U.S. DEPARTMENT OF ENERGY
SOLAR DISTRICT CUP
COLLEGIATE DESIGN COMPETITION

# Solar District Cup Class of 2021-2022 Rules

Release date: January 18, 2022

U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY
SOLAR ENERGY TECHNOLOGIES OFFICE

NREL Transforming ENERGY

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# Acronyms and Abbreviations

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|---|---|
| DOE | U.S. Department of Energy |
| DSS | distribution system simulator |
| IRR | internal rate of return |
| MACRS | modified accelerated cost recovery system |
| NPV | net present value |
| NREL | National Renewable Energy Laboratory |
| PPA | power purchase agreement |
| PV | photovoltaic |
| SAM | System Advisor Model |

# Summary of Changes for This Edition

1. Revised date for Project Pitch event.
2. Added PV system hosting capacity heatmap to list of data sets included in the Division and District Use Cases section.
3. Revised Final Deliverable Package—Solar PV Plus Battery Electric Storage System section for the battery challenge.
4. Revised the Table 2. Sections 3, 4, and 5. Judging Statements for Evaluation.
5. Updated Project Pitch Event for First-Place Division Winners via Video Conference (and no travel).
6. Added the list of district use case partners to the Partners section.
7. In Appendix A. Resources for Assumptions, added two new sections for Guidance for Distribution System Impact Summary and References for Development Plan.
8. In Appendix D, revised the Content Requirements of sections 3. Distribution System Impact Summary, 4. Financial Analysis, and 5. Development Plan.

# Summary of Changes for the Sept. 16 Edition

1. In Summary Timeline section, changed September 16, 2021, to September 27, 2021, 5 p.m. ET for the Deadline for teams to complete registration.
2. In Summary Timeline section, changed September 23, 2021, to September 29, 2021, for Participating teams announced.
3. In Solar Power International section, deleted “in-person and” and “in New Orleans,” and changed dates from Sept. 20 – 23, 2021, to Sept. 28 – 29, 2021.

# 1. COMPETITION OVERVIEW

Welcome to the U.S. Department of Energy (DOE) Solar District Cup Collegiate Design Competition!

To support DOE's ongoing work addressing structural employment gaps for professionals in the energy industry, the Solar District Cup challenges multidisciplinary collegiate student teams to develop forward-thinking approaches for campus or urban district solar-plus-storage systems that inspire students and professionals alike—and then design and model those systems.

The competition engages students across engineering, finance, urban planning, sustainability, and other disciplines or degree programs to reconsider how electric energy is generated, managed, and used in urban areas. Students assume the role of a solar-plus-storage developer to produce a proposal and analyze electric distribution grid interactions for a district use case. For the purposes of this competition, "campus" and "urban district" are distinct areas of developed land containing a group of mixed-use buildings served by a distribution feeder. The competition organizers provide the teams with district use cases—including energy use data for multiple buildings, electrical infrastructure, and the district master plan—to serve as the basis for the solutions the teams develop in the challenge.

Each team competes against other teams in one of multiple divisions. Each division is structured around a single district use case. A division judging panel selects winning teams after the teams submit their final deliverables and present their designs via live video conference. The strongest submissions provide innovative solutions that maximize the district's energy offset and financial savings over the contracted or useful life of the system while integrating aesthetic, infrastructure, and community considerations.

The Solar District Cup is designed to inspire students to consider new career opportunities, learn new industry-relevant skills, engage with the professional marketplace, and prepare to lead the next generation of workforce in distributed solar energy. As competitors, students:

- Gain experience with innovative renewable energy design
- Develop real-world solutions that shape the future of solar energy
- Engage with industry professionals to forge relationships and connections that aid participating students' transition to the solar energy workforce upon graduation
- Compete to earn a trophy and national recognition.

The Solar District Cup invites participation by teams of at least three students enrolled in accredited U.S.-based collegiate institutions. In this case, "collegiate institution" refers to any school of post-secondary or higher education, including but not limited to community colleges, technical colleges, and traditional four-year and graduate-level universities. There is no cost to register for or participate in the Solar District Cup, including the final online competition event, and participating team members receive complimentary passes to industry conferences associated with the competition. Following registration, teams receive notification of acceptance on a rolling basis up to the registration deadline.

Competition organizers support student team efforts through educational webinars on system design, modeling, and techno-economic analysis topics free of charge to all student teams. Learn more at www.energy.gov/solardistrictcup.

Register to compete at www.herox.com/solardistrictcup.

## Summary Timeline

The Solar District Cup Class of 2021-2022 is a two-semester (or three-academic-quarter) project, starting in fall 2021 and culminating in spring 2022.

- April 30, 2021—Competition announced, and team registration opened
- August 18, 2021—Informational webinar held
- August 31, 2021—Rules published
- September 27, 2021, 5 p.m. ET—Deadline for teams to complete registration
- September 29, 2021—Participating teams announced
- September 30, 2021—Warm-Up Workshop held for participating teams (by video conference)
- November 18, 2021, 5 p.m. ET—Deadline for receipt of Progress Deliverable Package from participating teams
- December 16, 2021—Finalist teams announced, and Progress Deliverable Package feedback provided
- April 14, 2022, 5 p.m. ET—Deadline for receipt of Final Deliverable Package from finalist teams
- April 21, 2022, 5 p.m. ET—Deadline for receipt of presentation files from finalist teams
- April 24–25, 2022—Finalists present projects by video conference; winners announced. Live video attendance and live presentation by at least one student team member from each finalist team is required (no pre-recorded presentations). Only students may present to judges at the finalist event.
- April 25, 2022—First-place winners of each division present in the Project Pitch event.

## Background

Rapid advancements in solar electric generation and battery electric storage technologies have resulted in decreasing costs and increasing rates of deployment. At the same time, preparation for careers in these technology applications—particularly at the nexus between the two—has limited existing post-secondary curricula.

As indicated in Chapter 5 of DOE's *Quadrennial Energy Review: Transforming the Nation's Electricity System:*

> Workforce retirements are a pressing challenge. Industry hiring managers often report that lack of candidate training, experience, or technical skills are major reasons why replacement personnel can be challenging to find—especially in electric power generation.

Although the solar industry has matured significantly over the last decade, additional opportunities exist to integrate solar-plus-storage solutions at the district scale. With innovation and careful integration, property owners and utilities alike can realize benefits of a more resilient, cost-effective, and sustainable distributed energy source.

As stated in the DOE Solar Energy Technologies Office (SETO) Multi-Year Program Plan, SETO does research, development, demonstration, and deployment assistance for solar energy. SETO accelerates the advancement and deployment of solar technology in support of an equitable transition to a decarbonized energy sector by 2050, starting with a decarbonized electricity system by 2035. For rapid deployment and growing the U.S. solar industry, a SETO goal for 2025 is a well-supported and diverse solar workforce that meets the needs of the industry and of underserved communities that grows to employ at least 300,000 workers.

DOE has a history of supporting workforce development through competitions focused on project-based learning (e.g., Solar Decathlon, Collegiate Wind Competition, EcoCAR, Cleantech University Prize). Student competitors gain experience solving relevant industry challenges that prepare them for successful careers in solar and related energy fields, benefiting from mentorship, training, collaboration, and networking. The competition supports DOE's ongoing work to help industry address structural employment gaps through comprehensive workforce development activities that simultaneously provide innovative solutions for partner districts' consideration and district-level ideas that inspire industry members. The Solar District Cup encourages collaboration between academia and industry. The program seeks to establish public-private partnerships and demonstrate corporate and nonprofit industry co-sponsorship.

# 2. COMPETITION PROCESS

## Introduction

The Solar District Cup challenges collegiate student teams to design and model distributed energy systems for a campus or urban district. The strongest teams are often multidisciplinary, including students from mechanical, civil, or electrical engineering; business or finance; urban planning; construction management; communications; or sustainability degree programs. A campus or district is a defined area of developed land containing a mixed-use group of buildings served by a local electrical distribution feeder. The systems proposed by students shall integrate solar photovoltaic (PV) generation, battery electric storage, and other distributed technologies and capabilities within the district's existing energy sources, uses, and infrastructure.

The winning teams in each division of the Solar District Cup Class of 2021-2022 receive a trophy and national recognition. Additionally, one team is identified by a public audience of peers and industry professionals as the Project Pitch winner. All student competitors gain valuable experience in innovative renewable energy design working with real-life examples. Competitors learn leading industry software, present to nationally respected judges, and engage with industry mentors.

For the purpose of this competition, the organizers present the teams with district use cases based on existing campuses or urban areas and assign a district use case to each division. Each team develops a solution for its assigned district use case, which enables students to work on a real-world project of actual energy load, utility rate, and site data while developing distributed-energy solutions. These use cases are developed using input from district partners to provide real-world constraints and considerations. The solutions the teams develop provide insights that could inform the partner districts for future development of distributed energy resources.

The competition organizers host an online informational webinar and Warm-Up Workshop that provides information and guidance about the competition rules, deliverables, and judging criteria to help all teams succeed. Competition organizers also support student team efforts through educational webinars on solar and battery system design, modeling, and techno-economic analysis topics. Additionally, through a partnership with Solar Power Events, registered team members receive access to the educational, poster, and trade show sessions of the Solar Power International conference, part of North America Smart Energy Week. At the conclusion of the competition, student teams present their solutions to industry leaders and judges on a video conference, where winners are also announced.

## Goal

The goal for each team is to design a solar-plus-storage system for a campus or district that maximizes energy offset and financial savings over the contracted [if power purchase agreement (PPA) or lease] or useful (if cash purchase) life of the system. Competition teams analyze electric distribution grid interactions and assume the role of renewable energy systems developers to produce a PPA, lease, and/or cash purchase proposal for their division's district.

## How to Enter

1. Go to the Challenge page at www.herox.com/solardistrictcup.
2. Create a HeroX account if you don't already have one, including activating your account by clicking the verification link sent to your email, or sign in and then choose "Solve this Challenge." You'll need to accept the "Solar District Cup 2022 Competitor Agreement" to get started. This indicates your interest in competing; it is not a commitment.
3. If you know the email addresses of your team members, or if you're joining an already established team, you can choose those options, but otherwise – just choose "No, I want to compete individually". You can set up your team at a later date.
4. By the registration deadline, one person from each team must click "Begin Entry", fill out the necessary form items, then choose "Save & Preview". You then must click "Submit Final Entry" on HeroX to complete registration. This step is when you identify your collegiate institution and expected team makeup. There is no cost to submit a Register entry. Note that you can edit and re-submit your entry as many times as you would like up until the registration deadline.
5. Registration entries received by the deadline are deemed participating teams. All teams who successfully complete a Register entry and meet eligibility are accepted.
6. Divisions are assigned by the competition organizers following receipt of a complete Register entry and by the date on which participating teams are announced. Assignments ensure an equal number of teams in each division.
7. Multiple teams from a single school may submit a Register entry, but only one team may compete per division. Three or four divisions are expected.
8. Only one person per team may submit a Register entry. Other members join that registered team via HeroX. Team members may be added or removed from a team at any time. Once you have registered a team, you can invite additional members using HeroX.

## How to Win

A team competes against other teams in a division, and each division has a single district use case. Competition organizers assign teams to divisions upon registration. Each team designs its own solution for the assigned division's district use case. The strongest team concepts are those that maximize the district's energy offset and financial savings over the system's contracted (if PPA or lease) or useful (if cash purchase) lifetime while integrating aesthetic, infrastructure, and community considerations. A team wins based on its average score as determined by a panel of three to five judges who evaluate the competition entries through review of deliverable packages and presentations. The first-place winners of each division compete against each other to determine a Project Pitch winner.

## Divisions and District Use Cases

The Solar District Cup has multiple divisions. Each division has at least six teams competing against each other.

Each division is assigned a use case of an existing mixed-use urban district or campus interested in increased distributed energy development. The competition organizers provide each team with the details of their division's district use case.

A district use case is a defined area served by one or more electrical distribution feeders with a collection of spaces potentially available for PV installation, including but not limited to: building rooftops, façades, open land, parking, agricultural dual use, bodies of water, and other facilities. The use case for each district includes the following data sets, at a minimum:

- Sustainability goals of the district use case
- A map designating the boundaries of the campus or district in which student teams are confined to designing their systems
- Twelve consecutive months of interval load (energy consumption) data (in intervals ranging from 15 minutes to hourly) for several of the buildings that are within the district and connected to the feeder
- Electric utility rate schedule
- Base-case information for distribution system impact analysis
- A development master plan, land ownership status, local zoning codes, and permitting requirements for land use
- Battery storage challenge (included at the Final Deliverable Package phase)
- A PV system hosting capacity heatmap for the distribution system serving the campus or district.

The district use cases might have select data simulated or otherwise changed by the organizers for the purposes of the competition. Information provided to teams is intended to be used only by the team members. The data provided is not for redistribution to the public or for use outside of the competition.

## What to Submit

Teams submit two deliverables: a Progress Deliverable Package and a Final Deliverable Package. These packages are summarized in Table 1 and Table 2 and are described in greater detail in the appendices. Competition deliverables are submitted via HeroX.

Deliverable packages are considered to be on time if they are received by the respective due date and time as indicated on HeroX. Late submissions may be considered on a case-by-case basis and are marked as such when distributed to the reviewers or judges.

### Progress Deliverable Package—Solar PV System

A complete submission for the progress deliverable is a design and analysis of interconnected solar PV systems that maximize energy offset and savings over the system's contracted (if PPA or lease) or useful (if cash purchase) lifetime for the division district use case.

The competition organizers evaluate the Progress Deliverable Package using the evaluation statements in Table 1. Organizer staff reviewers evaluate the degree to which they "agree" or "disagree" with the individual evaluation statements. Teams advance as finalists if the reviewers agree, on average, with the evaluation statements more than they disagree with the statements. **Teams do not compete against each other to become finalists**. Written feedback regarding rules compliance is provided to all teams who submit a Progress Deliverable Package.

Table 1 comprises the content requirement summaries and corresponding evaluation statements for the Progress Deliverable Package. The required file format of each component of the Progress Deliverable Package is indicated in brackets. Each deliverable must use the information provided in the district use case and the assumptions and resources cited in Appendix A. Additional details on the required components of the deliverable package are provided in Appendices B and C. Additionally, the submission form on the HeroX platform asks teams to answer a few short questions about team makeup, approach to work done to date, and planned work for winning the competition in the next stage. These additional questions are not judged, but they are used to enable continuous program improvement by the organizers.

Table 1. Progress Deliverable Package Content and Evaluation Statements

| Content | Evaluation Statement |
|---|---|
| **1. Executive Project Summary** | |
| A project overview, including PV system sizing; distribution system impacts; PPA, lease, and/or purchase price with financial performance; and development plan highlights [PDF]. | The team communicates its solution clearly, concisely, effectively, and professionally with proper spelling and grammar. |
| **2. Conceptual System Design** | |
| A. Layout and specifications for the PV systems proposed on one or more rooftops, façades, parking lots, bodies of water, or ground areas within the district [PDF].<br>B. Average hourly energy production output for each system over annual period [Excel spreadsheet]. | A. Conceptual system design is complete and reasonable for PV system location and specifications.<br>B. Energy output is provided, based on reasonable yield factor accounting for climatic variables, and clearly conveyed. |
| **3. Distribution System Impact Summary** | |
| Descriptive report demonstrating the team's understanding of how the proposed PV system integration might impact the distribution network [PDF]. The report will:<br>- Document distribution system constraints that are most likely to limit PV integration.<br>- Describe how these constraints may impact interconnection cost and the proposed PPA or lease price. | Report demonstrates the team's understanding of the possible distribution impact of integrating their proposed PV system, system constraints that may limit PV hosting capacity, and the possible impact of interconnection costs. |
| **4. Financial Analysis** | |
| Financial model [Excel spreadsheet(s)] comprised of:<br>- A project financial model that uses the production data, PPA or lease price, and other inputs to calculate investor internal rate of return (IRR) at a net present value (NPV) of $0.<br>- Customer savings analysis that demonstrates economics for system offtaker (the district) over the contractual (if PPA or lease) or useful (if cash purchase) life of the system. | Financial model has a complete set of reasonable inputs, models cash flows competently, has a PPA or lease price that is reasonable by market standards, and a rate of return that would be acceptable to investors. |
| **5. Development Plan** | |
| A project development plan [PDF] composed of:<br>- Building and site plan for conceptual system design, including applicable local ordinances.<br>- Construction plan to procure necessary permits and comply with local codes. | The building and site plan demonstrates alignment with district master plan, zoning, and other land use or building restrictions. The construction plan includes a timeline and demonstrates compliance with permitting and relevant codes. |

See Appendices B and C for Progress Deliverable Package content and formatting requirements.

## Final Deliverable Package—Solar PV Plus Battery Electric Storage System

The Final Deliverable Package includes a complete conceptual design and techno-economic analysis of a proposed **interconnected solar PV plus battery electric storage system that maximizes energy offset and savings over the system's contracted (if PPA or lease) or useful (if cash purchase) lifetime for the division district,** given its use case parameters and conditions.

The competition organizers will provide teams with a battery challenge for each district use case at the beginning of the Final Deliverable Package phase, for which they must design a battery system and model its performance given one or more use cases. For the PV-only systems, teams are *required* to integrate their own input assumptions in the financial model provided on HeatSpring and submit the completed spreadsheet in the deliverable packages. For the battery systems, students may use Energy Toolbase, REopt Lite, SAM, or another tool of their choice to model performance and economics.

Student teams must perform a customer savings analysis in the Final Deliverable Package in addition to the project financial model. Student teams must perform a customer savings analysis for the solar-plus-battery storage system, as well as each of the PV systems they've proposed in their district. The Final Deliverable Package requires student teams to update their Progress Deliverable Package and to present their solution.

Table 2 provides a content requirement summary of the Final Deliverable Package. The required file type for each component of the final deliverable is indicated in brackets. Additional details on the required content and formatting of the deliverable package sections are provided in Appendices B and D.

**Table 2. Final Deliverable Package Content and Judging Statements**

| Content | Judging Statements for Evaluation |
|---|---|
| 1. Project Proposal | |
| A. Proposal document that encapsulates and summarizes deliverable sections 2–5. The proposal should make the case as to why the proposed solar system and developer team are the best choice for the district [PDF].<br>B. Presentation that demonstrates the team's approach to the system design, operation, and innovation [PowerPoint and live presentations]. | The proposal presents a clear and concise summary of the project. Both the proposal and the presentation make a compelling case as to why the proposed solution is the best choice for the district given its needs, constraints, and goals. |
| 2. Conceptual System Design | |
| A. Layout and specifications for PV system(s) with battery electric storage system(s) added, including summary description of results and underlying assumptions used in the analysis [PDF].<br>B. Average hourly energy production output over annual period, including battery charge and discharge cycles [Excel spreadsheet]. | Conceptual system design proposes creative and innovative solution that demonstrates excellent analysis, system design, and optimal battery use strategy. |

| Table 2. Final Deliverable Package Content and Judging Statements (cont.) | |
|---|---|
| **Content** | **Judging Statements for Evaluation** |
| 3. Distribution System Impact Summary | |
| Descriptive report demonstrating the team's understanding of how the proposed PV system integration might impact the distribution network [PDF]. The report will:<br>- Document distribution system constraints that are most likely to limit PV integration.<br>- Describe how these constraints may impact interconnection cost and the proposed PPA or lease price.<br>- Describe how use of battery systems and/or smart inverter controls may help mitigate impacts of PV system interconnection.<br>- Use provided PV hosting capacity heatmap to appropriately size the PV systems for the distribution network. | The team demonstrates understanding of thermal and voltage constraints on a distribution system. The report provides an understanding of the origin of these two constraints. The report also demonstrates the team's understanding of the possible distribution impact of integrating their proposed solar-plus-storage system, distribution system constraints that may limit PV hosting capacity, and the possible impact of interconnection costs. PV systems specified in the conceptual design section adhere to the hosting capacity limitations of the distribution network. |
| 4. Financial Analysis | |
| Financial model [Excel spreadsheet(s)] comprised of:<br>- Two project financial models: one for the solar systems (HeatSpring model) and one for the solar-plus-storage system (battery analysis software). The solar system model outputs an IRR and the solar-plus-storage model should output a contract price (e.g., $/kWh, $/month).<br>- Customer savings analysis that demonstrates economics for system offtaker (the district) over the contractual (if PPA or lease) or useful (if cash purchase) life of the system. | Financial analyses communicate a strong grasp of renewable energy project finance. Input assumptions are justifiable, calculations are correct, battery operation strategy delivers maximum economic benefits, and pricing and rate of return are attractive to the market. The outputs of both the battery analysis and the customer savings analysis are included as tabs to the HeatSpring Solar MBA spreadsheet model. |

| Table 2. Final Deliverable Package Content and Judging Statements (cont.) | |
|---|---|
| **Content** | **Judging Statements for Evaluation** |
| 5. Development Plan | |
| A project development plan [PDF] comprised of:<br>- Building and site plan demonstrating conceptual system design, including any proposed rezoning, is in alignment with the campus master plan.<br>- A construction schedule and development plan to implement the design, including:<br>  - Necessary construction and land use permits<br>  - Compliance with applicable local codes<br>  - Potential risks to successful deployment<br>  - Approach to address potential concerns and questions of district decision makers and surrounding community members. | Proposed building, site, construction, and development plans with any rezoning adds significant value in a comprehensive, actionable, and feasible approach for the district, authorities having jurisdiction, and surrounding community. |

See Appendices B and D for Final Deliverable Package content and formatting requirements.

## How Entries Are Scored

A qualified panel of three to five judges—comprising subject-matter experts and representatives from the partner district use cases selected by the competition organizers—score finalist submissions according to the extent to which they agree that the content and formatting requirements were met and with the solution aligns with the judging statements listed in Table 2. Judges evaluate the Final Deliverable Package sections using a scale from 1 to 6 for disagreement or agreement with the evaluation statements, as shown in Table 3.

**Table 3. Scoring Scale**

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly disagree | Disagree | Slightly disagree | Slightly agree | Agree | Strongly agree |

Judges are assigned deliverable sections and evaluation statements based on their areas of expertise as shown in Table 4. All judges evaluate the Project Proposal.

**Table 4. Judging Panel Makeup and Assignments**

| Content | System Design Judge | Utility Judge | Financial Analysis Judge | District Use Case Judge |
|---|---|---|---|---|
| Project Proposal | X | X | X | X |
| Conceptual System Design | X | | | |
| Distribution System Impact Summary | | X | | |
| Financial Analysis | | | X | |
| Development Plan | | | | X |

The following is a list of steps and actions the judges take to ensure each finalist entry receives fair and equal consideration.

1. Judges review their assigned content of the Final Deliverable Packages submitted by each team.
2. Each statement listed in the "Judging Statements for Evaluation" receives a preliminary score between 1, "strongly disagree," and 6, "strongly agree" (on the scoring scale shown in Table 3), based on the subjective determination of each judge.
3. The evaluation statements form the basis of each judge's score, so it is critical that teams successfully complete each component of the deliverable package while maintaining a comprehensive and innovative strategy overall.
4. The scores from each judge are collected to determine the team's preliminary score. The summed score from each judge is averaged across the judging panel as the preliminary average score each team.
5. The preliminary scores for all teams in the division yield a preliminary ranking of teams.

6. The judges witness a 15-minute live presentation by each team. Each division presents in parallel. Ten minutes are provided for judges to ask questions of each team. A maximum of five students per team may present, and up to ten students per team may answer questions from the judges.
7. The judging panel convenes following the live video conference presentations to review preliminary scores, discuss and agree upon final evaluation of each statement, and determine the winners of the competition.
8. First-, second-, and third-place winners and optional honorable mentions are identified and announced. Individual scores for each team are not released. No ranking is completed beyond third place. The judges' feedback is provided to each team individually.
9. The first-place winner of each division presents an 8-minute project proposal pitch at the final event. Final event attendees select a Proposal Pitch winner from among the presenting teams. The presentations are open to the public and promoted to industry, increasing the recognition of the top teams. The competition division process is illustrated in Figure 1.

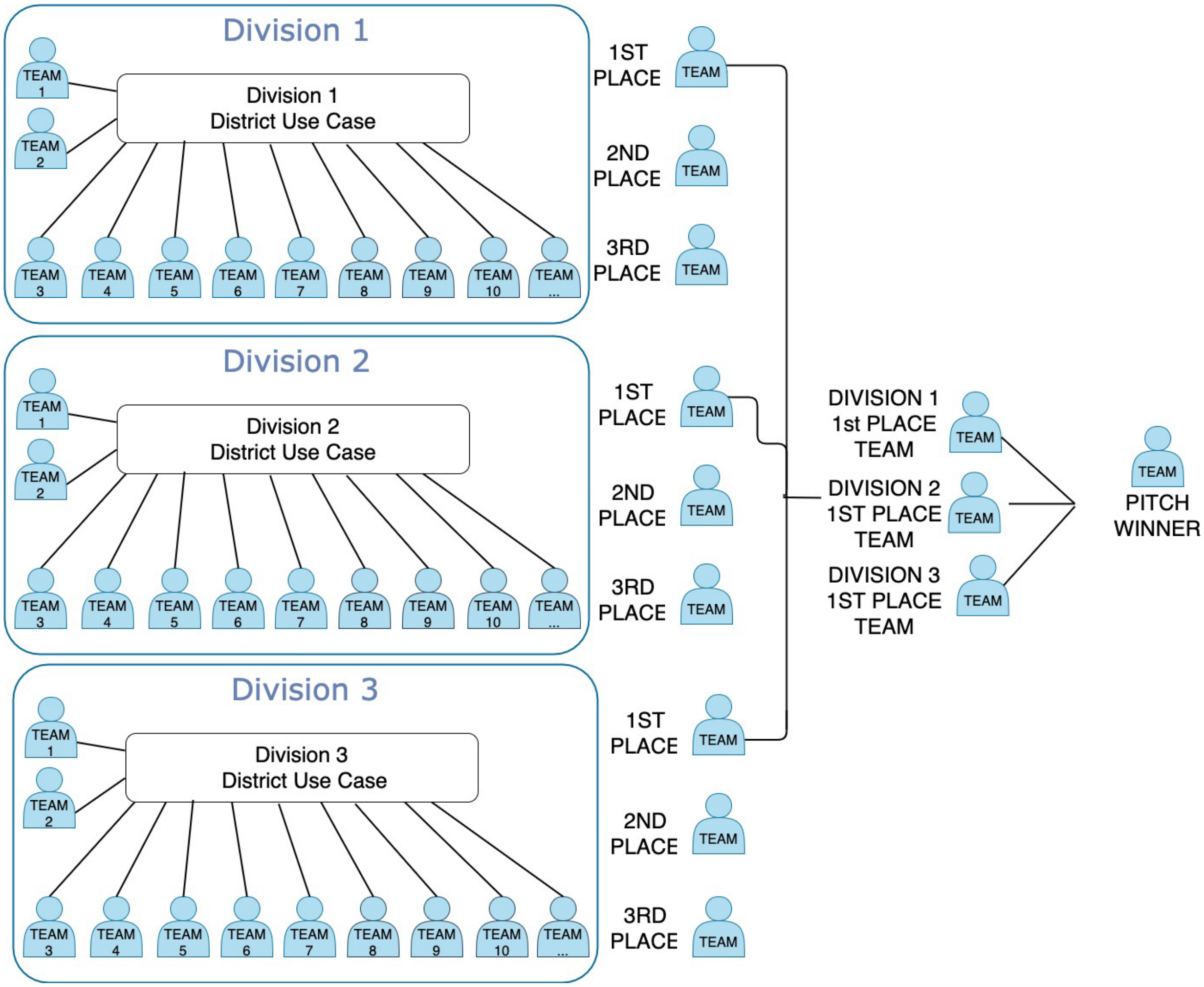



Figure 1. Division and competition process

## Who Can Enter

The Solar District Cup invites participation of teams composed of at least three students enrolled in accredited U.S.-based collegiate institutions. Students must be enrolled in at least one class and be pursuing a degree for the duration of the competition. Students and faculty advisors are not required to be U.S. citizens at the time of the competition. Members of the judging panels, competition organizer staff, and DOE and national laboratory employees are ineligible to compete.

Although any level of collegiate student is eligible to compete, the challenge scope is intended for multidisciplinary teams of upper-level undergraduate students. Student participation may be integrated into senior design or capstone project, count as elective or independent study course credit, be added to the curriculum of existing classes, treated as a seminar topic, engaged as part of a student interest club, or be an extracurricular student activity.

Each team is encouraged to have at least one faculty advisor, but this is not required for participation. If a team of students needs assistance in identifying a faculty advisor or mentor, they can contact the competition organizers for help.

By uploading a deliverable package, a team certifies that it is in compliance with the eligibility requirements. If the organizers become aware that a team or individual is not eligible, that team may be disqualified from competition.

## Competition Events

### Solar Power International (optional)

The competition organizers provide access for students of registered and alumni teams to the educational and poster sessions of the virtual Solar Power International conference, on Sept. 28 – 29, 2021. By attending this conference, team members have an opportunity to engage with and learn from industry leaders. Conference registration is free to participating students who are listed as team members via HeroX.

### Warm-Up Workshop

The competition organizers host an all-team Warm-Up Workshop (see Summary Timeline) as a video conference. At this workshop, teams engage with each other, learn from industry leaders, and receive training from the competition organizers. The Warm-Up Workshop is free to team members.

### Final Competition Event via Video Conference

The competition organizers conduct the final competition event as a video conference. At this event, teams present their projects live to industry judges, and the winners of each division are announced. Live video conference attendance and presentation by at least one student team member from each finalist team is required (no pre-recorded presentations allowed). Up to five team members may present live. Up to an additional five team members may participate in the live question-and-answer portion.

### Project Pitch Event for First-Place Division Winners via Video Conference

The first-place winners of each division will present to their peers and invited industry members, who then select a Project Pitch winner. Live video conference attendance and presentation by at least one student team member from each first-place team is required.

## Curriculum Support

Team efforts are supported by a series of optional online educational webinars presented by the competition organizers on competition, design, and analysis topics. The webinar topics relate specifically to the required elements of the deliverable packages. Faculty advisors or mentors are expected to provide guidance to teams toward successful completion and may integrate competition activities into coursework, academic credits, or related curriculum.

Instructive videos are provided to all registered team member students and faculty on HeatSpring, a platform that enables knowledge leaders to better reach knowledge seekers. Content is added throughout the competition period and includes topics such as:

- Conceptual system design
- Distribution system impact analysis
- Solar project finance
- Development planning
- Using Aurora Solar for conceptual system design
- Using tools for distribution system modeling
- Excerpts from the "Solar Executive MBA" course focusing on Development Plans, Sizing a Distributed Generation System and Economic Modeling Basics, Risk Management and Budgeting, and Request for Proposal and Financing Strategies.

Additionally, throughout the competition period, the organizers host a series of webinars and optional "office hours" to provide guidance or to answer student questions.

Student teams are encouraged to engage with faculty advisors and/or mentors for support, guidance, and consultation. Mentors may be teachers, staff, or other industry professionals, such as collegiate alumni, members of local chapters of professional societies or associations, staff from local electric utilities, emeritus professors, adjunct instructors, or faculty from other departments.

# 3. COMPETITION AUTHORITY AND ADMINISTRATION

The Solar District Cup is organized by DOE and the National Renewable Energy Laboratory (NREL), which is managed and operated by the Alliance for Sustainable Energy, LLC, for DOE. Funding is provided by DOE's Office of Energy Efficiency and Renewable Energy Solar Energy Technologies Office. The views expressed herein do not necessarily represent the views of DOE or the U.S. government.

The Solar District Cup Class of 2021–2022 is governed and adjudicated by this rules document, which is intended to establish fair contest rules and requirements. The competition is designed and administered by a team of competition organizers consisting primarily of DOE and NREL staff. In the case of a discrepancy with other competition materials or communication, this document takes precedence. The latest release of these rules takes precedence over any prior release. The organizers reserve the right to change contest criteria, rules, and outcomes as needed. Additionally, competitors are encouraged to bring to the organizers' attention rules that are unclear, misguided, or in need of improvement. For the purposes of competition evaluation, a violation of the intent of a rule will be considered a violation of the rule itself. Questions on these rules or the program overall can be directed to solardistrictcup@nrel.gov.

Judges may not have personal or financial interests in; be an employee, officer, coordinator, or agent of any entity that is a registered participant in; or have a familial or financial relationship with an individual who is a registered competitor in this contest.

The Solar District Cup is a collegiate design competition. There is no expectation that any of the submitted entries will be built or implemented by the students or partner districts.

# 4. PARTNERS

The Solar District Cup depends on partnerships to be successful. We would like to thank the following organizations for their support of the competition and the student teams:

### Aurora Solar

This software company has created a one-stop, cloud-based solution to streamline the solar design and sales process. It provides all competing teams free accounts and access to its solar software, offering customized training, and staffing “office hours” sessions throughout the competition.

### Energy Toolbase

This software platform provides a cohesive suite of project modeling, storage control, and asset monitoring products that enable solar and storage developers to deploy projects more efficiently. It provides all competing teams free accounts and access to its software, offering customized training, and staffing “office hour” sessions throughout the competition.

### HeatSpring, LLC

This technology firm has developed a platform that helps knowledge leaders better reach knowledge seekers. It offers online courses led by industry experts for professionals in renewable energy industries, including solar and green building. HeatSpring provides a training platform and solar industry training content for all competing students as well as staff “office hours” with solar business experts Keith Cronin and Chris Lord.

### Solar Power Events

This group is behind North America’s largest solar and storage events and is owned by the Solar Energy Industry Association and Smart Electric Power Alliance. The organization provided space, promotion, and amenities for the Solar District Cup at Solar Power International 2019 and helps the competition participants engage with solar industry professionals throughout the 2021-2022 competition.

### District Use Cases

The Solar District Cup Class of 2021-2022 has multiple divisions to which teams are assigned. Each division centers on a distinct use case of a real-world mixed-use urban district or campus interested in pursuing distributed energy solutions.

The Solar District Cup would not be able to provide these district and campus use cases without the collaboration of our Solar District Cup 2022 use case partners and their willingness share valuable data with the student teams:

- Cheyney University of Pennsylvania
- Pacific Northwest National Laboratory
- The Ohio State University.

These organizations have generously given their time and data to ensure that their districts were accurately represented and provided the student teams with robust challenges to drive competition.

"Our university benefitted tremendously by serving as a use case in this inaugural competition. The professionalism of presentations by the interdisciplinary academic teams showing the strategic breadth and technical depth of final recommendations will indeed inform our next steps as we work to achieve our 2030 climate goals."

Robert Koester
*Solar District Cup 2020 District Use Case Representative from Ball State University*

"The Solar District Cup was an immersive and technically challenging event that allowed our future innovators to work with actual region-specific utility data. Allowing students to navigate real-world engineering, financial and social challenges associated with renewable technologies is educationally invaluable. The positive takeaway was the opportunity to view things from the mind of today's students and has ultimately inspired me to take serious consideration of the many solutions I observed."

Patrick Chavez
*Solar District Cup 2020 District Use Case Representative from New Mexico State University*

# Appendix A. Resources for Assumptions

## Appendix A.1. Resources for Financial Model Input Assumptions

A series of assumptions and resources are provided to serve as a baseline for all teams' design and analysis. NREL and other organizations regularly publish cost benchmarks and industry-analysis documentation that estimate the cost for system technologies and components, the prevailing cost of capital for financial inputs, market-appropriate PPA prices, and other related figures. Teams are encouraged to conduct their own research, and several starting resources are provided here. Assumptions should be cited where appropriate, and, if deemed necessary by the team, justified in the project proposal. Although teams are encouraged to discuss the competition and their proposed solution with industry professionals, costs or assumptions not publicly available to all teams are not to be used in calculations. Unless qualified alternates are used following the previously described process, all teams should use the input values listed under the "Financial Assumption" section below.

Note that in addition to providing system production output, NREL's System Advisor Model (SAM) also includes default assumptions for many of the input values required to run the financial model. The SAM tool and materials specified below can be used as a baseline for successful analysis. The link for SAM is provided (users are required to register when using SAM for the first time, but registration is free).

Students may use any resources or tools desired to derive their financial modeling inputs, study modeling mechanics, or validate their results. Teams are ***required*** to integrate their own input assumptions in the financial model provided on HeatSpring and submit the completed spreadsheet in the deliverable packages.

### Financial Model Baseline Assumptions

- Property tax: Assume $0 over the course of the PPA or lease.
- Sales tax: Assume all sales tax is already expressed in the total system cost.
- Corporate tax rate: Assume 27% for state plus federal total rate.
- Developer margin: 10% (this is a different figure from the developer's cost of capital or rate of return).
- Construction timeline: approximately eight months.
- PV lifetime is 30 years (e.g., if your PV system has a 20-year PPA, there are 10 years of "residual value" on the system).
- PPA or lease contract term is 20 years.
- System degradation is 0.5% per year.
- Inflation (applies an annual increase in operating costs) is 2% per year.

### Written Resources

- NREL PV System Cost Benchmark provides data points for PV system and component costs. Additional unitized balance of system costs are available in the "Financial Model Assumptions" section.
- Current and Future Costs of Renewable Energy Project Finance Across Technologies provides data points for PV cost of capital (debt, tax equity, and partner equity inputs).
- Best Practices for Operation and Maintenance of Photovoltaic and Energy Storage Systems (3rd Edition) provides cost figures for operations and maintenance.

- Database of State Incentives for Renewables and Efficiency provides information on state and local incentives for PV and PV-plus-storage systems.
- Solar District Cup Training Course on HeatSpring provides free videos and written resources relating specifically to the required activities of the Solar District Cup.
- Examples of real-world project proposals from SunPower and Borrego Solar have been provided in the data room for reference.

## Models and Software Tools

- Aurora Solar—Can be used to create 3D site layouts, design PV systems, perform shading analysis, and estimate PV system performance.
- Energy Toolbase—Can be used to model customer savings, determine value of solar, and perform battery analysis
- SAM—Can be used for PV systems production modeling and financial model validation.
- REopt™ Lite—Can be used for battery operations analysis.
- OpenDSS—An electric power distribution system simulator (DSS) for supporting distributed resource integration and grid modernization. It is available free of charge at http://smartgrid.epri.com/SimulationTool.aspx. It can be used for distribution system voltage analysis.
- NREL Annual Technology Baseline and levelized cost of energy calculator—Can be used to source data points and validate the inputs/outputs of other models.
- ArcGIS Online—Can provide parcel, zoning, and other information for plan development.
- HeatSpring Solar Executive MBA Financial Model template—Required for use as a template financial model for the system(s) proposed by competing teams. Note: must be logged in to the free HeatSpring course to access.

## Customer Savings Analysis Guidance for Solar and Storage Systems

The customer savings analysis is an evaluation of the economics for the *offtaker* of the solar-plus-storage system, while the financial analysis is an evaluation of the economics for the *investors* in the solar-plus-storage system. Several tools are available to perform the customer savings analyses, including Energy Toolbase, the load analysis model and the financial model in the HeatSpring platform, SAM, and REopt Lite. Energy Toolbase, provided free-of-charge to the teams participating in the Solar District Cup, is a preferred method for completing customer savings analysis.

Charts displaying annual and cumulative customer savings (or losses) over the contract lifetime period should be included in the proposal document, as well as a table displaying total system characteristics, such as the example in Table 5 below. A breakout of each system's individual savings can also help the customer determine which systems may be more economical and therefore more likely to be chosen for installation.

**Table 5. Sample Solar-Plus-Storage Summary Table**

| System | Aggregate Size | All Inclusive PPA Price | PV Only Price | Year 1 Generation | Total 20 yr Savings |
|---|---|---|---|---|---|
| PV System | 3.3 MW | $0.11/kWh | $0.07/kWh | 3,960,000 MWh | $1,200,000 |
| Battery Storage System | 1 MW / 2 MWh | | | Based on demand charge mgmt. strategy | $1,800,000 (with PV system) |

**Note:** The numbers above are not based on a real system and is provided for illustrative purposes. In fact, adding a battery may create negative savings (which student teams may choose to characterize as the value of resilience[1] or some other non-monetary benefit). Further examples of how student teams can display customer savings and system specifications can be found in the proposal documents in the data room.

The customer savings analysis will depend on the agreement structure under which the battery is contracted: i.e., PPA, lease, or some other arrangement (e.g., tolling agreement, shared savings agreement). Student teams should determine which contracting mechanism is best given their battery discharge strategy and state regulatory environment and include the rationale behind their choice in the proposal documents.

Student teams may find that the economics of a battery system are not as compelling as standalone PV. If this is the case, teams may make this statement in their proposal and focus on the system configuration that offers the district the best value (e.g., standalone PV installed on select rooftops, façades, or bodies of water). However, teams will still be required to provide the summary results of their battery evaluation and provide a rationale for either including or excluding it in their system proposal.

## Appendix A.2. Guidance for Distribution System Impact Summary

Distribution system PV hosting capacity analysis is often performed by utilities to calculate the maximum distributed generation capacity a given distribution system can host without violating thermal and voltage constraints on the system. Utilities often use distribution system simulation tools to conduct hosting capacity analysis and publish hosting capacity heatmaps on their websites,

Students will use the heatmaps provided in the data room to ensure that proposed solar-plus-storage systems comply with system constraints. If the proposed PV systems violate hosting capacity limits, teams should either:

a. Iterate and reduce the system size until the system size complies with the hosting capacity limit, or
b. If the proposed PV system sizes are necessary to make project economics work, then the teams should propose methods (both wired and non-wire alternatives) that may be employed to relax these constraints. Cost of these potential upgrades should be considered and documented in the distribution system impact summary report.

## Appendix A.3. References for Development Plan

Resource references for use in the development plan including potential authority(ies) having jurisdiction (AHJ) for land ownership; zoning ordinances; other land use or building restrictions or regulations; permitting; codes; and interconnection. These AHJs could be at any combination of levels at district or campus; city, municipal, or township; county; state; federal; utility; and public utility commission.

- Zoning ordinances—Look at county assessor records or a citywide zoning map to find applicable policy.

[1] For more on the value of resilience, see: https://www.nrel.gov/docs/fy20osti/74241.pdf

## *Appendix A. Resources for Assumptions*

- United States Geological Survey (USGS) National Map Viewer—Determine the site conditions and topography of the prospective ground-mount solar system locations. Also reference online satellite imagery. The district master plan may also have specific references.
- Land Use Plans—Look for a comprehensive or specific area plan with the city or county AHJ. This may be further governed by the district's master plan. Also, double check transportation plans for rights of way and easements that may inform property boundary and construction setbacks.
- National Register of Historic Places—Consider any individual building or aesthetic viewshed area concerns.
- United States Department of Agriculture Web Soil Survey—Consider the soil conditions for ground-mount solar. Caliche or bedrock might require more costly drilling for structural posts. Sandy soils may require deeper post embedment to meet snow or wind loading requirements for structural reliability. Corrosive soils may require measures to protect embedded posts from corrosion.
- U.S. Fish and Wildlife Service Critical Habitat Mapper—Consider any habitat that may be impacted by your proposed solar development including riparian areas and endangered species.
- U.S. Fish and Wildlife Service National Wetlands Inventory Mapper—Consider water bodies, ephemeral streams, drainage, or underground water systems in the placement of your proposed ground-mount solar systems and any underground support infrastructure.
- FEMA Flood Map Service Center—Consider any floodplain risks or added permitting for ground-mount systems.

# Appendix B. Deliverable Package Submission Requirements

## File Name Requirements

Submitted deliverable package files must be named as follows:

- [DistrictUseCaseAbbreviation]_[SchoolShortName]_[DeliverableSection].[extension]
  - [DistrictUseCaseAbbreviation] provided within the district use case profile
  - [SchoolShortName] is your collegiate institution commonly recognized and distinct short name, abbreviation, or acronym
  - [DeliverableSection] is given in the Appendix C and D format requirements
  - [extension] is PDF, XLSX, ZIP, or PPTX.

Note that HeroX has a file size maximum of 200 MB for individual files.

# Appendix C. Progress Deliverable Package Requirements

## 1. Executive Summary

*Format Requirements*

| | |
|---|---|
| ☐ | File type: single, bookmarked PDF with all fonts embedded and 300 dpi minimum resolution |
| ☐ | Up to 6 pages total; any additional pages submitted are not reviewed. Title page does not count toward this limit |
| ☐ | ANSI A (8.5" x 11") paper size must be used |
| ☐ | Minimum font size of 11 points, minimum ½" margin on all sides |
| ☐ | Written in complete, grammatically correct, and spell-checked English |
| ☐ | File name: [DistrictUseCaseAbbreviation]_[SchoolShortName]_ExecutiveSummary.PDF |

*Content Requirements*

| | |
|---|---|
| ☐ | Title page that includes names of school, team, district use case, and deliverable section (this page does not count toward the page limit) |
| ☐ | Brief narrative of system design (e.g., locations, rationale, total system size, total production), potential distribution system impacts, financial information including PPA or lease price with the project IRR and NPV for the systems under PPA or lease, savings for the district, and development considerations (e.g., zoning, permitting, conformity with district master plan) |
| ☐ | Summary tables of system sizes, total annual production, and associated PPA, lease, or cash purchase prices (if systems have individual associated prices; if one price for all systems, indicate this) |
| ☐ | Summary graphics (e.g., overhead graphic of district-wide solar solution, flow chart depicting team collaboration process, charts from financial analysis) |

## 2.A. Conceptual System Design—Layout and Specifications

*Format Requirements*

| | |
|---|---|
| ☐ | File type: single, bookmarked PDF with all fonts embedded and 300 dpi minimum resolution |
| ☐ | Up to 30 pages total; any additional pages submitted are not reviewed |
| ☐ | ANSI A (8.5" x 11") paper size must be used |
| ☐ | Minimum font size of 11 points, minimum ½" margin on all sides |
| ☐ | Written in complete, grammatically correct, and spell-checked English |
| ☐ | File name: [DistrictUseCaseAbbreviation]_[SchoolShortName]_ConceptualDesign.PDF |

*Content Requirements*

| | |
|---|---|
| ☐ | Heading or title block with names of school, team, district use case, and deliverable section |
| ☐ | System design summary of approach and solution (maximum 2 pages) |
| ☐ | Listing of equipment selection and specifications (maximum 2 pages) |
| ☐ | Summary site plan(s) showing layout of all proposed installations |
| ☐ | Individual system plans showing panels and location of associated equipment |
| ☐ | Shading model image for each proposed installation |

## 2.B. Conceptual System Design—Energy Production

*Format Requirements*

| | |
|---|---|
| ☐ | Packaged into a single Excel file, multiple tabs expected |
| ☐ | Include column labels and relevant units |
| ☐ | Include all formulas used to calculate results |
| ☐ | Explain any macros or associated internal scripts |
| ☐ | Indicate where cells are using an input assumption versus a calculated result |
| ☐ | Generate natively if possible; exports from other programs should be carefully reviewed |
| ☐ | File name: [DistrictUseCaseAbbreviation]_[SchoolShortName]_EnergyProduction.XLSX |

*Content Requirements*

| | |
|---|---|
| ☐ | Hourly generation profile for each proposed solar installation over a year |
| ☐ | Details of inputs and process used to calculate the hourly generation profile |
| ☐ | Source of irradiance model used |

## 3. Distribution System Impact Summary

### *Format Requirements*

| | |
|---|---|
| ☐ | File type: single, bookmarked PDF with all fonts embedded and 300 dpi minimum resolution |
| ☐ | Up to 10 pages total; any additional pages submitted are not reviewed |
| ☐ | ANSI A (8.5" x 11") paper size must be used |
| ☐ | Minimum font size of 11 points, minimum ½" margin on all sides |
| ☐ | Written in complete, grammatically correct, and spell-checked English |
| ☐ | File name: [DistrictUseCaseAbbreviation]_[SchoolShortName]_DistributionApproach.PDF |

### *Content Requirements*

| | |
|---|---|
| ☐ | Heading or title block with names of school, team, district use case, and deliverable section |
| ☐ | Summarize understanding of the distribution system impacts originating from PV system interconnection on the distribution network. Summarize sensitivities of these impact in relation to PV system size and interconnection location. |
| ☐ | Summarize factors that limit PV hosting capacity on the distribution network and impact their impact on interconnection cost |

## 4. Financial Analysis—Financial Model and Customer Savings Analysis

### *Format Requirements*

| | |
|---|---|
| ☐ | Packaged into a single Excel file with multiple tabs for each PV system or multiple Excel files representing each PV system |
| ☐ | Include column labels and relevant units |
| ☐ | Include all formulas used to calculate results |
| ☐ | Explain any macros or associated internal scripts |
| ☐ | Indicate where cells are using an input assumption versus a calculated result |
| ☐ | Generate natively if possible; exports from other programs should be documented (links to external spreadsheets are prohibited) |
| ☐ | File name: [DistrictUseCaseAbbreviation]_[SchoolShortName]_Financial.XLSX |

### *Content Requirements*

| | |
|---|---|
| ☐ | The Excel-based financial model (for calculation of investor economics) provided in the HeatSpring course materials is *required* for the project financial analysis |
| ☐ | Calculate a reasonable project IRR and an investor NPV of $0 given a certain PPA or lease price and other input assumptions |
| ☐ | Customer savings analysis *of solar systems only* included as a separate tab in the HeatSpring model or as a separate spreadsheet. This analysis should present savings for the system offtaker (i.e., the district) over the contractual life (if PPA or lease) of the system. If a cash purchase, those savings can be calculated over the useful life of the system. Student teams may use Energy Toolbase for the customer savings analysis, or another tool of their choice (including spreadsheets of their own design). |

## 5. Development Plan—Building, Site, and Construction Plans

### *Format Requirements*

| | |
|---|---|
| ☐ | File type: single, bookmarked PDF with all fonts embedded and 300 dpi minimum resolution |
| ☐ | Up to 12 pages total; any additional pages submitted are not reviewed |
| ☐ | ANSI A (8.5" x 11") paper size must be used |
| ☐ | Minimum font size of 11 points, minimum ½" margin on all sides |
| ☐ | Written in complete, grammatically correct, and spell-checked English |
| ☐ | File name: [DistrictUseCaseAbbreviation]_[SchoolShortName]_DevelopmentPlan.PDF |

### *Content Requirements*

| | |
|---|---|
| ☐ | Heading or title block with names of school, team, district use case, and deliverable section |
| ☐ | Identification of applicable land use and zoning ordinances and analysis of compliance |
| ☐ | Demonstration of compliance with district use case master plan |
| ☐ | Demonstration of compliance with other land-use or building restrictions or regulations |
| ☐ | Identify applicable local construction permitting and codes |
| ☐ | Approach to procure necessary permits and comply with local codes |
| ☐ | Proposed timeline for permitting, construction, and interconnection |
| ☐ | Annotated list of references or citations |

# Appendix D. Final Deliverable Package Requirements

## 1.A. Project Proposal—Written

*Format Requirements*

| | |
|---|---|
| ☐ | File type: single, bookmarked PDF with all fonts embedded and 300 dpi minimum resolution |
| ☐ | Up to 18 pages total; any additional pages submitted are not reviewed. Title page does not count toward this limit |
| ☐ | ANSI A (8.5" x 11") paper size must be used |
| ☐ | Minimum font size of 11 points, minimum ½" margin on all sides |
| ☐ | Written in complete, grammatically correct, and spell-checked English |
| ☐ | File name: [DistrictUseCaseAbbreviation]_[SchoolShortName]_ProjectProposal.PDF |

*Content Requirements*

| | |
|---|---|
| ☐ | Title page that includes names of school, team, district use case, and deliverable section (this page does not count toward the page limit) |
| ☐ | Executive summary of the project including the proposed PV systems, battery system, pricing, and how the proposed solution is uniquely tailored to serve the district's needs, constraints, and goals (1–2 pages) |
| ☐ | Introduction of the team, including student team member field of study and work performed on proposal, and advisors, including both faculty and external mentors (1–2 pages) |
| ☐ | Project overview with charts, tables, and summary graphics, including narratives describing the following: (up to 12 pages) |
| | System sizing and design rationale with a table of location, size, and annual production (1–3 pages) |
| | The solar and storage system's potential impacts on the local distribution system (1–3 pages) |
| | Proposed PPA, lease, and/or purchase price; price justification; sources for model inputs; expected savings for the district over the contract lifetime; and the economic benefits of the system for investors. This section should also include a summary of the applicable state and local policies and regulations (e.g., net metering, state incentives) and how these have influenced the system economics (1–3 pages). |
| | Development plan highlights and how the proposed solar and storage solution conforms to the district master plan (1–3 pages) |
| ☐ | Conclusion recapping Project Pitch and benefits to the district (1 page) |

## 1.B. Project Proposal—Pitch Presentations

### *Format Requirements*

| | |
|---|---|
| ☐ | File type: PowerPoint, with all fonts and images embedded without external file references and no embedded video or audio |
| ☐ | 16:9 aspect ratio |
| ☐ | Written in complete, grammatically correct, and spell-checked English |
| ☐ | Duration of 15 minutes for division presentation and 8 minutes for pitch presentation |
| ☐ | File name: [DistrictUseCaseAbbreviation]_[SchoolShortName]_DivisionPresentation.PPTX |
| ☐ | Optional: a second, shorter presentation. File name: [DistrictUseCaseAbbreviation]_[SchoolShortName]_PitchPresentation.PPTX |

### *Content Requirements*

| | |
|---|---|
| ☐ | Title slide including names of school, team, and district use case. |
| ☐ | Summary of team's solar-plus-storage solution, as well as its approach to:<br>• Competition, including team structure and work effort<br>• Solar-plus-storage design<br>• Expected operation<br>• Distribution system risks<br>• Financial performance<br>• Development plans |
| ☐ | Innovation as it relates to:<br>• Analysis methods<br>• Technology selection, system design, and operation<br>• Financial result |
| ☐ | Pitch how this project proposal helps achieve the district goals |
| ☐ | Pitch why your team should win |

## 2.A. Conceptual System Design—Layout and Specifications

### *Format Requirements*

| | |
|---|---|
| ☐ | File type: single, bookmarked PDF with all fonts embedded and 300 dpi minimum resolution |
| ☐ | Up to 40 pages total; any additional pages submitted are not reviewed |
| ☐ | ANSI A (8.5" x 11") paper size must be used |
| ☐ | Minimum font size of 11 points, minimum ½" margin on all sides |
| ☐ | Written in complete, grammatically correct, and spell-checked English |
| ☐ | File name: [DistrictUseCaseAbbreviation]_[SchoolShortName]_ConceptualDesign.PDF |

### *Content Requirements*

| | |
|---|---|
| ☐ | Heading or title block with names of school, team, district use case, and deliverable section |
| ☐ | System design approach and description of final solution (maximum 2 pages) |
| ☐ | Description of equipment selection strategy and specifications, including total direct current size of each system, total project size, and battery details (maximum 2 pages) |
| ☐ | Diagram showing location of all proposed PV and battery systems within the district |
| ☐ | Individual PV system plans showing panels and location of associated equipment |
| ☐ | One-line diagrams for each system and wiring required between systems |
| ☐ | Shading model image for each PV installation |

## 2.B. Conceptual System Design—Energy Production and Battery Cycles

### *Format Requirements*

| | |
|---|---|
| ☐ | Packaged into a single Excel file, multiple tabs expected |
| ☐ | Include column labels and relevant units |
| ☐ | Include all formulas used to calculate results |
| ☐ | Explain any macros or associated internal scripts |
| ☐ | Indicate where cells are using an input assumption versus a calculated result |
| ☐ | Generate natively if possible; exports from other programs should be carefully reviewed |
| ☐ | Proofread document for spelling, grammar, legibility, and formatting |
| ☐ | File name: [DistrictUseCaseAbbreviation]_[SchoolShortName]_EnergyProduction.XLSX |

### *Content Requirements*

| | |
|---|---|
| ☐ | Hourly generation profile for each solar system over a year |
| ☐ | Details of inputs and process used to calculate the hourly generation profile |
| ☐ | Source of irradiance model used |
| ☐ | Inputs for the battery charge/discharge strategy |

## 3. Distribution System Impact Summary

### *Format Requirements*

| | |
|---|---|
| ☐ | File type: single, bookmarked PDF with all fonts embedded and 300 dpi minimum resolution |
| ☐ | Up to 10 pages total; any additional pages submitted are not reviewed |
| ☐ | ANSI A (8.5" x 11") paper size must be used |
| ☐ | Minimum font size of 11 points, minimum ½" margin on all sides |
| ☐ | Written in complete, grammatically correct, and spell-checked English |
| ☐ | File name: [DistrictUseCaseAbbreviation]_[SchoolShortName]_DistributionApproach.PDF |

### *Content Requirements*

| | |
|---|---|
| ☐ | Heading or title block with names of school, team, district use case, and deliverable section |
| ☐ | Summarize understanding of the distribution system impacts originating from solar-plus-storage system interconnection on the distribution network. Summarize understanding specifically of the origin of thermal and voltage constraints on the distribution system. Summarize sensitivities of these impacts in relation to PV system size and interconnection location. |
| ☐ | Summarize factors that limit PV hosting capacity on the distribution network and their impact on interconnection cost |
| ☐ | Summarize how use of battery systems and/or smart inverter control modes can help improve PV host capacity. If non-wired alternatives are employed to relax thermal or voltage constraints on the distribution system, these methods and their impact on the distribution system should be discussed in the report. |
| ☐ | Use the provided hosting capacity heatmap(s) to ensure that the proposed PV systems do not violate hosting capacity constraints on the distribution system. Summarize how hosting capacity heatmaps have been incorporated in the design workflow to ensure distribution system constraints have been satisfied. |

## 4. Financial Analysis—Financial Model and Customer Savings Analysis

### *Format Requirements*

| | |
|---|---|
| ☐ | Packaged into a single Excel file with multiple tabs for each PV system or multiple Excel files representing each PV system. Additional tabs for the battery and analysis and customer savings analysis required. |
| ☐ | Include column labels and relevant units |
| ☐ | Include all formulas used to calculate results |
| ☐ | Explain any macros or associated internal scripts |
| ☐ | Indicate where cells are using an input assumption versus a calculated result |
| ☐ | Generate natively if possible; exports from other programs should be documented (links to external spreadsheets are prohibited) |
| ☐ | File name: [DistrictUseCaseAbbreviation]_[SchoolShortName]_FinancialModel.XLSX |

### *Content Requirements*

| | |
|---|---|
| ☐ | The Excel-based financial model (for calculation of investor economics) provided in the HeatSpring course materials is *required* for the solar portion of the project financial analysis. For the solar-plus-storage analysis, student teams may use Energy Toolbase, SAM, REopt Lite or another tool of their choice. The relevant outputs of this analysis—e.g., summary of inputs and outputs, cash flows, charts, and others—should be pasted in a tab or multiple tabs in the HeatSpring model Excel spreadsheet. |
| ☐ | Calculate a reasonable project IRR and an investor NPV of $0 given a certain PPA or lease price and other input assumptions |
| ☐ | Possible purchase option to the district (depending on instructions in use case profile) |
| ☐ | Customer savings analysis *of solar and storage systems* included as a separate tab in the HeatSpring model or as a separate spreadsheet. This analysis should present savings for the system offtaker (i.e., the district) over the contractual life (if PPA or lease) of the system. If a cash purchase, those savings can be calculated over the useful life of the system. Student teams may use Energy Toolbase for the customer savings analysis, or another tool of their choice (including spreadsheets of their own design). |

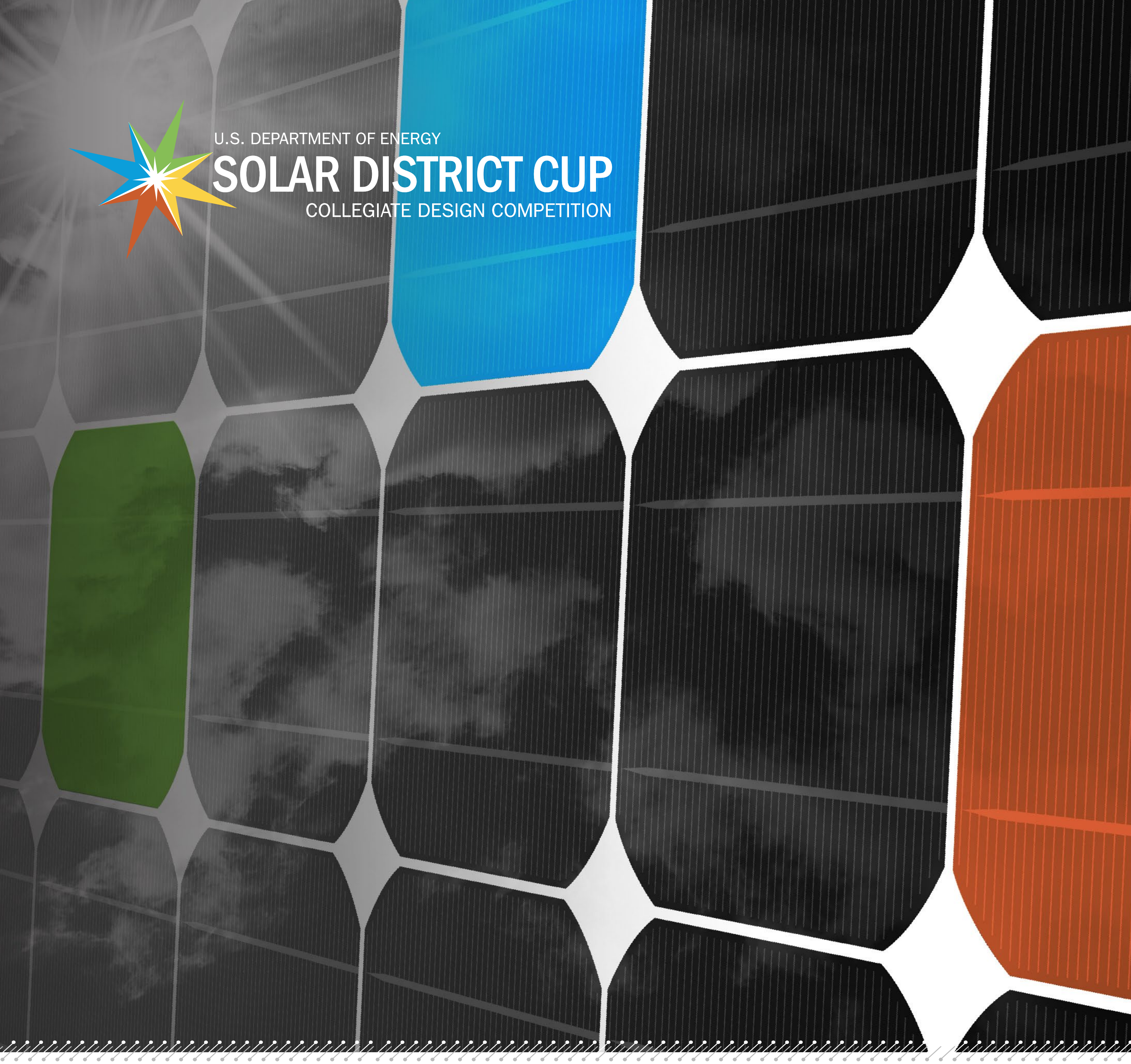
## 5. Development Plan—Building, Site, and Construction Plans

### *Format Requirements*

| | |
|---|---|
| ☐ | File type: single, bookmarked PDF with all fonts embedded and 300 dpi minimum resolution |
| ☐ | Up to 25 pages total; any additional pages submitted are not reviewed |
| ☐ | ANSI A (8.5" x 11") paper size must be used |
| ☐ | Minimum font size of 11 points, minimum ½" margin on all sides |
| ☐ | Written in complete, grammatically correct, and spell-checked English |
| ☐ | File name: [DistrictUseCaseAbbreviation]_[SchoolShortName]_DevelopmentPlan.PDF |

### *Content Requirements*

| | |
|---|---|
| ☐ | Heading or title block with names of school, team, district use case, and deliverable section |
| ☐ | Analysis of authority(ies) having jurisdiction (AHJ) for land ownership; zoning ordinances; other land use or building restrictions or regulations; permitting; codes; and interconnection. These AHJs could be at any combination of levels at district or campus; city, municipal, or township; county; state; federal; utility; or public utility commission. |
| ☐ | Identification of applicable land use and zoning ordinances, analysis of compliance, and any proposed rezoning |
| ☐ | Analysis of aesthetic appearance in surrounding viewshed |
| ☐ | Demonstration of compliance with or fulfillment of district master plan |
| ☐ | Demonstration of compliance with other land use or building restrictions or regulations |
| ☐ | Identify applicable local construction permitting and codes |
| ☐ | Approach to procure necessary permits and comply with local codes |
| ☐ | Proposed timeline for permitting, construction, and interconnection |
| ☐ | Construction staging approach |
| ☐ | Identification of risks to successful project development and deployment |
| ☐ | Strategy to engage community members and achieve buy-in for project |
| ☐ | Annotated list of references or citations |




## Thank You to Our Partners!

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