U.S. DEPARTMENT OF ENERGY

SOLAR DISTRICT CUP

COLLEGIATE DESIGN COMPETITION

Kick-off Webinar

Aug. 15, 2019

Garrett Nilsen & Shamara Collins, U.S. Department of Energy (DOE)
Sara Farrar, Travis Lowder, & Joe Simon, National Renewable Energy Laboratory (NREL)

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SOLAR ENERGY TECHNOLOGIES OFFICE
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SOLAR DISTRICT CUP
COLLEGIATE DESIGN COMPETITION

Welcome to the Competition!

Garrett Nilsen

Technology to Market Program Manager and Acting Soft Costs Program Manager
Energy Efficiency & Renewable Energy, Solar Energy Technologies Office
U.S. Department of Energy (DOE)

Kick-off Webinar Agenda:

1. Introduction
2. Participation
3. Rules
4. Divisions & District Use Cases
5. Training: Knowledge Support
6. Coaching: Communications
7. Sign-Up: Registration
8. Next Play
9. Closing Q&A

Solar District Cup Overview

- Goal: to prepare students for the renewable energy workforce.
- Develop forward-thinking designs for optimized campus or urban district distributed energy systems.
- Engage students across engineering, finance, urban planning, sustainability, and other disciplines.
- Reimagine how electric energy is generated, managed, and used in urban areas.

U.S. DEPARTMENT OF ENERGY

SOLAR DISTRICT CUP

COLLEGIATE DESIGN COMPETITION

A new competition challenging student teams to design and model solar + storage systems for a campus or urban district.

Introduction

WHO
we are

WHAT
you'll do

WHY
we're hosting this competition

HOW
and what you win

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

Who We Are: Meet the Solar District Cup Organizers

Shamara Collins
DOE

Joe Simon
NREL

Sara Farrar
NREL

Travis Lowder
NREL

Aadil Latif
NREL

Jackie Petre
NREL

What You'll Do:

- Assume the role of a solar + storage developer to produce a proposal and analyze electric distribution grid interactions for a district use case.
- Learn about the development of distributed energy + storage systems.
- Present your solution to judges and industry.

Why We're Hosting This Competition:

- Help address workforce gaps for professionals in the energy industry.
- Showcase innovative solutions for increased penetration of distributed energy generation at the campus or district scale.
- Inspire industry to think differently about optimized district energy systems.

How and What You Win:

- Design a solar + storage system for a campus or district that maximizes energy offset and financial savings over 20 years.
- Win a trophy and national recognition!
- Gain valuable experience with real-life examples of innovative renewable energy design and engagement with industry.

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Participation

WHO
you are

WHEN
to engage

WHY
participate

WHERE
and how much to compete

Who You Are: Eligibility

- A team composed of at least 3 students.
- Multidisciplinary highly encouraged.
  - Engineering
  - Finance
  - Urban Planning
  - Sustainability
  - Environmental Policy
  - Others
- Enrolled student.
  - Accredited U.S.-based colleges or universities
  - At least one class and pursuing a degree
- Any level college student.

  Scope aimed at upper-level undergraduate
- Faculty advisor.

  Recommended (not required)

Why Participate?

- Build experience with innovative renewable energy design.
- Develop real-world solutions that shape the future of solar energy.
- Network with industry for jobs.
- Enhance education and build resume.
  - Senior design/capstone project
  - Elective or independent study credit
  - Part of class or thesis
  - Extracurricular activity

When to Engage: Summary Timeline 2019 – 2020

- **July 31** — Rules released.
- **Aug. 15** — Kick-off Webinar.
- **Sept. 12**, 5:00 p.m. ET — Deadline to register participating team.
- **Sept. 19** — Participating teams and universities announced.
- **Sept. 23** — Warmup Workshop (optional) at Solar Power International in Salt Lake City, Utah.
- **Nov. 21**, 5:00 p.m. ET — Deadline to submit Progress Deliverable Package for all participating teams.
- **Dec. 12** — Finalist teams announced.
- **April 11**, 5:00 p.m. ET — Deadline to submit Final Deliverable Package for finalist teams.
- **April 19–20** — Finalists present projects at Solar Power Southeast in Atlanta, GA; winners announced.

Where and How Much to Compete?

- Where competition takes place:
  - Complete registration and deliverable packages at home campus and submit via HeroX platform.
  - Webinar Training and Office Hours online.
  - Warmup Workshop (optional) at Solar Power International in Salt Lake City, Utah.
  - Solar District Cup 2020 Competition (at least one student required), where finalist teams present at Solar Power Southeast in Atlanta, GA.
- How much does it cost?
  - Registration for competition and conference events is free to students and faculty.
  - Pay for your team member travel costs.

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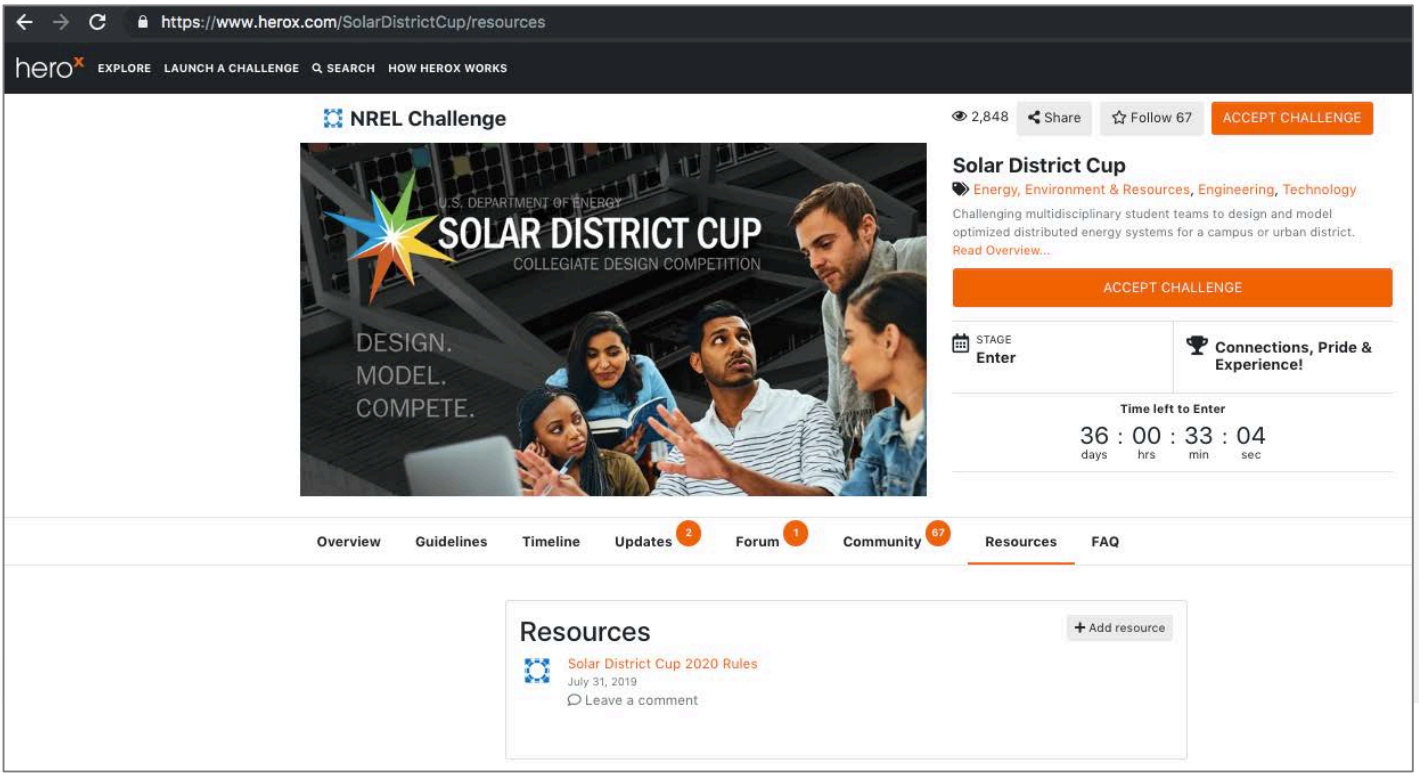
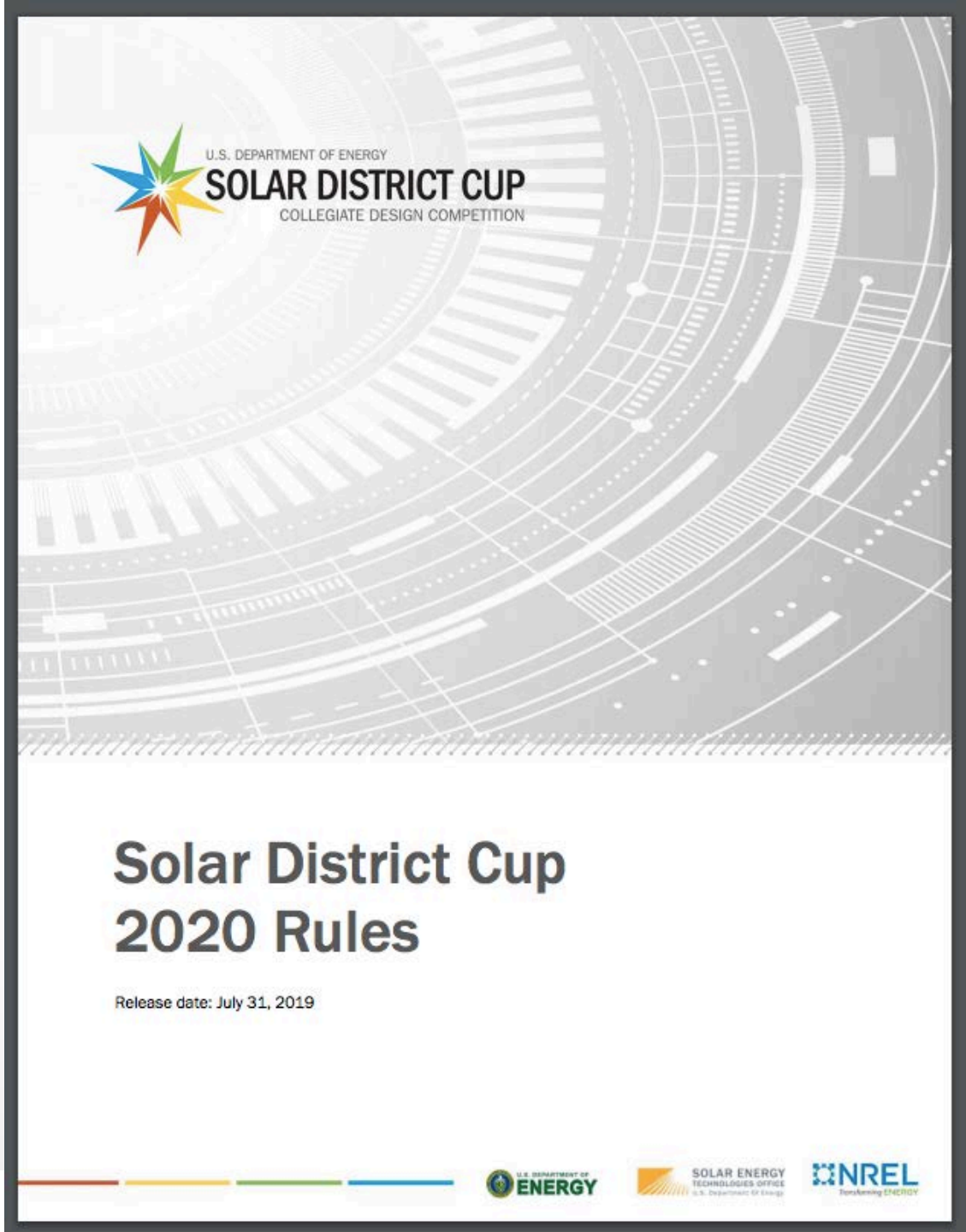
Rules

- 1st release available now on HeroX platform.
- 2nd release planned for January 2020 with minor revisions.





Rules: Content Summary

- Competition Overview:
  - Summary Timeline
  - Background
- Competition Process:
  - Introduction
  - Goal
  - How to Enter
  - How to Win
  - Divisions & District Use Cases
  - What to Submit
  - How Entries Are scored
  - Who Can Enter
  - Travel for Competition
  - Curriculum Support
- Competition Authority & Administration.

What to Submit:

- **Deliverable Packages:**
  - Progress Deliverable Package – Solar PV System
  - Final Deliverable Package – Solar PV + Battery Electric Storage System

- **Content:**
  - Conceptual System Design
  - Distribution System Impact Analysis
  - Financial Analysis
  - Development Plan
  - Optimization Strategy

- **Evaluation Process:**
  - Evaluation Statements vs. Judging Statements for Evaluation

Evaluation Statements: Progress Deliverable Package

Table 1. Progress Deliverable Package Content and Evaluation Statements

Content	Evaluation Statement
1. Conceptual System Design	
A. Layout and specifications for the solar electric PV systems proposed within the district on one or more rooftops, parking lots, or ground areas [PDF].	A. Conceptual system design is complete and reasonable for PV system location and specifications.
B. Average hourly energy production output for each system over annual period [Excel spreadsheet].	B. Energy output is complete, based on a reasonable yield factor, and accounts for climatic variables.
2. Distribution System Impact Analysis	
A. Descriptive approach to power flow model [PDF], including: i. Irradiance profiles for the proposed PV systems ii. Load profiles for the connected buildings iii. Size of PV systems to comply with utility code iii. Control settings for the PV systems, capacitor banks, and voltage regulators.	A. Approach document provides clear explanation of input choices.
B. Power flow model [OpenDSS[1] input and output]: i. Demonstrating all network elements satisfy loading and voltage constraints ii. Demonstrating active elements have realistic settings, responses, and dead times.	B. Power flow model voltage analysis shows operation within expected bandwidth and with reasonable inputs.
3. Financial Analysis	
A. A project financial model that uses the production data and other inputs to generate a PPA price for a 20-year term and that achieves a net present value of $0 [Excel spreadsheet].	A. Financial model has a complete set of reasonable inputs, models cash flows competently, and has a PPA price output that conforms to market benchmarks.
4. Development Plan	
A. Building and site plan for conceptual system design, including applicable local ordinances [PDF].	A. Building and site plan demonstrates compliance with district master plan, zoning, and other land use building restrictions.
B. Construction plan to procure necessary permits and comply with local codes [PDF].	B. Development plan demonstrates compliance with permitting and relevant codes.

Excerpt from Rules, page 6

Evaluation Statements: Progress Deliverable Package

Content	Evaluation Statement
1. Conceptual System Design	
A. Layout and specifications for the solar electric PV systems proposed within the district on one or more rooftops, parking lots, or ground areas [PDF].	A. Conceptual system design is complete and reasonable for PV system location and specifications.
B. Average hourly energy production output for each system over annual period [Excel spreadsheet].	B. Energy output is complete, based on a reasonable yield factor, and accounts for climatic variables.

Excerpt from Rules, page 6

Judging Statements for Evaluation: Final Deliverable Package

Table 2. Final Deliverable Package Content and Judging Statements

Content	Judging Statements for Evaluation
1. 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]. 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 site analysis, alignment with partner district goals, and optimal battery use.
2. Distribution System Impact Analysis	
A. Descriptive approach to power flow modeling, including summary description of results and underlying assumptions used in the analysis [PDF]. B. Rationale for sizing and siting the battery, including: i. Explanation and selection of operating mode (e.g., peak shaving, self-consumption, capacity firming) and corresponding input settings for the battery system ii. Assumptions made to model the battery, including round-trip efficiency parameters iii. Justification for any changes to the distribution system infrastructure either needed or avoided as a result of adding the PV and battery systems. C. Power flow model demonstrating the proposed solar PV plus battery systems can operate without voltage violations [OpenDSS input and output].	Power flow modeling approach demonstrates sophisticated strategy to integrate a reliable solution into the distribution system while operating within voltage and loading restrictions.
3. Financial Analysis	
A. Financial narrative including: i. Expected system operation within utility rate structure ii. Value stacking of battery use cases iii. Valuation of resilience premium. B. Financial model comprising i. Project financial model that uses the production data, battery operation, and other inputs to generate a PPA price for a 20-year term[Excel spreadsheet] ii. Customer savings model that demonstrates annual cash flows for the PPA offtakers (i.e., the district) and provides a net present value of savings over the term of a 20-year PPA contract [Excel spreadsheet].	Financial analysis communicates a compelling solution integrating thoughtful approach to renewable energy project finance, justifiable input assumptions, proper calculations, sound battery-operation strategy, and a creative methodology for value stacking.

Table 2 continued. Final Deliverable Package Content and Judging Statements

Content	Judging Statements for Evaluation
4. Development Plan	
A. Building and site plan for conceptual system design, including any proposed rezoning. B. A construction and development plan to implement the design [PDF], including: i. Necessary construction and land use permits ii. Compliance with applicable local codes iii. Potential risks to successful deployment iv. Approach to address potential concerns and questions of district decision makers and surrounding community members.	Proposed building and site plan with any rezoning adds significant value in a comprehensive, actionable, and feasible approach for the entire district and surrounding community.
5. Optimization Strategy	
A. Written narrative that describes the team's structure, approach to system design, strategy for optimization, final solution, and progress toward meeting district goals [PDF]. B. Presentations on the team's approach to the system design, operation, optimization, and innovation [PPT & live presentations].	The team communicates its solution effectively, clearly demonstrating why it should win.

Excerpt from Rules, pages 8 & 9

Judging Statements for Evaluation: Final Deliverable Package

Content	Judging Statements for Evaluation
1. 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]. 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 site analysis, alignment with partner district goals, and optimal battery use.

Excerpt from Rules, page 8

How Entries are Scored

Table 3. Scoring Scale

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

Excerpt from Rules, page 9

1. Judges review Final Deliverable Packages.
2. Each statement receives a preliminary score from each judge.
3. Statements have equal weight.
4. Scores are averaged and the averages are summed.
5. Preliminary scores yield a preliminary ranking of division teams.
6. Judges witness a 10- to 25-minute live presentation.
7. Judging panel convenes to determine division winners.
8. 1st-, 2nd-, and 3rd-place winners are identified and announced.
9. 1st-place winner of each division presents to conference attendees, and an industry choice winner is selected and announced.

Rules Appendices A & B

- Appendix A. Resources for Model Input Assumptions:
  - Written Resources
  - Model and Software Tools
  - Financial Model Assumptions
  - Open DSS Information
    - Topological Data
    - Loading Profiles

- Appendix B. Deliverable Package Submission Requirements:
  - PDF Requirements
  - Excel Requirements

Rules Appendix C

- *Progress* Deliverable Package:
  - 1.A. Conceptual System Design – Layout and Specifications
  - 1.B. Conceptual System Design – Energy Production
  - 2.A. Distribution System Impact Analysis – Approach to Power Flow Model
  - 2.B. Distribution System Impact Analysis – Power Flow Model
  - 3.A. Financial Analysis
  - 4.A. Development Plan – Building and Site Plan
  - 4.B. Development Plan – Construction Plan

Progress Deliverable Package

1. A. Conceptual System Design—Layout and Specifications

Format Requirements

☐	File type: single, bookmarked PDF
☐	Up to 30 pages total; any additional pages submitted will not be reviewed
☐	ANSI A (8.5" x 11") paper size must be used
☐	Minimum font size of 11 points, minimum ½" margin on all sides

Content Requirements

☐	System design summary of approach and solution (maximum 2 pages)
☐	Description of equipment selection and specifications, including process for optimization (maximum 2 pages)
☐	Site plan showing all proposed installations
☐	Individual installation plans showing individual panels and location of associated equipment
☐	Shading models for each proposed installation

1. B. Conceptual System Design—Energy Production

Format Requirements

☐	Packaged into a single Excel file, multiple tabs allowed

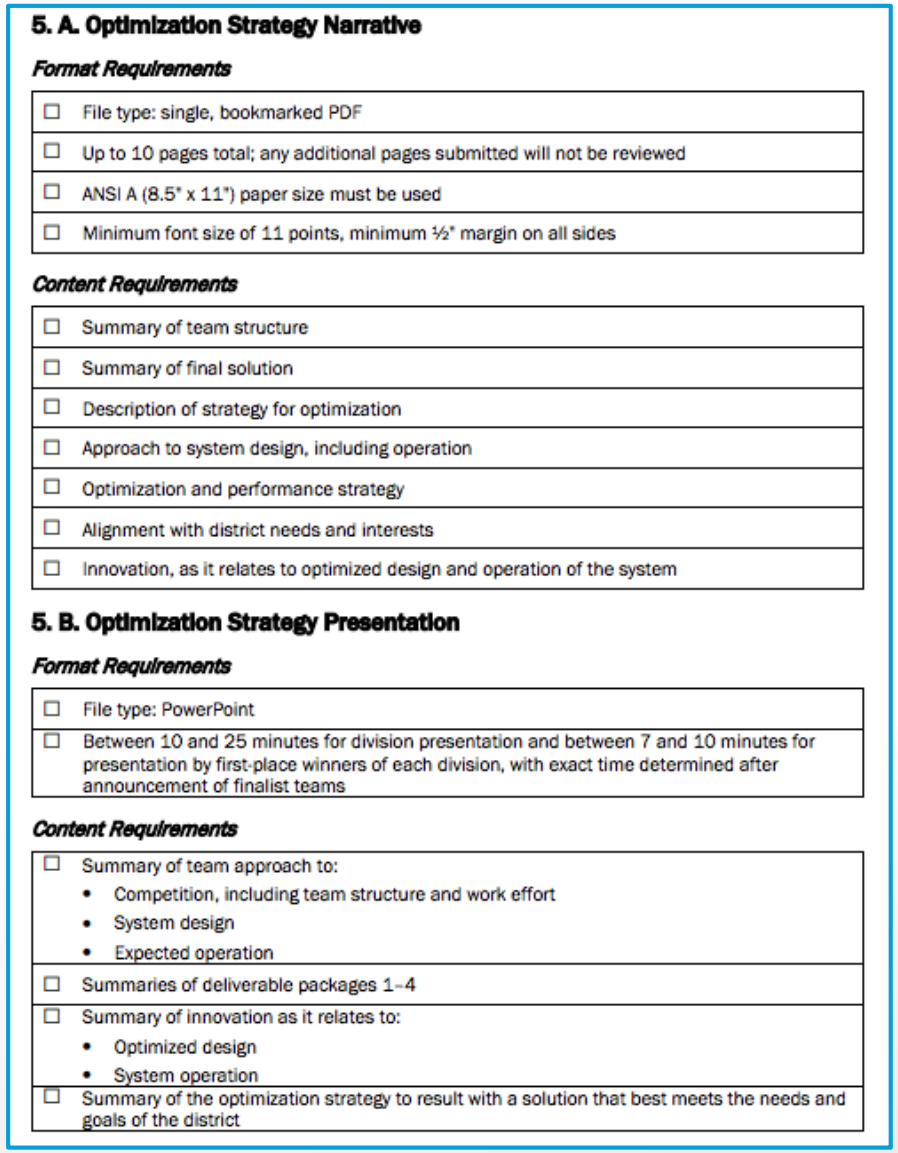
Content Requirements

☐	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

Excerpt from Rules, page 16

Rules Appendix C

- *Final* Deliverable Package:
  - 1.A. Conceptual System Design – Layout and Specifications
  - 1.B. Conceptual System Design – Energy Production and Battery Cycles
  - 2.A. Distribution System Impact Analysis – Approach to Power Flow Model
  - 2.B. Distribution System Impact Analysis – Power Flow Model
  - 3.A. Financial Analysis – Financial Narrative
  - 3.B. Financial Analysis – Financial Model
  - 4.A. Development Plan – Building and Site Plan
  - 4.B. Development Plan – Construction and Development Plan
  - 5.A. Optimization Strategy Narrative
  - 5.B. Optimization Strategy Presentation



5. A. Optimization Strategy Narrative

Format Requirements

☐ File type: single, bookmarked PDF
☐ Up to 10 pages total; any additional pages submitted will not be reviewed
☐ ANSI A (8.5" x 11") paper size must be used
☐ Minimum font size of 11 points, minimum ½" margin on all sides

Content Requirements

☐ Summary of team structure
☐ Summary of final solution
☐ Description of strategy for optimization
☐ Approach to system design, including operation
☐ Optimization and performance strategy
☐ Alignment with district needs and interests
☐ Innovation, as it relates to optimized design and operation of the system

5. B. Optimization Strategy Presentation

Format Requirements

☐ File type: PowerPoint
☐ Between 10 and 25 minutes for division presentation and between 7 and 10 minutes for presentation by first-place winners of each division, with exact time determined after announcement of finalist teams

Content Requirements

☐ Summary of team approach to: • Competition, including team structure and work effort • System design • Expected operation
☐ Summaries of deliverable packages 1–4
☐ Summary of innovation as it relates to: • Optimized design • System operation
☐ Summary of the optimization strategy to result with a solution that best meets the needs and goals of the district

Excerpt from Rules, page 25

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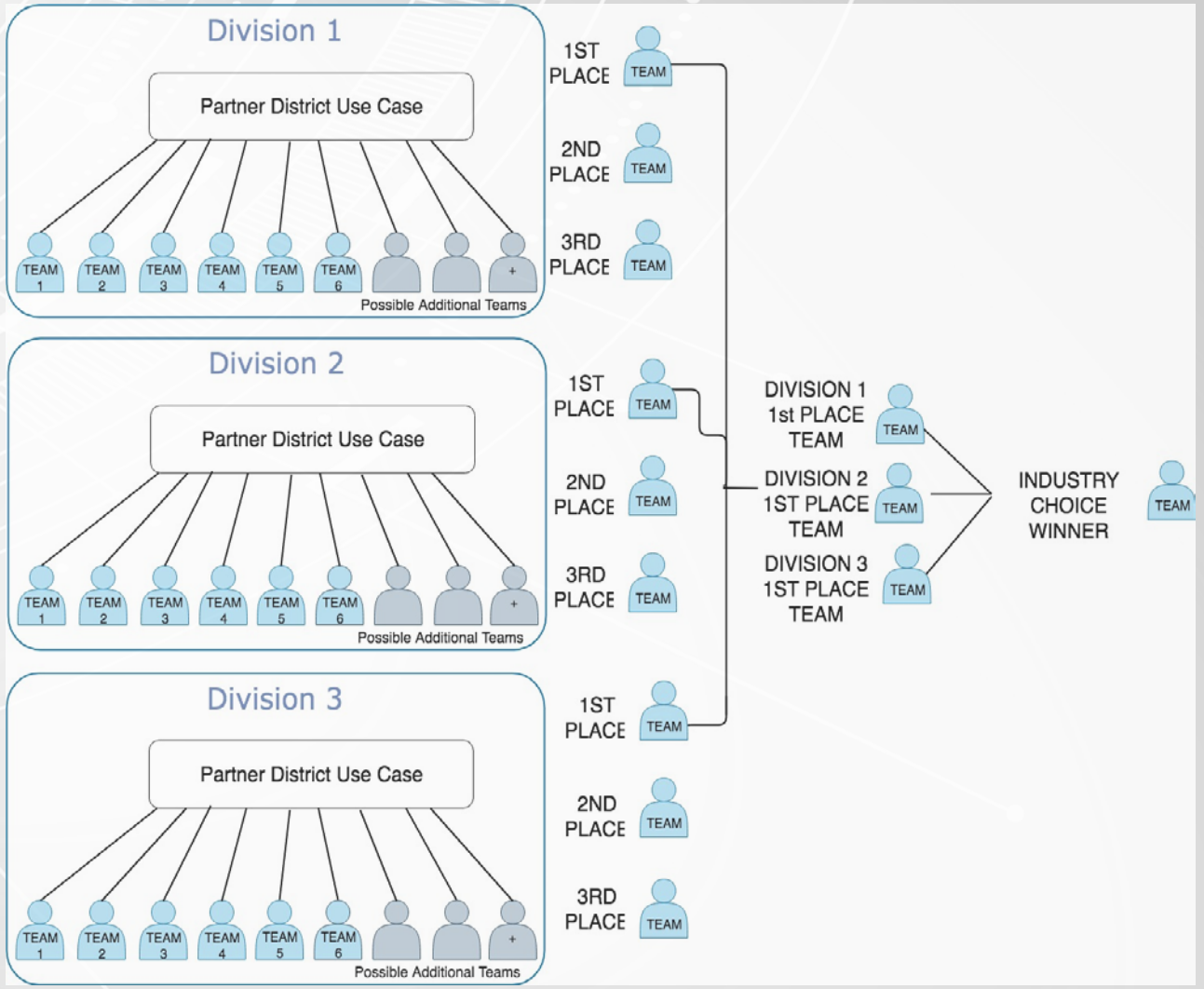
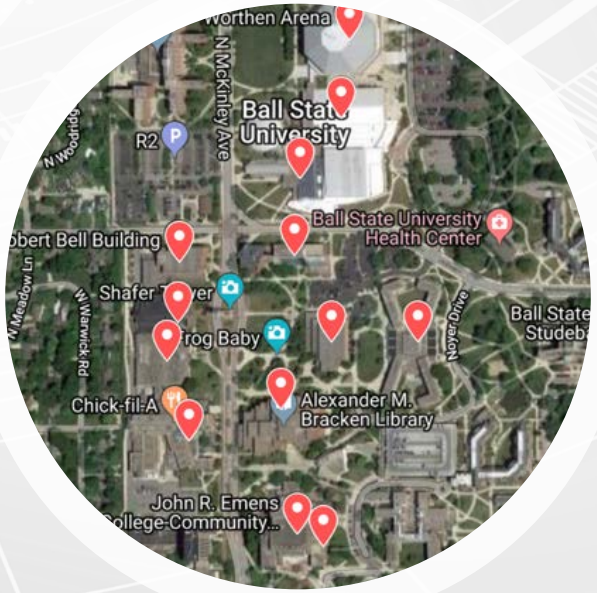
Divisions (the Competition Cohort)

- 3 Divisions.
  - 6-11 Teams in each Division
- Teams assigned to Divisions by the competition organizers.
- Winners of each Division selected by judges.
- One Industry Choice winner selected at Solar Power Southeast.



Excerpt from Rules, page 10



Use Cases (the Competition Challenges)

- Ball State University
- New Mexico State University
- Crystal City, VA Complex

Use Case Data

- Available in a secure online data room. Teams will be sent log-in credentials.
  - Data includes:
    - 15-minute interval energy usage (.xlsx).
    - District Google Earth map with identifiers (.kmz).
    - Utility rate schedule (.pdf).
    - District master plan (.pdf).
    - Distribution system and substation models (OpenDSS).
    - Use Case profile (.doc).

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Training

- Prerecorded webinars.
- “Office Hours”:
  - Open to all registered teams.
  - Held September through November and again January through February.

Training Webinars (Required)

Training Topic	Description
Solar District Cup Deep Dive	Review the Rules, Districts, and tips on how to form and coach a team.
Conceptual System Design	Learn the considerations and techniques for designing and specifying solar systems.
Distribution System Impact Analysis	Learn to evaluate voltage impacts of solar installations on distribution feeders.
Financial Model	Learn the principles of renewable energy project modeling.
Development Plan	Learn the principles of land use, zoning ordinances, and other regulations that impact solar project development.

Webinars will be published periodically throughout the competition. This is a preliminary list and is subject to change.

Tool Webinars (Optional)

Training on Tools	Description
System Advisor Model (SAM)	SAM is a project model that includes both an energy production engine and a financial model, among other features.
Aurora Solar	Aurora Solar is a solar design and rendering program that includes an energy production engine and a financial model, among other capabilities.
OpenDSS	OpenDSS is an open-source power flow model to evaluate voltage impacts on the distribution system.
REOpt Lite	REOpt Lite is a browser-based renewable energy optimization tool that can be used to optimize battery operation for a given utility rate.
Savings Model Building	Learn how to build an Excel model to calculate customer savings over the term of a 20-year PPA.

Webinars will be published periodically throughout the competition. This is a preliminary list and is subject to change.

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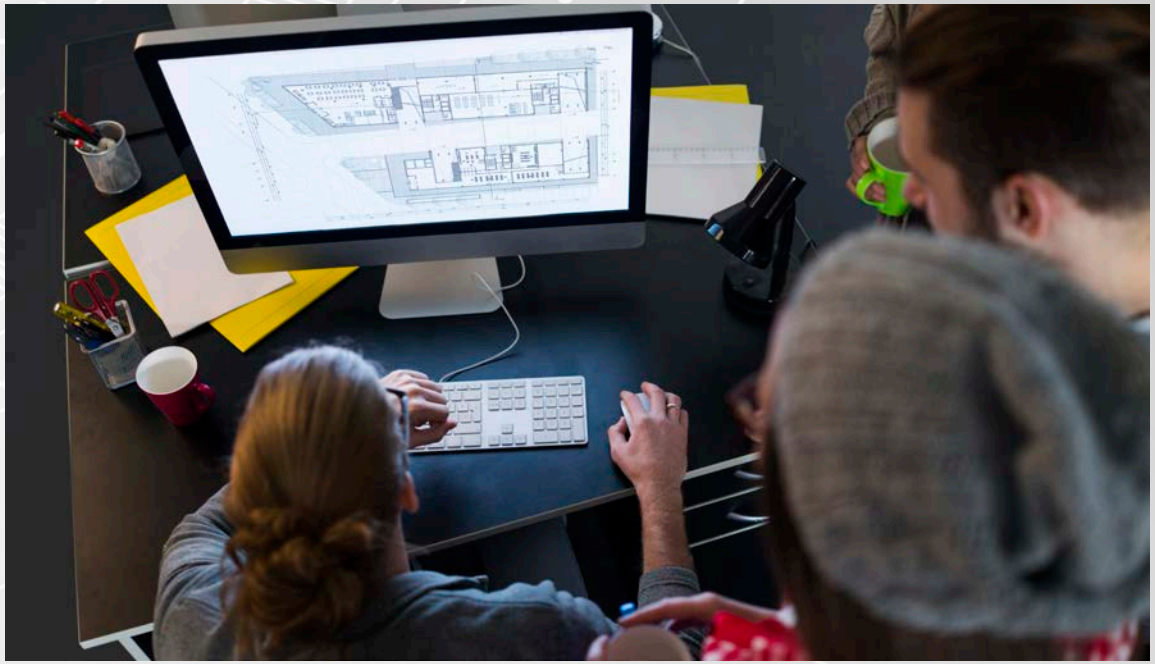

Communications

- Competition overview: www.energy.gov/solardistrictcup.
- Competition details and participation: www.herox.com/solardistrictcup.
  - Updates
  - Notifications
  - Submissions
  - Forum
- General announcements: Mailchimp newsletter.
- Webinars: webinars and Office Hours.
- Direct contact: solardistrictcup@nrel.gov.

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Team Registration: You Must Complete the “Register” Entry

NREL Challenge

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Solar District Cup

Energy, Environment & Resources, Engineering, Technology

Challenging multidisciplinary student teams to design and model optimized distributed energy systems for a campus or urban district.
Read Overview...

Register

BEGIN ENTRY

Progress

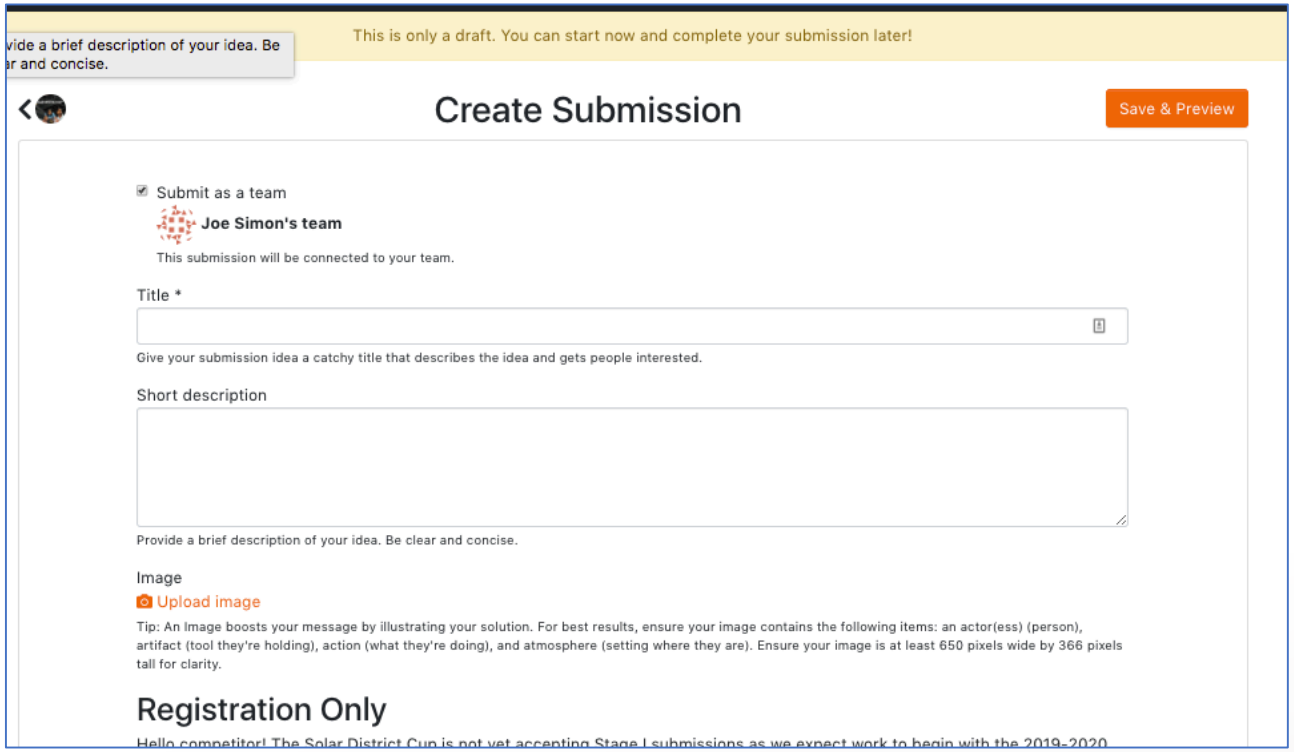
BEGIN ENTRY

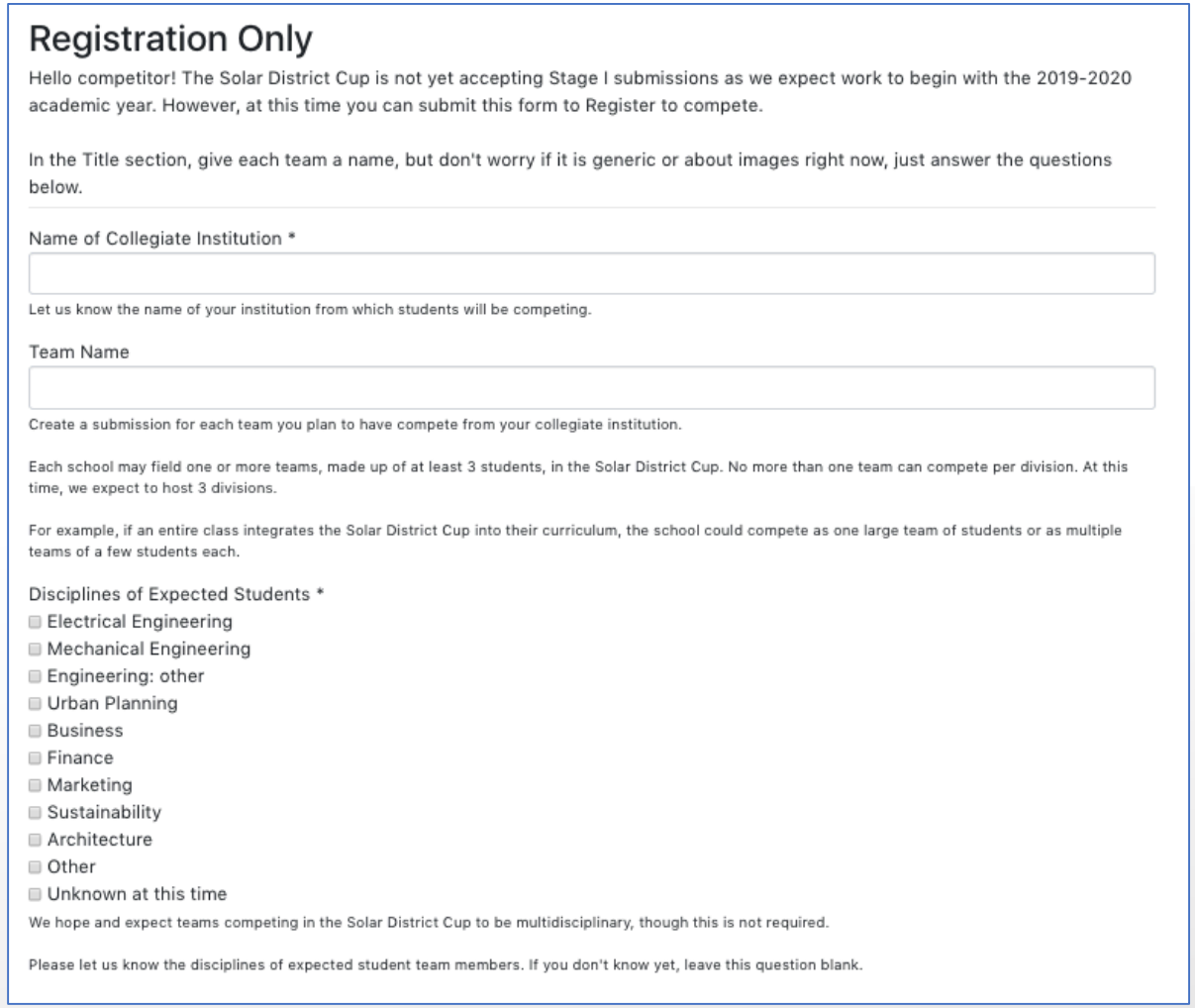
Final

BEGIN ENTRY

Legal agreement Leave challenge

Team Registration: You Must Complete the “Register” Entry





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Team Next Steps

1) Recruit team members:
    - Digital postcard and messaging available upon request.
2) Register your team.
3) Read the Rules.
4) Read supplemental communications, including District Use Case.
5) Plan for Warmup Workshop.
6) Dig into the solar designs of your division district!

Solar District Cup Warmup Workshop at Solar Power International Smart Energy Week

- Monday, Sept. 23, 2019, 8:30 a.m. – 12:00 p.m.
- Salt Lake City, Utah.
- Target: Student and faculty team leaders and members.
- Goal: Prepare teams for success and industry networking.

Solar District Cup Warmup Workshop Agenda

8:30 a.m. **Welcome**
Shamara Collins, U.S. Department of Energy
Joe Simon, National Renewable Energy Laboratory
Chloe Thomas, Solar Energy Trade Shows

8:45 a.m. **Introduction to the Solar District Cup**
Presentation by Joe Simon

9:15 a.m. **Know Your Division: District Use Case Review**
Presentation by Travis Lowder

9:30 a.m. **Starting Lineups: Team Introductions**
Facilitated by Sara Farrar

10:15 a.m. **Break**

10:30 a.m. **Top 10 Tips for Taking Home Glory**
Presentation by NREL Staff

11:00 a.m. **Learning from the Pros: District Example**
Presentation by Guest Speaker

11:45 a.m. **Conclude**

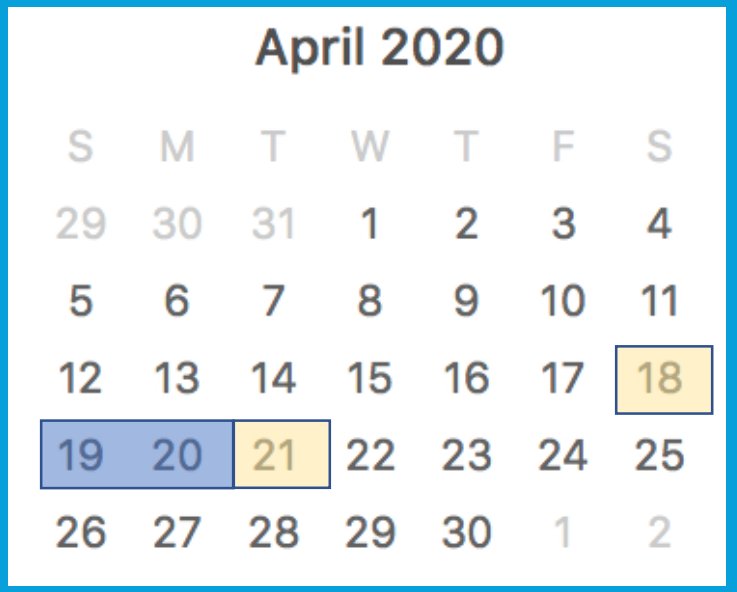
Additional Activities

1 – 3 p.m. Tentative: Mock Interviews
Conducted by NREL staff for students

3 – 4:30 p.m. **First-Time Attendee Orientation**
Presentation by SPI staff

*** Registration code for free student and faculty access will be given to registered teams. ****

Presentations will be made available online.



Solar Power Southeast: April 20 – 21, 2020

Solar District Cup 2020 Competition: April 19 – 20

- Student teams travel on Saturday, April 18.
- Present to division judges on Sunday, April 19.
- Winners announced & plenary presentation by division 1st-place teams on Monday, April 20.
- Student teams travel home Monday night or optionally attend more of conference.

U.S. DEPARTMENT OF ENERGY

SOLAR DISTRICT CUP

COLLEGIATE DESIGN COMPETITION

Questions?

Tag & follow on social:

#SolarDistrictCup

Learn more, sign up for our newsletter, and register a team at:

energy.gov/solardistrictcup

solardistrictcup@nrel.gov

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