zoning differentiation on deployment patterns throughout Colorado. Finally, a review of recent solar permit applications denied by counties could provide valuable lessons

learned for other counties and solar developers to understand and prepare for key issues that are arising across the state.

Comprehensive Analysis of Local Solar Regulations in the United States

While analysis of local solar regulations has been completed in Illinois (Guarino and Swanson 2023), the Great Lakes region (Owusu-Obeng, Mills, and Craig 2024), and now Colorado, data are limited across the United States. Comprehensive state-by-state analysis of local solar regulations could help inform developers and policymakers of local solar policies and their potential diversity. Lopez et al. (2023) have performed a similar analysis that examines local setback requirements across the United States, but further variables explored in this report (e.g., panel height restrictions, vegetation management plans, decommissioning requirements) could be relevant to add. This analysis could also include the impact of statewide regulations that have been used to create consistency for solar regulations throughout other states (e.g., Connecticut, Vermont, New Hampshire, Maine, New York [Farm and Energy Initiative 2024]) to understand the impact of statewide versus local codes on solar development. As evidenced by the Colorado example, the solar industry is rapidly expanding, and state and local governments are presently trying to update their codes and regulations to match this pace of development. Future analyses and overviews of local policies would be most useful in a dynamic format that could be readily adjusted as states and counties update their policies.

Socioeconomic Solar Analysis

While research has been limited, several studies have reviewed the impact of solar policy or solar deployment on environmental justice or socioeconomic factors (Si and Stephens 2021; Lukanov and Krieger 2019). Si and Stephens (2021) found that while low-income households were represented in the 2020 Solar Massachusetts Renewable Target (SMART) Emergency Regulation, they had less political power and representation than other groups (e.g., corporations). Lukanov and Krieger (2019) found that solar adoption levels were disproportionally lower in disadvantaged communities in California. High-level state and county data comparisons of renewable energy deployment and environmental justice factors have also been initiated by the Deployment Gap Model Education Fund (2023) through their found that 82% of Dashboard. Using a similar but more detailed and policy-related framework, socioeconomic analysis throughout the cities and counties of Colorado could help to determine the impact of local solar regulations on inclusivity of environmental justice and disadvantaged communities in policymaking and solar deployment. This analysis could include use of EPA's Environmental Justice Screening and Mapping Tool to evaluate local variables such as environmental justice indexes, pollution and sources, socioeconomic indicators, health disparities, climate change data, critical service gaps, and demographics (EPA 2024).

6 Conclusion

The state of Colorado has experienced the rapid expansion of solar projects over the past few years (EIA 2023a). Solar policy across Colorado counties can impact the types, sizes, and locations of solar projects approved, the complexity and cost of the permitting and construction process, and ability to incorporate agrivoltaic systems. This report presents an overview of the status of county-level solar policy across the state of Colorado as of November 2023. By reviewing county documents, such as land-use codes, zoning ordinances, and comprehensive and master plans, this report summarizes regulations that can impact the permitting, design, and viability of ground-mounted solar arrays. These policy topics include regulation requirements, 1041 permitting, solar on agricultural land, panel height restrictions, fencing requirements, vegetation management, visual impacts, and decommissioning plans and financial assurance.

While we found that the majority of counties have some solar-specific definitions in their land-use code, less than half have documented requirements on all the policy topics reviewed here. The vast majority (89%) of Colorado's utility-scale installed solar capacity is located in counties with at least some documentation of the policies reviewed. Some counties also regulate solar projects on a case-by-case basis, which presents unclear requirements and guidelines for solar development. As solar power plants have long development timelines from planning to completion, regulation changes or revisions can disrupt project planning and execution. Therefore, documented permit and planning requirements enable interested landowners and solar developers to make informed decisions and manage project risk. Colorado's policy landscape is also continually evolving, with many counties adopting and amending solar-specific code in the last few years. Additionally, six counties had moratoriums on solar development in effect during the review to allow time for county staff to review and update land use.[12]

Due to Colorado's county-by-county approach to regulating solar, we also found variation in solar permitting requirements across the state. Counties often apply different permitting requirements to PV systems based on their installed capacity, land area, and/or electricity end use. Due to gaps or ambiguity in definitions, these groupings might not be applied as intended for new and emerging solar configurations, such agrivoltaic systems with low capacity density (MW/acre) or large off-grid commercial and industrial applications. There are also potential ambiguities in permitting requirements from overlap with legacy 1041 regulations, in some instances requiring developers to complete both a 1041 permit and a conditional use or special use permit (e.g., County of Elbert 2018) at the expense of additional developer and county time and resources.

Lopez et al. (2023) show that certain local permitting policies have the possibility to affect solar deployment, which could impact broader state-wide goals for renewable energy deployment, such as the Colorado governor's goal of 100% renewable energy by 2040 (Colorado Energy Office 2019). In response to similar concerns about meeting state renewable goals, other states have opted to either regulate and standardize local permitting requirements or establish state-level siting authorities for large renewable projects (Granholm, Antoniolli, and Montgomery

[12] Including Mesa County, which instituted a moratorium after the review had completed but during the report preparation period.

2023; State of Oregon 2024; Farm and Energy Initiative 2024). As of February 2024, Colorado lawmakers are drafting legislation that would establish a standardized process for local government reviews of renewable energy proposals, including limits on the durations of moratoriums and setback restrictions (Brasch 2024). While it is likely too early to assess the efficacy of these state approaches compared to county-based approaches, we expect solar policy in Colorado to continue to evolve alongside the expansion of solar energy in the state.

Finally, this report also considered the potential impact of county policies on agrivoltaics deployment. While agrivoltaics projects have been deployed in multiple Colorado counties, only Morgan County has a definition for agrivoltaics in its land-use code. In other counties, certain policies might limit the deployment of agrivoltaics. This includes four counties that restrict solar on some or all agricultural zones, several counties that consider agricultural impacts in the solar review process, four counties with 10–15-ft panel height limits, and six counties with higher permitting stringency for any development on irrigated land.

Glossary

Term	Definition
Agrivoltaics	Co-location of agriculture and solar photovoltaics on the same land.
Dry-up	Permanent cessation of irrigation.
Ground-mounted solar	An array of solar photovoltaic modules mounted on a racking system on the ground, as opposed to a rooftop-mounted system.
Prime farmland	USDA designation of high-quality farmland of major importance in meeting national needs for food and fiber production, including cultivated land, pastureland, and forestland.
Utility-scale solar	Solar generators for electric utilities with nameplate capacity of 1 MW or greater. Almost all utility-scale solar is ground-mounted, but ground-mounted solar can also include small or off-grid applications.

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Appendix A. County Land-Use and Permitting References

Table A-1. County Documents Referenced in the Review Results

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Appendix B. Solar Definitions by County

Table B-1 quotes each county's solar definitions, which are presented in the review results in Section 4.1. Definitions include solar-specific definitions as well as definitions applied more broadly to public utilities and/or power plants. Definitions are gathered from the references listed for each county in Appendix A.

Table B-1. Solar Siting Definitions by County

County	Solar Definitions
Adams County	Solar Energy System. Any device or structural design feature whose primary purpose is to provide for the collection, storage, or distribution of solar energy for space heating, space cooling, electricity generation, or water heating. Solar Energy System, Small Scale. Solar Energy Systems that encompass less than 35 acres of surface area. Solar Energy System, Medium Scale. Solar Energy Systems that encompass greater than 35 and less than 320 acres of surface area Solar Energy System, Large Scale. Solar Energy Systems that encompass 320 acres or more of surface area.
Alamosa County	Utility-Scale Solar Facility. in Alamosa County is defined as either covering more than 5 acres or producing more than 10 megawatts. Power Plant. Any electrical energy generating facility which either utilizes more than 5 acres of land regardless of its generating capacity, or any electrical energy generating facility with a generating capacity of greater than or equal to 10 megawatts or more, regardless of how much acreage is utilized, and any facilities appurtenant thereto, or any addition thereto increasing the existing design capacity of the facility by a combined 10 megawatts or more. Solar panel field. An experimental, demonstrational, or commercial facility utilizing energy to produce other forms of energy, including but not limited to: equipment used to capture solar energy (e.g., photoelectric panels, mirrors); equipment that converts solar power to other power, including electrical generators; ancillary and associated equipment, including water treatment plants, power lines, substations, cooling equipment and any other equipment or facility necessary for the successful operation of the facility. Utility, minor. All utility facilities not considered major, including, but not limited to neighborhood-serving facilities such as pump stations, telephone exchanges, lift stations, electric substation, and storm water detention facilities, or any similar use. Utility, major. A large-scale utility such as … electrical generation plant; solar or wind energy farms; experimental, demonstration or commercial energy generation facilities
Arapahoe County	Small Solar System **Facility or Facilities.** A definable area where an Applicant has disturbed or intends to disturb the land surface in order to locate a solar power generating facility designed to produce electricity with a maximum capacity of 5 Megawatts (MWac) alternating current, or MW capacity whichever is greater. A small solar system does not include battery storage equipment of facilities. SOLAR FACILITY OR FACILITIES. Is a facility or facilities that use solar energy to generate electricity through the use of solar panels, racking structures, inverters, transformers, overhead or underground wiring, and associated roads intended to generate power for a utility. A solar facility or facilities does not include any facility or facilities that exceed two megawatts (2 MW) in power generation or twenty (20) acres in size.
Archuleta County	Electric Power Onsite Generation. A typical Accessory Use, electric energy generating facility with capacity of ten (10) kWh [kilowatt-hours] or less, and any appurtenant facilities thereto

County	Solar Definitions
	Electric Power Distributed Generation. Any electric energy generating facility with capacity between ten (10) kWh and ten (10) megawatts, and any appurtenant facilities thereto Electric Power Generation Facility. Any electric energy generating facility with capacity of ten (10) megawatts or more, and any appurtenant facilities thereto
Baca County	No relevant definitions present.
Bent County	No relevant definitions present.
Boulder County	Large Solar Energy System. A system composed of a solar energy collector which may include an energy storage facility, and components for the transmission and distribution of transformed energy, and which may be used for one or more users...the system has a rated capacity greater than 2 MW but does not meet the Land Use Code definition of Power Plant. Medium Solar Energy System or Solar Garden. A system composed of a solar energy collector which may include an energy storage facility, and components for the transmission and distribution of transformed energy, and which may be used for one or more users... the rated capacity of the system will be at least 500kw but not more than 2 MW. Small Solar Energy System or Solar Garden. A system composed of a solar energy collector which may include an energy storage facility, and components for the transmission and distribution of transformed energy... the system will have a rated capacity of 100 kW or less. Power Plant. An electrical energy generating facility with generating capacity of more than 50 megawatts and any appurtenant facilities.
Broomfield County	Public Utility. Any person, firm or corporation operating heat, power or light systems, communication systems, water, sewer or scheduled transportation systems, and serving or supplying the public under a franchise granted by the City.
Chaffee County	Power Plant. A facility that converts one or more energy sources, including but limited to water power, geothermal resources, fossil fuels, nuclear, wind, or solar power into electrical energy or steam, for commercial uses. A power generation plant may also perform either or both of the following: (a) operation of a transmission system that conveys the energy from the generation facility to a power distribution system; (b) operation of a distribution system that conveys energy from the generation facility or the transmission to the final consumers. Solar Energy Device. A device which converts the sun’s radiant energy into thermal, chemical, mechanical, or electric energy. Solar Energy System. A system composed of a solar energy collector, an energy storage facility, and components for the distribution of transformed energy, which may be attached to a residence or other structures. Small Scale Renewable Energy System. A renewable energy system including wind, solar, hydro-electric or geothermal sources that are primarily intended to serve the on-site use, but which may be grid-connected Electric Power Generation Facility. Any electric power generating facility and appurtenant facilities with generating capacity of ten (10) megawatts or more
Cheyenne County	Small. Single residential or small business-scale solar energy conversion system. A system consisting of roof panels, ground-mounted solar arrays, or other solar energy fixtures, and associated control or conversion electronics with a rated capacity of less than 500 kW, occupying no more than 2.5 acres of land, and that will be used to produce utility power to on-site uses. Medium. Distributed solar energy system. Solar electrical power generation that occurs

County	Solar Definitions
	close to where the power is consumed and is primarily used on site by the system owner. A private on-site solar energy conversion system consisting of many ground-mounted solar arrays in rows or roof panels, and associated control or conversion electronics, occupying more than 2.5 acres and no more than 30 acres of land, and that will be used to produce utility power to on-site uses Large. Utility-scale solar energy conversion system. A system consisting of many ground-mounted solar arrays in rows, and associated control or conversion electronics and includes substations, MET stations, cables/wires, energy storage and other buildings and structures accessory to such facility, occupying more than 30 acres and that will be used to produce utility power to off-site customers. Generative Facility (Commercial). A facility capable of producing electricity by means of gas, oil, steam, nuclear fuel, waterpower, solar energy, or wind power. Generative Facility (Private). A small facility capable of producing electricity to be used on-site, as specified in Colorado HB-1160
Clear Creek County	Solar Energy System. Related equipment that relies upon direct sunlight as an energy source, a substantial purpose of which is to transform solar energy into thermal, mechanical, chemical, or electrical energy. Small Solar Energy System. A solar energy system that is used to generate thermal, mechanical, chemical, or electrical energy accessory to the use(s) on the same parcel(s) of land. It may be free-standing, or attached to an existing permitted structure. Distributed Solar Energy System. A solar energy system that is used to generate thermal, mechanical, chemical, or electrical energy that is used to produce energy for more than one (1) user. Such systems may be free-standing, or attached to an existing permitted structure. Utility Scale Solar Energy Facility. A power plant that directly converts solar energy into usable thermal mechanical, or electrical energy, including such devises as solar energy systems and supporting structures and such directly connected equipment as generators, alternators, inverters, batteries and associated control equipment.
Conejos County	Major Electrical or Natural Gas Facilities. Major electrical or natural gas facilities include one or more of the following: 1. Electrical generating facilities. 2. Substations used for switching, regulating, transforming, or otherwise modifying the characteristics of electricity. 3. Transmission lines operated at a nominal voltage of sixty-nine thousand volts or greater. 4. Structures and equipment associated with such electrical generating facilities, substations, or transmission lines. 5. Structures and equipment utilized for the local distribution of natural gas service including, but not limited to, compressors, gas mains, and gas laterals. (Considers solar plants of the community solar garden size and larger to be Major Electrical Facilities)
Costilla County	Major Facility of a Public or Private Utility. Any electric transmission lines, power plants, or substations of electric utilities; major gas regulator stations, transmission and gathering pipelines, and storage areas of utilities providing natural gas or petroleum derivatives; and their appurtenant facilities. Major electrical or natural gas facilities include one or more of the following: 1. Electrical generating facilities, including wind and solar facilities [...]
Crowley County	Public Utility and Public Service Structures. Private energy generation structures, including wind, solar, nuclear, coal, natural gas, and geo-thermal facilities, and all necessary substations, gas regulator stations, communications equipment and buildings, pumping stations and reservoirs, transmission lines and pipelines.

County	Solar Definitions
	Solar Access. The ability to receive sunlight across real property. Solar Energy Device. A device which converts the sun's radiant energy into thermal, chemical, mechanical, or electrical energy. Solar Energy System. A system comprised of a solar energy collector, an energy storage facility and components for the distribution of transformed energy, which may be attached to a residence or other structures Solar Panels, Solar Arrays (Solar Energy). A device consisting of solar cells that convert light into electricity (panel), or an electrical device consisting of a large array of connected solar cells (arrays)
Custer County	No relevant definitions present.
Delta County	Renewable Energy Facility. Commercial facility for the production of more than 100 kW of renewable energy (e.g., solar, wind, or geothermal). Renewable energy facilities include necessary transmission. The phrase "renewable energy facility" does not include the generation of renewable energy to cover the energy demands of the principal land use, even if the demands exceed 100 kW.
Denver County	Major impact utility. including solar generating stations with a gross site area of 10,000 square feet or greater (SIC group 4911) Minor impact utility, Above-grade utilities of less than 10,000 square feet of gross site area that have a localized impact on surrounding properties and are necessary to provide essential services, including 4911 Electric services
Dolores County	Public or private utilities, major facilities and utility lines. Utilities include suppliers of water, electricity, natural and other gases, petroleum products of any kind, telephone communication and television broadcasts.
Douglas County	Utility - Major Facility: Power Plant. Any electrical energy generating facility with an energy generation capacity of 50 megawatts or more, and Appurtenance(s); Utility Service Facility. Any Neighborhood Substation, Personal Wireless Communication Facility, Water Storage/Treatment Facility: • Neighborhood Substation: Any facility used for the purpose of reducing voltages to levels of 115 kV, or less, for distribution to individual users;
Eagle County	Ancillary Solar Energy System. Any Solar Energy System which purpose is to provide up to 120% of the energy to support other structures and/or on-site uses contained upon a subject property. Such systems are incidental to other primary use(s) on the property and may be structure-integrated or ground mounted. Solar Energy System. A system of solar collectors and associated equipment to provide for the collection, conversion, storage, and transmission of radiant energy from the sun for electricity generation, space heating, space cooling or water heating. Solar Farm. Parcel or land area primarily utilized as a Ground-mounted Solar Energy System. Ground-Mounted Solar Energy System. A Solar Energy System which is free-standing and constructed upon a natural and/or improved surface, including but not limited to pedestal mounted collectors, tracking devices, including associated infrastructure and site improvements.
El Paso County	Solar Energy Generation Facility. A large-scale electrical energy generation facility with a minimum energy generation capacity of 500 kilowatts typically consisting of photovoltaic panels, heliostats (mirrors), collection tower(s), turbine(s), collection lines, electrical substation(s), transmission line(s), and other appurtenant facilities.

County	Solar Definitions
	Energy Generation Facilities. An electrical energy generating facility with generating capacity of less than 50 megawatts for commercial delivery and any appurtenant facilities.
Elbert County	Solar Power Plant. The entire exterior or perimeter envelope, or outermost boundary for a solar power plant facility, to include all infrastructure and equipment, including exterior fencing. Solar Energy System, Accessory. Facilities are generally generating electricity from sunlight primarily to reduce onsite consumption of utility power for residential or agricultural applications Solar Energy System, Small Commercial. Facilities are generally generating electricity from sunlight primarily to reduce onsite consumption of utility power for commercial, and industrial applications
Fremont County	No relevant definitions present.
Garfield County	Solar Energy System, Accessory. A device and/or system that has a combined name plate DC rating of less than 15 kilowatt and includes the equivalent kilowatt measurement of energy for systems other than photovoltaic that converts the sun's radiant energy into thermal, chemical, mechanical, or electric energy. Solar Energy System, Small. A device and/or system that has a combined name plate DC rating of 15 kilowatt to 500 kilowatt and includes the equivalent kilowatt measurement of energy for systems other that photovoltaic that converts the sun's radiant energy into thermal, chemical, mechanical, or electrical energy. Solar Energy System, Large. A device and/or system that has a combined name plate DC rating of greater than 500 kilowatt and includes the equivalent kilowatt measurement of energy for systems other than photovoltaic that converts the sun's radiant energy into thermal, chemical, mechanical, or electric energy.
Gilpin County	SOLAR ENERGY SYSTEM, PRINCIPAL[13] SOLAR ENERGY SYSTEM, ACCESSORY
Grand County	Public Utility. The term public utility includes every common carrier, pipeline corporation, gas corporations, electrical corporation, telephone corporation, water corporation, person, or municipality operating for the purpose of supplying the public for domestic, mechanical, or public uses and every corporation, or person declared by law to be affected with a public interest
Gunnison County	Solar-Generated Electricity. The production of electric current in a solid material with the aid of sunlight by direct conversion of light into electricity by use of photovoltaic (PV) cells
Hinsdale County	No relevant definitions present.
Huerfano County	Solar energy device. A solar collector or other device or a structural design feature of a structure which provides for the collection of sunlight and which comprises part of a system for the conversion of the sun's radiant energy into thermal, chemical, mechanical or electrical energy.
Jackson County	No relevant definitions present.

[13] Solar Energy System, Principal and Accessory, are both listed without a specific definitions

County	Solar Definitions
Jefferson County	Energy Conversion Systems (ECS). includes Solar Energy Conversion Systems (SECS). Solar Energy Conversion System. A system whose purpose is to harvest energy by transforming solar energy into another form of energy or transferring heat from a collector to another medium using mechanical, electrical, or chemical means. Non-commercial ECS. This ECS shall only serve the principal and accessory uses of the property and shall not be designed with the intention of generating excess energy that can be sold to neighboring properties or to the public utility. However, this provision shall not be interpreted to prohibit the sale of excess energy generated from the system back to the public utility Commercial ECS. This ECS shall have the primary purpose of research and development of ECS technology, or the generation of electrical power for sale, resale, or off-site use.
Kiowa County	Power Plant means (a) any electrical generating facility regardless of power source or generating capacity, including but not limited to wind, solar, or geothermal generating facilities, which utilizes more than five (5) acres of land; (b) any electrical generating facility which has a generating capacity of ten (10) megawatts or more regardless of how much acreage is utilized; and (c) any addition to, or modification of, any existing electrical generating facility which addition or modification has the effect of increasing the existing design capacity of the facility by a combined ten (10) megawatts or more
Kit Carson County	Solar Energy Facility. An electricity generating facility consisting of one or more solar panels under common ownership or operating control, and includes substations, cables/wires and other buildings accessory to such facility, whose main purpose is to supply electricity to off-site customer(s) with equal to or greater than 100 kilowatts in total nameplate capacity.
La Plata County	Solar Energy Facility. Those solar energy facilities defined in C.R.S. § 39-4-101 or any solar energy facility utilizing more than five (5) acres of land regardless of generating capacity. Power Plant. Any solar energy facility or wind energy facility which either utilizes more than five (5) acres of land regardless of its generating capacity, or any solar or wind electrical energy generating facility with a generating capacity in excess of two (2) megawatts, regardless of how much acreage is utilized and any appurtenant facilities thereto, or any addition or series of additions thereto increasing the existing design capacity of the facility in excess of two (2) megawatts.
Lake County	Solar Energy Device. A solar collector or other device or design feature of a structure which provides for the collection of sunlight and which comprises part of a system for the conversion of the sun’s radiant energy into thermal, chemical, mechanical or electrical energy. Solar Energy Equipment. Items including, but not limited to, solar panels, lines, pumps, batteries, mounting brackets, framing, and foundations used for or intended to be used for the collection of solar energy in connection with a building. Solar energy equipment and its use is accessory to the principal use of the property.
Larimer County	Small Solar Energy Facility. A facility which is used for the production of electrical energy from energy collected by the sun including solar energy collectors, power generation facilities, facilities for storing and transforming energy, other appurtenant facilities, and any transmission lines, which is developed for the purpose of supplying or distributing electrical energy to users, a customer, or customers. (Note: this could include a solar garden that has a disturbed area of five or fewer acres.) Solar Garden. A community solar garden as defined in section 40-2-127 (2) of the Colorado Revised Statues [sic] Power plant. A facility designed, constructed and operated to generate electric power by steam, wind, solar, water or other means.

County	Solar Definitions
	Solar Energy System. A system which is used for the production of electrical energy from energy collected by the sun including solar energy collectors, power generation facilities, facilities for storing and transforming energy, and any other appurtenant facilities, which is designed to supply power to principal use(s) on the lot.
Las Animas County	Las Animas uses its wind farm regulations to regulate solar Small wind energy system. A wind energy conversion system consisting of a wind turbine, a tower and associated control or conversion electronics, which has a rated capacity of not more than one hundred (100) kW and which is intended to primarily reduce on-site consumption of utility power Wind farm. A single wind-driven machine or a collection of wind-driven machines or turbines that convert wind energy into electrical power for the primary purpose of sale, resale or offsite use Solar energy device. A solar collector or other device or a structural design feature of a structure which provides for the collection of sunlight and which comprises part of a system for the conversion of the sun's radiant energy into thermal, chemical, mechanical or electrical energy
Lincoln County	Community solar garden. A solar electric generation facility with a nameplate rating of two megawatts (2 MWDC) or less that is located in or near a community served by a qualifying retail utility where the beneficial use of the electricity generated by the facility belongs to the subscribers to the community solar garden. There shall be at least ten subscribers. The owner of the community solar garden may be the qualifying retail utility or any other for-profit or nonprofit entity or organization, including a subscriber organization that contracts to sell the output from the community solar garden to the qualifying retail utility. A community solar garden shall be deemed to be "located on the site of customer facilities. Small scale solar. Development systems with a 50 kWDC generation capacity or less serving a single user Large scale solar facility. A system with a nameplate rating of greater than two megawatts, Direct Current (2 MWDC) generation capacity providing power to one or more users, which may include components for the transmission and distribution of energy
Logan County	Solar Energy Facility. An electricity generating facility consisting of one or more solar panels under common ownership or operating control, and includes substations, cables/wires and other buildings accessory to such facility, whose main purpose is to supply electricity to off-site customer(s) with equal to or greater than 100 kilowatts in total nameplate capacity.
Mesa County	Private Utility. A business or service which is engaged in regularly supplying the public with some commodity or service which is of public consequences and need, such as electricity, gas, transportation or communication
Mineral County	Alternative Energy System. a form of energy derived from a natural source, and includes all but not limited to, solar, wind and hydro power.
Moffat County	Solar Collector. For the purpose of this Resolution; Solar collector, heat pump, storage facilities and distribution components for space heating and cooling and water heating, whether attached or unattached to a structure

County	Solar Definitions
Montezuma County	No relevant definitions present.
Montrose County	Solar Energy Facility. A generation facility which uses solar energy and the required components to distribute the transformed solar energy. Power Generation. An electrical generating facility for the purpose of generating power for public use. This does not include alternative onsite energy generation (distributed solar is included in this category)
Morgan County	Agrivoltaic Systems. A system designed for the simultaneous use of areas of land for both ground-mounted solar collectors and agriculture. Solar Collector: A photovoltaic (PV) panel, array of panels or other solar energy device, the primary purpose of which is to provide for the collection, inversion, storage, and distribution of solar energy for electricity generation, space heating, space cooling, or water heating. Ground-mounted solar collector includes agrivoltaic systems and parking canopy solar systems when installed on surface parking lots. Building-mounted solar collector includes parking canopy solar systems when installed on the roof of a parking garage.
Otero County	Solar Energy Device. A device which converts the sun's radiant energy into thermal, chemical, mechanical or electric energy. Solar Energy System. A system composed of a solar energy collector, an energy storage facility and components for the distribution of transformed energy, which may be attached to a residence or other structures. Solar Panels, Solar Arrays (Solar Energy). A device consisting of solar cells that convert light into electricity (panel), or an electrical device consisting of a large array of connected solar cells (arrays) "Power plant". means any electrical energy generating facility which either utilizes more than five (5) acres of land regardless of its generating capacity, or any electrical energy generating facility with a generating capacity of greater than or equal to ten (10) megawatts or more, regardless of how much acreage is utilized, and any facilities appurtenant thereto, or any addition thereto increasing the existing design capacity of the facility by a combined ten (10) megawatts or more.
Ouray County	Public Utility. Transmission, generation and storage and treatment facilities of providers of electrical, water, gas, and other like services.
Park County	Small Solar Energy System. Equipment that converts solar energy into electrical energy solely for consumption by a lawful use on the lot that the equipment is located on, except that if the lot is connected to a distribution line owned by a utility company excess energy not needed for the lot's primary use may be used by the utility company (i.e. net metering). Utility Facility, Major. An underground, surface or overhead structure or facility or an area of land used to generate, store, transmit, distribute or regulate electricity, oil, gas, or water; to pump or chemically treat water, sewage or solid waste; or for storm water drainage exceeding one hundred and twenty square feet in area. A major utility facility may include accessories such as poles, wires, mains, drains, vaults, culverts, sewers, pipes, signals or pumps. Specifically included as a major utility facility are transmission lines capable of the transmission of electricity more than 115 kilovolts (KV), water pipelines with a capacity of more than 15 cubic feet per second, and water storage facilities with a capacity of 30,000 gallons or more of water. (Although this definition does not say it includes solar, any array with distributed energy and built for more than one user is considered a major utility facility according to the senior planner).

County	Solar Definitions
Phillips County	Solar Energy System, Residential. A single residential or small business-scale solar energy conversion system consisting of roof panels, ground-mounted solar arrays, or other solar energy fixtures, and associated control or conversion electronics with a rated capacity of less than 500 kW, occupying no more than 2.5 acres of land, and that will be used to produce utility power to on-site uses. Solar Energy System, Utility-Scale. A utility-scale solar energy conversion system consisting of many ground-mounted solar arrays in rows, and associated control or conversion electronics, occupying more than 30 acres and that will be used to produce utility power to off-site customers.
Pitkin County	Solar Energy Collector. means a device for the passive collection of solar energy for use in the heating of water or the generation of electricity, together with related wires and pipes necessary for operation. Ground-Mounted Solar Energy Collector. means any solar energy collector that is not directly attached to a building via any ancillary development (racking assembly, balancing system, etc.) Solar Farm. means any collection of ground-mounted solar generators that occupies one-quarter (1/4) acre of land or more but generates less than two (2) Mega-Watts (MW). Solar Facility. means any ground-mounted solar generators that occupy one-quarter (1/4) acre of land or more and generates two (2) Mega-Watts (MW) or more. Solar Facilities are considered Major Public Utilities.
Prowers County	Solar Energy Facilities. Solar collector or other device that provides for the collection of sunlight for the conversion of sunlight to energy.
Pueblo County	Solar Facility, Small-Scale. A solar facility of less than one (1) acre. This size is approximately equivalent to a rated capacity of about ten (10) kilowatts (kW) to 250 kW alternating current. Facilities are generally generating electricity from sunlight primarily to reduce onsite consumption of utility power for residential, agricultural, commercial, and industrial applications. Solar Facility, Medium-Scale. A facility between one (1) acre and ten (10) acres. This size is approximately equivalent to a rated capacity of about 250 kW to one (1) megawatt (MW) alternating current. Facilities are generally generating electricity from sunlight primarily to reduce onsite consumption of utility power for commercial and industrial applications. Solar Facility, Utility-Scale. A solar facility of more than ten (10) acres. This size is approximately equivalent to a rated capacity of about one (1) MW alternating current or greater. Facilities are generally generating electricity from sunlight to provide electricity to a utility provider.
Rio Blanco County	Major Electrical or Natural Gas Facilities. (Article 14 - Areas and Activities of State Interest only) Major electrical or natural gas facilities include one or more of the following: 1. Electric power generation...
Rio Grande County	Solar Energy Facility. A solar energy collector and the required components to the distribute the transformed solar energy. Public Utilities. Electricity, natural gas, water and wastewater service, wire telephone service, and similar public services. The term “public utilities” does not include wireless telecommunication facilities.
Routt County	Production Facility, Renewable Energy. Production Facilities, Renewable Energy are relating to the operation of solar, wind, hydrologic, bio-fuels or other energy production not based on fossil fuels such as coal, oil, gas or coal bed methane (see also Solar Energy System).

County	Solar Definitions
	Solar Energy System. A system composed of a solar energy collector which may include an energy storage facility and components for the transmission and distribution of transformed energy sized to 120% of the average annual load of the use by right and/or an approved use. Public Utilities – Major Facilities. Major facilities of electrical utilities including: 1) Electrical generating plants and associated facilities designed for, or capable of, operation at a capacity of ten megawatts or more.
Saguache County	Power plant. means any electrical energy generating facility with a generating capacity of fifty (50) megawatts or more, and any facilities appurtenant thereto, or any addition thereto increasing the existing design capacity of the facility by fifty (50) megawatts or more, with a generating source of natural gas, coal, geothermal resources or solar energy.
San Juan County	No relevant definitions present.
San Miguel County	Renewable Energy Facility (solar, wind). A facility designed to produce energy, through, either: (a) A series of solar photovoltaic cells in panels used to convert sunlight into electricity (often integrated with agriculture) Solar Energy Collector. Solar panels used to power a farm, home or business.
Sedgewick County	Distributed Solar Energy System. Solar electrical power generation that occurs close to where the power is consumed and is primarily used on site by the system owner. A private on-site solar energy conversion system consisting of many ground-mounted solar arrays in rows or roof panels, and associated control or conversion electronics, occupying more than 2.5 acres and no more than 30 acres of land, and that will be used to produce utility power to on-site uses. Residential Solar Energy System. A single residential or small business-scale solar energy conversion system consisting of roof panels, ground-mounted solar arrays, or other solar energy fixtures, and associated control or conversion electronics with a rated capacity of less than 500 kW, occupying no more than 2.5 acres of land, and that will be used to produce utility power to on-site uses
Summit County	Solar Energy System. A system that converts the sun’s radiant energy into thermal or electrical energy. For purposes of this Code, solar energy systems are classified as follows: a. Small Scale: Small scale solar energy systems shall be used primarily for on-site purposes. Excess power may be sold back to a utility company, but is not the primary purpose of the system. b. Large Scale: Large scale solar energy systems generate power primarily to be sold for use off-site.
Teller County	Public utility. Every common carrier, pipeline corporation, gas corporation, electrical corporation, telephone corporation, telegraph corporation, water corporation, or person, individual, firm, partnership, other corporation, or other entity, operating for the purpose of supplying the public for domestic, mechanical, or public uses; and every person, individual, firm, corporation, partnership, and/ or other entity, declared by law to be affected with a public interest; each of which is subject to the jurisdiction, control, and regulation of and by State and /or Federal law.
Washington County	Solar Power Production Facility (SPPF). A utility on an area of land over one-half acre designated for the purpose of producing photovoltaic electricity with a nameplate capacity of over 1/2 megawatt (500,000 kilowatts [sic]) and includes, but is not limited to, an assembly of solar panels and solar equipment that convert sunlight into electricity and

County	Solar Definitions
	then stores and/or transfers that electricity. Solar Power Production Facilities may include mechanical buildings, transmission lines, and other uses that are typical to a SPPR, however offices and other commercial uses are prohibited.
Weld County	Solar Energy Facility. means a commercial facility whose primary purpose is to supply electricity and consists of one or more solar arrays and other accessory structures, equipment, including substations, switchyards, battery storage, electrical infrastructure, generators, transmission lines, communications infrastructure, and other appurtenant structures and/or facilities. Large scale solar facility. A facility which is used for the production of electrical energy from energy collected by the sun including solar energy collectors, power generation facilities, facilities for storing and transforming energy, other appurtenant facilities and any transmission lines, which is developed for the purpose of supplying or distributing electrical energy to users, a customer or customers and will have a rated capacity greater than thirty (30) megawatts. This designation shall not include roof and/or ground mounted solar systems located on permitted principal and accessory buildings and designed to supply power to the principle use(s) on site.
Yuma County	Residential Solar Energy System. A single residential or small business-scale solar energy conversion system consisting of roof panels, ground-mounted solar arrays, or other solar energy fixtures, and associated control or conversion electronics with a rated capacity of less than 500 kW, occupying no more than 2.5 acres of land, and that will be used to produce utility power to on-site uses. Distributed Solar Energy System. Solar electrical power generation that occurs close to where the power is consumed and is primarily used on site by the system owner. A private on-site solar energy conversion system consisting of many ground-mounted solar arrays in rows or roof panels, and associated control or conversion electronics, occupying more than 2.5 acres and no more than 30 acres of land, and that will be used to produce utility power to on-site uses. Utility Scale Solar Energy System. A utility-scale solar energy conversion system consisting of many ground-mounted solar arrays in rows, and associated control or conversion electronics, occupying more than 30 acres and that will be used to produce utility power to off-site customers.

Appendix C. 1041 Permit Thresholds by County

As discussed in Section 4.4, some Colorado counties have adopted thresholds triggering a 1041 permit under their 1041 power to regulate the siting of major facilities of a public utility. Additionally, some counties also have adopted 1041 regulations about the development of historically irrigated land for purposes other than irrigated agriculture, including development causing permanent or partial cessation of irrigation and/or transfer of water rights. Some counties have included their 1041 requirements as part of a solar-specific permitting process, while others have 1041 regulations in parallel with a solar-specific permitting process, which might or might not be applied to a given project. Table C-1 reports counties that have adopted specific thresholds that might impact the permitting of solar power plants. Data are gathered from the references listed for each county in Appendix A.

Table C-1. Colorado County Thresholds Potentially Triggering a 1041 Permitting Process for Solar Power Plants in Those Counties

	1041 Thresholds for a Solar Power Plant or "Major Facility of a Public Utility"		1041 Threshold for Development of Irrigated Land (acres)
County	**Generation Capacity (MW)**	**Land Area (acres)**	
Alamosa	2 MW	n/a	3 acres
Arapahoe	5 MW	n/a	n/a
Bent	n/a	n/a	10 acres
Boulder	50 MW	n/a	n/a
Cheyenne	10 MW	5 acres	3 acres
Clear Creek	1 MW	n/a	n/a
El Paso	0.5 MW (500 kW)	n/a	n/a
Elbert	1 MW	10 acres	n/a
Huerfano	50 MW	n/a	Required, no minimum
Kiowa	10 MW	5 acres	n/a
La Plata	2 MW	5 acres	n/a
Larimer	n/a	5 acres	n/a

	1041 Thresholds for a Solar Power Plant or "Major Facility of a Public Utility"		1041 Threshold for Development of Irrigated Land (acres)
County	**Generation Capacity (MW)**	**Land Area (acres)**	
Las Animas	50 MW[14]	n/a	n/a
Morgan	50 MW	n/a	n/a
Otero	10 MW	5 acres	3 acres
Pitkin	2 MW	¼ acre	n/a
Prowers	25 MW	5 acres	5 acres
Pueblo	1 MW	1 acre on some agricultural zones	n/a
Routt	10 MW	n/a	n/a
Saguache	5 MW	n/a	3 acres
Weld	30 MW	160 to 320 acres (zone specific)	n/a

[14] Las Animas currently permits solar power plants through its wind power plant regulations. Wind power plants are specifically exempted from this 1041 permit requirement. However, 1041 permits would also be required on some zoning districts.

Appendix D. Panel Height Restrictions by County

Table D-1 lists the review data on panel height restrictions presented in Section 4.6. Data are gathered or quoted from the references listed for each county in Appendix A. Some counties reference specific solar definitions related to panel height restrictions, where each county's solar definitions are available in Appendix B. This table only includes restrictions specific to ground-mounted solar. Neither height restrictions pertaining to rooftop systems (i.e., restrictions on height above a roof) nor general structure height restrictions, which are typically 35 ft or greater, are included. Counties without relevant height restrictions are omitted.

Table D-1. Height Restrictions on Solar Panel Heights by County

County	Maximum Panel Height Restrictions
Adams	20 ft measured from the highest grade below each solar panel
Arapahoe	15 ft at the solar mounting point for Small Solar Systems
Boulder	15 ft Systems exceeding 15 ft in height require an increased setback of 75 ft from all property lines unless visual impacts are mitigated In no case shall a system exceed 25 ft in height
Clear Creek	35 ft
Dolores	Determined through the Land Use Agreement Process
Douglas	Determined through the use by special review process specific to each site
Eagle	15 ft measured from the highest point of the improvement to existing or finished grad, whichever is more restrictive
El Paso	15 ft
Garfield	15 ft for Accessory solar systems, which is not directly applied to utility-scale systems. Utility-scale system need only demonstrate structure can support wind load (Personal Communication).
Gilpin	20 ft measured from highest grade below each solar panel
Jefferson	25 ft measured from the average natural ground level adjacent to the base of the array to the highest point of the array
Kiowa	No height restrictions but the solar array must be 1.2 times the maximum height from the property lines
Kit Carson	The height and location of any structure within the Wind or Solar Energy Facility shall be subject to FAA approval
La Plata	20 ft

County	Maximum Panel Height Restrictions
Lake	25 ft
Larimer	15 ft
Moffat	35 ft
Montezuma	35 ft
Morgan	The maximum height of the solar panels shall not exceed 30 feet in height or 35 feet in height for agrivoltaics when oriented at maximum tilt
Ouray	35 ft Any project located within 1.5 miles of the centerline of roads or highways is allocated a maximum of 5 "points" to use for size and height. For height, the project gets .3 points for each ft of the maximum height structure and for size, .1 points for 100 sq. ft.
Pitkin	15 ft measured from natural grade or finished grade, whichever is more restrictive, except to accommodate site specific needs if approved through special review
Pueblo	Solar Facility Narrative must contain an inventory with description of all proposed structures and uses including Battery Energy Storage Facilities, inverters, substations, and all structures over 60 ft. in height.
Rio Grande	10 ft
Summit	25 ft
Washington	20 ft measured from grade at the base of the equipment to its highest point during operation
Weld	25 ft measured from the highest grade below each solar panel to the highest extent of the solar panel rotation

Appendix E. Fencing

Table E-1 lists the review data on fencing requirements presented in Section 4.7. Data are gathered or quoted from the references listed for each county in Appendix A. This table includes both fencing requirements specifically intended for ground-mounted solar, as well as fencing requirements intended more generally for different types of development, which might include solar. Some counties reference specific solar definitions related to fencing restrictions, where each county's solar definitions are available in Appendix B. Counties are omitted in cases where the review did not find relevant fencing requirements.

Table E-1. Fencing Requirements by County

County	Fencing Requirements
Adams	All solar panels and equipment (excluding poles and wires necessary to connect to facilities of the electric utility) shall be enclosed by a fence at least six (6) feet high. Wildlife-friendly fence options are encouraged.
Alamosa	No standard requirements but off-site impact is considered during permit process; fencing/screening has been required for some permits
Arapahoe	Landscaping or fencing around the perimeter of the land occupied by the Facility shall be installed concurrently with the Small Solar System Facility's completion. The screening shall be designed to minimize visual impacts from adjacent properties and the nearest streets.
Bent	In the special review process: Uses with unsightly aspects, odors, or noise are set back a sufficient distance from adjacent property boundaries and proper fencing or screening is provided to that adjacent property is not adversely affected
Boulder	In areas where the facilities will have a substantial visual impact on the surrounding area, landscaping or screening of the site, or the use of less intrusive equipment, may be required. Specific landscaping or screening requirements may include, but are not necessarily limited to, establishing and properly maintaining ground cover, shrubs, and trees; shaping cuts and fills to appear as natural forms; designing the operation to utilize natural screens; or constructing fences for use with or instead of landscaping.
Cheyenne	For large solar energy systems: Fencing or other barriers acceptable to the County shall be installed to prevent unauthorized access to solar collectors and equipment and BESS battery enclosures
Clear Creek	Screening techniques should be considered and utilized depending on site conditions, including landscaping, berming, camouflaging, screening, and fencing, where appropriate.
Denver	In development intended for nonresidential uses and located near or abutting Residential Zone Districts, provide fences, walls or year-round screen planting when necessary to shield adjacent residential districts from parking lot illumination, headlights, fumes, heat, blowing papers and dust and to reduce the visual encroachment of commercial architectural, signs and activity on residential privacy and residential neighborhood character.
Eagle	The project applicant shall demonstrate through visual impact analysis, materials, and/or screening to the extent practicable, that the project will not create adverse visual impact to neighboring properties, surrounding

County	Fencing Requirements
	areas, and community buffers as further detail necessary to support Section 5-250.B.4 Design Minimizes Adverse Impact.
El Paso	Requirements for fencing will be determined during the permitting process.
Garfield	Where proposed development is located next to existing agricultural operations, partition fences must either exist or be installed to separate the proposed development from adjoining agricultural land or stock drives.
Gilpin	All solar panels and equipment (excluding poles and wires necessary to connect to facilities of the electric utility) shall be enclosed by a fence at least eight (8) feet high. Wildlife friendly fence options are encouraged.
Grand	Fencing may be required as determined during the permitting process.
Gunnison	Fencing or plant material can be used to fulfill screening and buffering requirements: Every land use change that is classified as Minor or Major Impact Project…shall provide landscaped buffering between adjacent uses when topographical or other natural barriers do not provide reasonable screening and when the County finds that: a. NEIGHBORING PROPERTIES. There is a need to shield neighboring properties from any adverse external effects of a proposed land use change; or b. ADVERSE IMPACTS. There is a need to shield the land use change from negative impacts or adjacent land uses in high-density land use changes, and/or when building design and siting do not provide privacy
Jefferson County	Required in site plan: warning signs, fencing, and access restrictions
Kit Carson	Fencing, or other barriers acceptable to the County, shall be installed to prevent unauthorized access to the Wind or Solar Energy Facility substations. All access doors to Wind Turbine towers or Solar Energy Facilities and electrical equipment shall be lockable
Larimer	Ground-mounted mechanical equipment located within view of customer entrances or public rights-of-way shall be integrated into the overall site design, the architectural design of the building, and screened from public view using one or a combination of the following: 1) Decorative wall, fence or enclosure that is constructed of materials that are compatible with the overall architectural design of the development and of a height that is not less than the height of the equipment to be screened; or 2) Landscaping that is of sufficient height at maturity and of opacity to effectively soften and screen the equipment, and that is integrated into the overall landscape plan.
Las Animas	Determined during the permitting process, based on recommendations by state parks service based on wildlife in the area
Lincoln	For large solar energy systems: An appropriate security/livestock fence (height and material to be established through the use by special review

County	Fencing Requirements
	process) shall be placed around the perimeter of the solar power plant and maintained by the facility operator.
Logan	Determined during the permitting process, and other barriers as acceptable to the County may be used in place of a fence.
Mesa	Determined during the permitting process
Mineral	Might be required during Conditional use process
Moffat	Uses permitted under a Conditional Use Permit which are found to be obnoxious or offensive because of odor, dust, smoke, gas, noise or vibration may require fencing or screening to a minimum height of 8 feet.
Montrose	Any combination of setbacks, berms, fencing, landscaping, and arrangement of uses on the site to effectively insulate adjacent uses from adverse impacts of the commercial uses.
Morgan	The setback requirement from inhabited structures may be reduced if appropriate screening through landscape or an opaque fence is installed.
Phillips	Fencing or other barriers acceptable to the County shall be installed to prevent unauthorized access to solar collectors and equipment.
Pitkin	Any ground-mounted solar energy collecting system using a quarter (1/4) acre of land or more shall be considered a Solar Farm and be subject to special review pursuant to section 2-40-20 (with total land used calculated by accounting for total land area needed to develop the ground-mounted system, including but not limited to, storage sheds, access, grading, fencing, revegetation, mounting equipment, panels, etc.).
Prowers	The Solar Energy Facilities shall be enclosed with a security fence as approved pursuant to a fencing plan submitted to the Prowers County Land Use Administrator. Appropriate signage shall be placed upon such fencing that warns the public of the high voltage therein.
Routt	Proposed landscaping, screening, fencing and other visual impact mitigation shall be approved by the Planning Director, Planning Commission or Board of County Commissioners prior to operation.
San Juan	In order to minimize visual impacts to view sheds and view corridors, additional setbacks, landscaping, screening or design requirements may be required by the County to preserve the natural beauty and historical resources of the area.
Teller	Appropriate screening, fencing, enclosing, and buffering of certain uses, primarily Special Review Uses, is required in order to adequately screen the use from public rights-of-way and adjoining and/or adjacent properties. It may be that if the proposed use can not be adequately screened, the site is not an appropriate location for that use.
Washington	SPPFs shall be screened or shall be enclosed by fencing a minimum of six (6) feet in height. Screening and/or fencing shall be consistent with the surrounding character and utilize landscaping and/or native vegetation strategies to screen the facility from routine view of public right-of-way or adjacent residential property. When fencing is used, the type and style of

County	Fencing Requirements
	fencing shall also reflect any safety concerns specific to the general public and adjacent wildlife. Entrances must be gated and locked
Weld	Small Solar System - shall be enclosed with a security fence as approved pursuant to a fencing plan submitted to the Department of Planning Services.
Yuma	Utility Scale Solar Energy Systems: Fencing or other barriers acceptable to the County shall be installed to prevent unauthorized access to solar collectors and equipment.