



## American-Made Challenges: Solar Desalination Prize

### OFFICIAL RULES

**These rules are effective April 12, 2021 and apply to all current Solar Desalination Prize competitors and future applicants.**

The U.S. Department of Energy (DOE)'s American-Made Challenges: Solar Desalination Prize will be governed by these official rules. The Prize Administrator and DOE reserve the right to modify the official rules if necessary and will publicly post any such modifications, as well as notify prize competitors.

# TABLE OF CONTENTS

- I. PROGRAM SUMMARY ..... 4
  - 1. INTRODUCTION..... 4
  - 2. BACKGROUND ..... 5
  - 3. THE FOUR PRIZE CONTESTS..... 6
  - 4. PROGRAM SCHEDULE ..... 10
  - 5. TARGET MARKETS AND PERFORMANCE METRICS ..... 10
  - 6. COMPETITOR ELIGIBILITY..... 14
  - 7. AMERICAN-MADE NETWORK ..... 17
  - 8. HOW TO ENTER ..... 19
  - 9. ADDITIONAL TERMS AND CONDITIONS ..... 19
- II. INNOVATION CONTEST RULES & REQUIREMENTS ..... 20
  - 1. INTRODUCTION..... 20
  - 2. GOAL..... 20
  - 3. PRIZES ..... 20
  - 4. HOW TO ENTER ..... 20
  - 5. CONTEST PROCESS ..... 20
  - 6. WHAT TO SUBMIT ..... 21
  - 7. HOW WINNERS ARE DETERMINED – INNOVATION CONTEST..... 24
  - 8. WHO CAN WIN..... 25
  - 9. FIND HELP ..... 25
  - 10. ADDITIONAL REQUIREMENTS ..... 25
- III. TEAMING CONTEST RULES & REQUIREMENTS..... 26
  - 1. INTRODUCTION..... 26
  - 2. GOAL..... 26
  - 3. PRIZES ..... 26
  - 4. HOW TO ENTER ..... 26
  - 5. CONTEST PROCESS ..... 26
  - 6. WHAT TO SUBMIT ..... 28
  - 7. HOW WINNERS ARE DETERMINED – TEAMING CONTEST ..... 33
  - 8. WHO CAN WIN..... 34
  - 9. FIND HELP..... 34
  - 10. ADDITIONAL REQUIREMENTS ..... 34
- IV. DESIGN CONTEST RULES & REQUIREMENTS ..... 35
  - 1. INTRODUCTION..... 35
  - 2. GOAL..... 35
  - 3. PRIZES ..... 35
  - 4. HOW TO ENTER ..... 36
  - 5. CONTEST PROCESS ..... 36
  - 6. WHAT TO SUBMIT ..... 37
  - 7. HOW WINNERS ARE DETERMINED – DESIGN CONTEST ..... 41
  - 8. WHO CAN WIN..... 41
  - 9. FIND HELP ..... 42
  - 10. ADDITIONAL REQUIREMENTS ..... 42

V. TEST CONTEST RULES & REQUIREMENTS .....	43
1. INTRODUCTION.....	43
2. GOAL.....	43
3. PRIZES .....	43
4. HOW TO ENTER .....	43
5. CONTEST PROCESS .....	44
6. WHAT TO SUBMIT .....	45
7. HOW WINNERS ARE DETERMINED – TEST CONTEST.....	49
8. WHO CAN WIN.....	50
9. FIND HELP .....	50
10. ADDITIONAL REQUIREMENTS .....	50
VI. ADDITIONAL TERMS AND CONDITIONS .....	51
1. UNIVERSAL CONTEST REQUIREMENTS .....	51
2. VOUCHER PAIRING SYSTEM.....	52
3. VERIFICATION FOR PAYMENTS: .....	52
4. TEAMS AND SINGLE ENTITY AWARDS.....	53
5. SUBMISSION RIGHTS .....	53
6. COPYRIGHT .....	54
7. CONTEST SUBJECT TO APPLICABLE LAW .....	54
8. RESOLUTION OF DISPUTES.....	54
9. PUBLICITY .....	54
10. LIABILITY .....	55
11. RECORDS RETENTION AND FREEDOM OF INFORMATION ACT.....	55
12. PRIVACY .....	56
13. GENERAL CONDITIONS .....	56
14. PROGRAM POLICY FACTORS .....	57
15. NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) COMPLIANCE .....	58
Technical Appendix - Performance Metrics.....	60

# I. PROGRAM SUMMARY

## 1. INTRODUCTION

The DOE Solar Energy Technologies Office (SETO) launched the American-Made Challenge: Solar Desalination Prize (Solar Desal Prize) in 2020 as a \$10 million four-contest program to accelerate the commercial development of thermal desalination systems powered by low-cost solar-thermal energy. In 2021, due to high interest and continued opportunities for technology development, SETO launched a second round of the Solar Desal Prize, adding \$5 million to the prize pool for a total of \$15 million.

The Solar Desal Prize gives innovators a pathway from initial concept to a field-tested system that provides clean, accessible water. Each successive phase of the competition will be more challenging than the last, with larger prizes and fewer competitors advancing. Round 1 competitors were awarded \$3.75 million in prizes (cash and technical support vouchers) in the first two phases. Round 2 competitors have access to \$2.8 million in prizes in the first two phases. Competitors in both rounds can access a pool of up to \$5.75 million in prizes in the third and fourth phases and have access to \$2.7 million in support services.

The goals of this prize are to expand the availability of fresh water by cost-effectively treating challenging saline water using solar-thermal energy, with minimal electricity and conventional energy resources. This prize program seeks to fund innovations that address a broad range of process parameters, including throughput, scale, product-water purity, and the ability to handle feed water with high salt content of greater than 30,000 parts per million (ppm). In Round 2, SETO particularly encourages the development of solar collector and thermal energy storage technologies that can provide low-cost heat to thermal desalination systems. Competitors will utilize collaborative pathways to rapidly develop ideas into operational desalination facilities in the next few years.

Building a clean energy economy and addressing the climate crisis is a top priority of the Biden Administration. This prize will advance the Biden Administration's goals to achieve carbon-pollution-free electricity by 2035, "deliver an equitable, clean energy future, and put the United States on a path to achieve net-zero emissions, economy-wide, by no later than 2050"<sup>1</sup> to the benefit of all Americans.

DOE is committed to pushing the frontiers of science and engineering, catalyzing clean energy jobs through research, development, demonstration, and deployment, and ensuring environmental justice and the inclusion of disadvantaged communities.

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<sup>1</sup> Executive Order 14008, "Tackling the Climate Crisis at Home and Abroad," January 27, 2021.

## 2. BACKGROUND

Water purification technologies are an essential part of U.S. infrastructure, providing a critical resource for human health, economic growth, and agricultural productivity. The United States has historically benefited from access to low-cost water supplies, but challenges for freshwater supplies could threaten U.S. economic competitiveness and water security. Expanding the use of nontraditional water sources can help ensure water security in the United States and improve the resilience of American infrastructure.<sup>2</sup>

Many of the largest water resources in the United States and around the world cannot be used cost-effectively for municipal or industrial use because they contain high concentrations of dissolved salts. The White House Office of Science and Technology Policy has identified desalination, or removal of these salts, as part of a national strategy to enhance water security.<sup>3</sup> Current standard technologies, like reverse osmosis (RO), are relatively efficient when salt concentrations are comparable to that of seawater and when electricity is readily available, but they cannot handle high-salt water produced from oil and gas wells, concentrated brines, and some industrial and agricultural wastewaters. For pressure-based systems like RO, the higher the salt concentration, the more energy is needed for desalination. Thermal desalination technologies are much more tolerant of high salt concentrations because there is a much weaker relationship between salt concentration and energy required. Thermal desalination is particularly valuable for inland applications where disposing of brine produced through RO is difficult or costly and where zero-liquid discharge (ZLD) may be needed. The purified water can be used for municipal drinking water systems, for agricultural or industrial uses, or to clean contaminated wastewater to allow for low-cost surface discharge.

Many locations in the U.S. that have a high degree of water stress—meaning they come close to draining their annual water store in a typical year—also have abundant solar resources. For example, sunny areas including much of the southwest region of the United States, Texas, and Florida are at high risk of being unable to maintain sustainable water supplies.<sup>4</sup>

Concentrated solar-thermal energy has been used primarily in concentrating solar-thermal power plants that deliver high-temperature heat—approximately 400°-565° Celsius—to drive steam turbines for electricity generation. Lower-temperature heat from solar energy (below 200°C) can directly drive thermal industrial processes, including systems that separate salt from water through thermally driven processes. Because it's relatively easy to store thermal energy (by storing hot fluids or other materials), solar-thermal energy can provide renewable energy on demand at any time of day. Additionally, solar-thermal power could advance water security at various scales—from small, modular systems easily deployed in remote areas to large, industrial-scale systems that provide communities with reliable water supplies.

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<sup>2</sup> <https://www.energy.gov/downloads/water-energy-nexus-challenges-and-opportunities>

<sup>3</sup> <https://www.whitehouse.gov/wp-content/uploads/2019/03/Coordinated-Strategic-Plan-to-Advance-Desalination-for-Enhanced-Water-Security-2019.pdf>

<sup>4</sup> <https://pubs.usgs.gov/pp/1833/pp1833.pdf>

The Solar Desal Prize is designed to accelerate technology innovation through a series of contests to design, develop, and demonstrate desalination systems that use the sun's power to generate fresh water from salt water. The Solar Desal Prize seeks to identify the most promising technology concepts; facilitate the formation of collaborative, interdisciplinary teams to advance these technologies; and identify test facilities where competitors can build and validate commercially relevant, operational prototypes of solar-thermal desalination systems.

The Solar Desal Prize is part of a larger effort known as the Water Security Grand Challenge, a White House–initiated and DOE-led framework to advance transformational technology and innovation to meet the global need for safe, secure, and affordable water.<sup>5</sup> Goal 1 of the Water Security Grand Challenge, which this prize addresses, is to launch desalination technologies that deliver cost-competitive clean water.

The program will make it faster and easier for our nation to transform innovative research and ideas into early-stage concepts and then build prototypes for validation. Competitors will not only be working to win cash prizes and other benefits; they also will be connected with mentoring, training, and other services from the American-Made Network to support U.S. water security and widespread, commercial use of solar-thermal desalination facilities.

Currently, the solar industry and its associated research community does not match the diversity of the United States. Women and minorities are underrepresented in the solar industry and in the science, technology, engineering, and math (STEM) fields. STEM fields also lack diversity in geographical origin, with U.S. rural areas underrepresented relative to large population centers. Since STEM students and graduates support R&D activities, which can often result in the formation of companies, the lack of diversity in that pipeline adversely affects the opportunities and potential outcomes in scientific and economic output. To achieve the administration's energy justice goals, SETO is working to ensure that the work SETO funds will support more equitable participation in the solar energy community. SETO recognizes the inherent advantages of diverse teams and encourages competitors to consider diversity and inclusion when developing their teams.

### 3. THE FOUR PRIZE CONTESTS

The American Made Challenges: Solar Desalination Prize consists of four consecutive contests that accelerate efforts to develop innovative solar desalination concepts into commercially viable products. Each contest will include a period during which competitors will work to rapidly advance their solutions, culminating in an operational prototype demonstration of their technology at a test facility using high-saline water. The competitors' performance will be reviewed using the criteria described in sections 6 and 7. The best-performing competitors will be awarded prizes and advance to the next contest.

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<sup>5</sup> <https://www.energy.gov/eere/water-security-grand-challenge>

The prize amounts are provided in Table 1, below.

Table 1 – Contests and Prizes

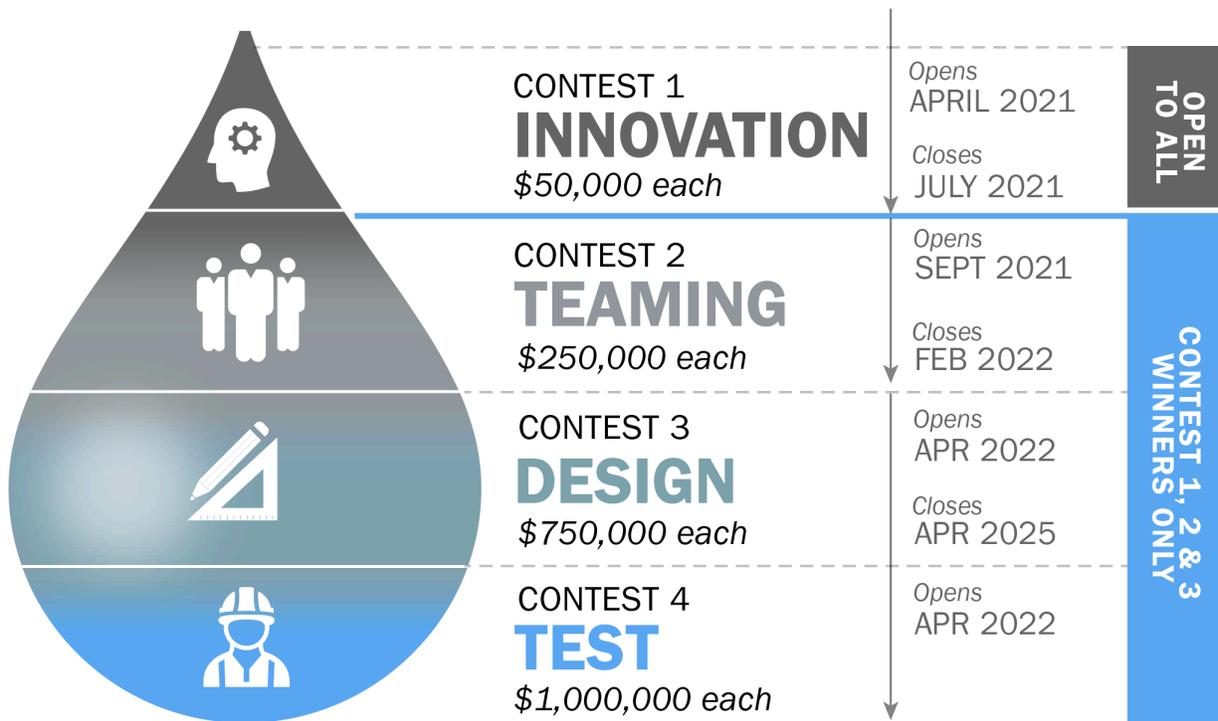
	Cash Prize	Vouchers	Round 1 Number of Awards*	Round 2 Anticipated Number of Awards
<b>Contest 1: Innovation</b>	\$50,000		19	14
<b>Contest 2: Teaming</b>	\$250,000	\$100,000	8	6
<b>Contest 3: Design</b>	\$750,000	\$100,000	5	
<b>Contest 4: Test</b>	\$1 million		2	

\*Innovation and teaming contest selections

**Cash prize amounts are the amounts paid to each competitor chosen to advance in each of the four contests. The number that advance will be determined by the number and quality of submissions provided in each contest.**

The program offers up to \$15 million in cash prizes and support over the course of four contests in both Rounds 1 and 2.

# Solar Desalination Prize **Round 2**



- Contest 1: Innovation**  
 Individuals or groups of competitors will demonstrate that they have identified a novel and feasible concept for a technology that can deliver desalinated water using solar-thermal energy. The innovation can be a solar-thermal desalination system component or an entire system. Round 2 particularly encourages developers of thermal energy storage and solar collector technologies to apply. Successful competitors in Contest 1 will have taken steps to determine the technical feasibility, scalability, and other potential benefits of the proposed solution and articulated a credible pathway to commercialization. Competitors selected to advance will receive \$50,000 and be eligible<sup>6</sup> to compete in the Teaming contest. Winners of this contest will be referred to as quarterfinalists.
- Contest 2: Teaming**  
 Only the teams selected in Contest 1 may advance to compete in the Teaming contest. Competitors will work to establish and solidify a complete cross-functional project team that can take a preliminary innovative desalination concept into a fully operational prototype. If the innovation selected in Contest 1 is a system component, teams must now plan to incorporate it into a full, functional system. Successful teams will include innovative technology developers; establish business

<sup>6</sup> See [Section VI – Additional Terms and Conditions](#) for more details on participant eligibility.

relationships with key vendors and end users; and identify a possible testing location. The possible location must be capable of hosting a solar-thermal desalination prototype at a scale compatible with the competitor's identified market and relevant water conditions. Competitors will be selected to advance to the third contest based on how well their submission package demonstrates their ability to build an operational prototype and the likelihood of their success. The teams selected to advance to the third contest will receive \$250,000 in cash and a \$100,000 voucher that may be redeemed at National Laboratories and/or qualified partner facilities in the American-Made Network to further develop their solution. Winners of this contest will be referred to as semifinalists.

- **Contest 3: Design**

Only the teams selected in Contest 2 may advance to compete in the Design contest. Competitors will work to complete a detailed design of their proposed prototype of a solar-thermal desalination facility to the point that they are “shovel-ready” for a site located in the United States or territories of the United States. To advance to the final contest in this competition, teams must prove they have obtained all required documentation and approvals needed to begin construction, and construction can begin almost immediately after receipt of the prize. Each team should submit its submission package for consideration as soon as possible but have up to three years to do so after winning the Teaming contest prize. Each team selected to advance to the fourth contest will receive \$750,000 and a \$100,000 voucher that may be redeemed at National Laboratories and/or qualified partner facilities in the American-Made Network, described in Section 6, to further develop its solution. Winners of this contest will be referred to as finalists.

- **Contest 4: Test**

Only the teams selected in Contest 3 may advance to compete in the Test contest. Competitors will build their prototype system with a production capacity of at least 100 cubic meters (m<sup>3</sup>) of fresh water per day.<sup>7</sup> Competitors will then demonstrate the consistent and repeatable operation of their prototype system. Demonstration must cover the full range of modes and input water conditions that they expect the commercial market to require, including transient conditions and start-up and shut-down procedures. Test contest competitors may submit their results only once, and they must submit within three years of winning the Design contest. Winners of the Test contest will be selected based on their ability to meet or exceed their innovation's technical and cost goals, and their ability to identify a commercial customer that has committed to implementing the next logical stage of development of the desalination technology.

One Test contest winner is expected to be announced per year, but zero or multiple winners in any given year are possible.

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<sup>7</sup> See full description of production capacity in the [Design Contest section](#).

This prize program will be the main effort for SETO thermal desalination-related activities.<sup>8</sup> The intent of this program (subject to funding and approval) is to operate on an annual cycle. Specifically, Contest 1: Innovation, Contest 2: Teaming, and Contest 4: Test are expected to be open for applications once per year at the same time each year. Contest 3: Design, will be reviewed and awarded on an as-completed basis in an effort to create a pipeline of technological desalination improvements that can be commercialized and brought to market efficiently.

DOE reserves the right to update and/or change the rules throughout the prize competition.

## 4. PROGRAM SCHEDULE

Below is the anticipated schedule for the Desal Prize:

### Innovation – Round 2

- Open: April 12, 2021
- Close: July 15, 2021, at 3:00 p.m. ET
- Quarterfinalists will be announced September 16, 2021.

### Teaming – Round 2

- Open: September 16, 2021
- Close: February 9, 2022, at 3:00 p.m. ET
- Semifinalists will be announced April 12, 2021.

### Design

- Open: April 12, 2021 for Round 1 competitors
- Open: April 12, 2022 for Round 2 competitors
- Submissions accepted: As soon as competitors are ready
- Finalists are expected to be announced one month after DOE receives submissions.
- Close: April 12, 2024 for Round 1 competitors
- Close: April 10, 2025 for Round 2 competitors

### Test Contest

- Open: April 12, 2021
- Submissions accepted: The second Monday in April annually
- Winners are expected to be announced one month after the DOE site visit.

## 5. TARGET MARKETS AND PERFORMANCE METRICS

The purpose of this prize program is to develop solar-thermal desalination systems that advance the state of the art in the desalination market categories listed in Table 2, below.

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<sup>8</sup> The fiscal year (FY) 2017, FY 2018, FY 2019, and FY 2020 SETO appropriations have included direction to provide at least \$5 million in funding toward desalination efforts. Subject to future appropriations, additional desalination-related funding may be added to this program's funding pool to either fund additional prizes in an existing round or fund prizes in future rounds.

Enabling cost-effective solar-thermal desalination systems requires more than just improving the efficiency and capital costs of thermal desalination technologies. A low levelized cost of heat (LCOH), derived from the solar collectors and thermal energy storage (TES), is strongly correlated with a low levelized cost of water (LCOW). Additionally, desalination systems are typically on a much smaller scale than systems for other, traditional power generation markets for energy. TES and solar collectors for power generation systems generally support a facility designed for a 30-year life in a permanent location, while modular, mobile solar systems may be more beneficial for desalination markets. The TES system, in particular, has a very significant effect on the LCOW, LCOH, and other key performance metrics due to the need, in many potential markets, for desalination systems to operate continuously.

To further the objectives stated above, Round 2 of the Solar Desalination Prize especially solicits innovations related to solar collectors and TES that are well suited to deliver heat to desalination processes. Participants with concepts in these areas are encouraged to apply even if they do not have a fully defined desalination system. If they become competitors who win the Innovation contest, SETO, the National Renewable Energy Laboratory (NREL), and the American-Made Network will provide support and facilitate connections during the Teaming contest to find thermal desalination technology providers to couple to their technologies. Parties who may be interested in joining a team include entities supported by other DOE funding programs, winners from Round 1 of this prize, Innovation winners from Round 2, and independent technology developers.

Competitors should identify one or more markets where their proposed innovation has the potential to outperform state-of-the-art technologies and reduce their cost. Competitors in the Innovation contest who have not yet defined their full system but have identified only an innovative desalination, solar collector, or TES technology should explicitly identify the other components that will need to be integrated during the Teaming Contest, and what cost and performance metrics they expect those systems to meet. All solutions that make it to the Test contest will be evaluated at each team's identified test site. Teams are strongly encouraged to use a real solar input for testing but may test with alternative heat sources. If direct solar input is not used, teams should demonstrate key technologies—like heat exchangers and TES—that are necessary to integrate solar-thermal energy with desalination. Teams should be able to simulate the full range of thermal input relevant for a solar-thermal desalination system.

The Solar Desal prize seeks innovations relevant to all desalination-related end uses, including generating both potable and nonpotable water while minimizing concentrated brine generation from a variety of inputs, such as seawater, inland brackish water, agricultural drainage, and oil/gas extraction-produced water. Solutions may be located on or off the coastline, be on- or off-grid, and have a small, medium, or large throughput. All competitors should clearly identify the market and application they are targeting as summarized below. For additional [refer](#) to the [Technical Appendix](#). Competitors should specifically consider the following factors:

- **Solar Collectors and Thermal Energy Storage:** The efficient collection of solar flux and the ability to store heat on demand should be considered when designing a complete solar-thermal desalination system. Competitors should understand and justify the relevant metrics, and the technical targets that need to be met, to cost-effectively deliver heat in temperature ranges relevant to thermal desalination

processes, typically lower than 200° C. For collectors, relevant technical targets may include optical error, concentration ratio, and optical efficiency while minimizing the capital cost of the systems. For TES, competitors should evaluate the efficacy of the heat-transfer fluid and storage medium while also minimizing the direct cost of storage. The ability to store heat and use it on demand optimizes the performance of the desalination system, resulting in lower operational costs and reduced environmental impact.

- **Input Water Quality:** This refers to the quality of the saline or brackish water source that needs to be purified by the proposed desalination technology. When designing their system, competitors should consider all components and contaminants of the raw water input, based on their targeted end use. As part of the Teaming contest, competitors are encouraged to replace these initial water qualities with more specific water analyses applicable to a specific end use and test location.
- **Product Water Quality:** This refers to the quality of the water produced by the proposed desalination technology. When designing their system, competitors should consider the water-quality criteria for the produced water's intended end use, as defined by relevant regulations, as appropriate. Once a prototype facility site has been identified, the initial water-quality criteria can be replaced with appropriate product-water qualities specific to the end use.
- **Performance Metrics:** Since the performance metrics may vary widely, based on the targeted desalination end use, each team must justify its innovation's performance metrics that will be validated in its operational prototype of a solar-thermal desalination system. Successful competitors are likely to consider calculations for levelized cost of water (LCOW), thermal energy consumption, capital costs, operational costs, recovery ratio, annualized solar-to-desalination thermal efficiency, and impact on the environment, and make a comparison to the state of the art. The technical guidance on the website (<https://americanmadechallenges.org/solardesalination/tech>) includes detailed considerations that competitors should take into account as they develop their performance metrics.

A solar-thermal desalination system's design is highly dependent on the type of water it will be used to treat, the available solar resource, and the required quality of the fresh water produced. The following table summarizes the key conditions competitors should consider when designing their prototype. The reviewers will also consider proposed alternative markets and identified commercial opportunities not shown in this table.

For each of these scenarios, competitors must make reasonable assumptions for solar resource, throughput, and grid connectivity.

Proposals for seawater applications must explain how they will be competitive with RO, which is relatively inexpensive and energy-efficient, and where concentrate minimization is typically not

important. The plan for disposing the concentrate that results from the desalination process is extremely important.

*Note: As specified in the program goal requirements, the prize does not target desalination technologies that are primarily electrically powered. For example, photovoltaic-powered RO is not of interest.*

**Table 2 – Potential Markets & Key Design Criteria for Solar-Thermal Desalination Systems**

	Input Water Quality	Output Water Quality Standard	Managing Concentrate (Salt and Particles)	Solar Resource
<b>Oil/Gas Product Water</b>	Often very high saline, up to 300,000 ppm	Usable for potable systems; Environmental Protection Agency requirements for surface discharge	High value for ZLD or minimizing concentrate to reduce disposal costs	Potentially high, particularly in California, New Mexico, and Texas
<b>Seawater for Potable Water Systems</b>	30-40,000 ppm	Municipal drinking water	Minimization typically not important	Typically lower than inland applications but potentially high in states like California, Texas, and Florida
<b>Seawater for Industrial Applications</b>	30-40,000 ppm	Not restricted by municipal drinking water requirements, but may have unique requirements depending on industrial process	Minimization typically not important	Typically lower than inland applications, but potentially high in states like California, Texas, and Florida
<b>Brackish Water for Municipal Use: Managing RO Concentrate for Inland Applications</b>	~60,000 ppm (rejected brine from RO)	Municipal drinking water	Minimization extremely important; solar-thermal desalination will probably be used after an initial RO process to minimize disposal costs	Potentially high, particularly in the Southwest
<b>Inland Brackish Water for Industrial Applications</b>	~60,000 ppm (rejected brine from RO)	Not restricted by municipal drinking water requirements, but may have unique requirements depending on industrial process	Minimization extremely important; solar-thermal desalination will probably be used after an initial RO process to minimize disposal costs	Potentially high, particularly in the Southwest

## 6. COMPETITOR ELIGIBILITY

To compete in this contest, competitors must comply with the eligibility requirements below. Eligibility is subject to verification before prizes are awarded. The registered competitor is the individual or entity that registers to compete in HeroX.

- For the Innovation contest, private entities (for-profits and nonprofits) academic institutions, and individuals can compete subject to the following requirements:
  - An individual prize competitor (who is not competing as a member of a group) must be a United States citizen or a permanent resident.
  - A group of individuals competing as one team may win, provided that registered competitor is a United States citizen or a permanent resident.
- For the Teaming, Design, and Test contests, the submission must be submitted by an entity (non-profit, for-profit or academic institution) that is formed in and maintains a primary place of business in the United States with majority domestic ownership and control.<sup>9</sup> Teams do not need to be incorporated under the same entity; teams can be comprised of multiple entities, including individuals.<sup>10</sup>
  - To be eligible to submit a Teaming contest submission, the team must include at least one competitor that was selected as a winner of the Innovation contest. Competitors selected as a winner of the Innovation contest include any team members or partners listed on a selected submission's cover page.
  - Only competitors who win the Teaming contest can compete in the Design contest.
  - Only competitors who win the Design contest can compete in the Test contest.
- For all contests:
  - Private entities must be incorporated in and maintain a primary place of business in the United States with majority domestic ownership and control.
  - If a private entity seeking to compete does not have domestic ownership and control, EERE may consider issuing a waiver of that eligibility requirement where the entity: submits a compelling justification; demonstrates the entity is incorporated in and maintains a primary place of business in the United States; and the entity otherwise meets the eligibility requirements. Entities seeking a waiver should include a

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<sup>9</sup> EERE will consider issuing a waiver of the domestic ownership and control eligibility requirement. See Section VI.17 for details.

<sup>10</sup> The entity that completes and uploads the submission package to HeroX would receive the prize payment and be responsible for the distribution of funds to other team members, if applicable.

justification along with their submission. EERE may require additional information before making a determination on the waiver request. There are no rights to appeal DOE's decision on the waiver request. See Section VI.17 for details and instructions on seeking a waiver.

- Academic and non-federal government entities must be based in the United States.
- Individuals who worked at DOE (federal employees or support service contractors) within six months prior to the submission deadline of any contest are not eligible to participate in any prize contests in this program.
- Non-DOE federal entities and federal employees are not eligible to win any prize contests in this program.
- Employees of an organization that co-sponsors this program with DOE are not eligible to participate in any prize contests in this program.
- NREL employees directly involved in administration of this prize are not eligible to participate in any prize contest in this program; however, NREL and other National Laboratory employees, including laboratory researchers, may participate. They can also win a prize contest, provided they are not competing in their official capacity.
- Entities and individuals publicly banned from doing business with the U.S. government such as entities and individuals debarred, suspended, or otherwise excluded from or ineligible for participating in Federal programs are not eligible to compete.
- Entities identified on a Department of Homeland Security (DHS), Binding Operational Directives (BOD) as an entity publicly banned from doing business with the United States government are not eligible to compete. See <https://cyber.dhs.gov/directives/>.
- Entities and individuals identified as a restricted party on one or more screening lists of Department of Commerce, State and the Treasury are not eligible to compete. See Consolidated Screening List.
- This prize competition is expected to positively impact U.S. economic competitiveness. Participation in a foreign government talent recruitment program<sup>11</sup>

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<sup>11</sup> Foreign government talent recruitment program is defined as an effort directly or indirectly organized, managed, or funded by a foreign government to recruit science and technology professionals or students (regardless of citizenship or national origin, and whether having a full-time or part-time position). Some foreign government-sponsored talent recruitment programs operate with the intent to import or otherwise acquire from abroad, sometimes through illicit means, proprietary technology or software, unpublished data and methods, and intellectual property to further the military modernization goals and/or economic goals of a foreign government. Many, but not all, programs aim to

could conflict with this objective by resulting in unauthorized transfer of scientific and technical information to foreign government entities. Therefore, individuals participating in foreign government talent recruitment programs of foreign countries of risk are not eligible to compete. Further, teams that include individuals participating in foreign government talent recruitment programs of foreign countries of risk<sup>12</sup> are not eligible to compete.

- As part of your submission to this prize program, you will be required to sign the following statement:

I am providing this submission package as part of my participation in this prize. I understand that I providing this submission to the Federal Government. I certify under penalty of perjury that the named competitor meets the eligibility requirements for this prize competition and complies with all other rules contained in the Official Rules document. I further represent that the information contained in the submission is true and contains no misrepresentations. I understand false statements or misrepresentations to the Federal Government may result in civil and/or criminal penalties under 18 U.S.C. § 1001 and § 287.

- Program Goal Eligibility Requirements - Only submissions relevant to the goals of this program are eligible to compete. DOE will review all submissions to ensure that the following statements are **true**:
  - The proposed solution is relevant to solar-thermal desalination.
  - The proposed desalination technology is primarily driven by thermal energy; electricity is not the primary driver of the desalination process.
  - The proposed solution represents an innovation that will move the industry beyond its current state.
  - The proposed solution is not dependent on new, pending, or proposed federal, state, or local government legislation, resolutions, appropriations, measures, or policies.
  - The proposed solution does not involve the lobbying of any federal, state, or local government office.

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incentivize the targeted individual to physically relocate to the foreign state for the above purpose. Some programs allow for or encourage continued employment at U.S. research facilities or receipt of Federal research funds while concurrently working at and/or receiving compensation from a foreign institution, and some direct participants not to disclose their participation to U.S. entities. Compensation could take many forms including cash, research funding, complimentary foreign travel, honorific titles, career advancement opportunities, promised future compensation, or other types of remuneration or consideration, including in-kind compensation.

<sup>12</sup> Currently, the list of countries of risk includes Russia, Iran, North Korea, and China.

- The proposed solution is based on fundamental technical principles and is consistent with a basic understanding of the U.S. market economy.
- Submission content sufficiently confirms the competitor's intent to commercialize early-stage technology and establish a viable U.S.-based business in the near future.

## 7. AMERICAN-MADE NETWORK

The American-Made Challenges: Solar Desalination Prize will tap into and expand the American-Made Network<sup>13</sup> consisting of National Laboratories, energy incubators, and other resources across the nation to provide expertise to Solar Desalination Prize competitors. Teams can use the Network for assistance with prototyping, business plans, and connections to testing facilities and other partners.

The American-Made Network will cultivate resources and build connections that enhance, accelerate, and amplify the competitors' efforts. The objective is to link participants with ideas, people, resources, financing, and relevant industry expertise, all of which are necessary for long-term success.

The Network is comprised of the following elements:

1. **Prize and Network Administrator: National Renewable Energy Laboratory:** The DOE has partnered with NREL to administer the Solar Desal Prize. NREL will help competitors locate and leverage the vast array of National Laboratories and program resources available to the Solar Desal Prize. NREL will also connect elements of the network with the competitors, as described below.
2. **Vouchers:** Selected competitors in the Teaming and Design contests will receive vouchers that they may use to fund work at National Laboratories and other approved facilities to accelerate the production, improvement, or validation of prototypes. Entities interested in helping the selected competitors through the voucher program can visit the following site for details: <https://americanmadechallenges.org/solardesalination/vouchers>.
3. **Connectors:** Connectors are entities that identify, recruit, and support competitors, including helping them navigate the innovation process. Connectors can be incubators, universities, think tanks, test facilities, industry groups, or any enabler seeking to help competitors win by performing support activities, such as:
  - Attracting a diverse range of talented individuals and teams to become contest competitors.

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<sup>13</sup> <https://americanmadechallenges.org/solardesalination/network>

- Providing resources and tools to help competitors refine their innovations, develop business plans, work with mentors, identify sites for their prototype solar desalination facility, connect with investors and industry partners, and reduce technology and business risks.
- Raising non-federal funding to support this program and its participants.
- Connecting competitors to regional prototyping and desalination expertise, facilities, and experts.

Connectors who support participants that go on to win any of the contests will be financially rewarded based on the table below.

**Table 3 – Connector Funding**

Reward Name	Award Amount	Total Amount Available	Details
Test Site	\$10,000	\$100,000 pool	Distributed to Connectors for recruiting new test site facilities that are not already part of the network and are capable of, and interested in, hosting a prototype solar desalination facility
Recruiting	\$5,000	\$100,000 pool	Distributed to Connectors for recruiting new competitors for the Innovation contest who have not previously applied for funding from SETO in the past three years
Team	\$5,000	\$100,000 pool	Distributed to Connectors who find team members who become part of a winning Teaming contest submission
Partner	\$25,000	\$100,000 pool	Distributed to Connectors who find a commercial partner and/or private funding that is incorporated into a winning Test contest submission

Competitors and expert submission reviewers in any given round cannot also be Connectors for that round. If a Connector formally joins a team, they forgo any financial incentive and recognition payment as a Connector for that round.

Entities interested in participating as a Connectors can visit the following site for details: <https://americanmadechallenges.org/solardesalination/network>.

4. **Power Connectors:** Some Connectors may be selected to play a more substantial role in the competition and receive funds to expand and amplify DOE and NREL’s efforts. Each selected Power Connector will be eligible to receive a contract with NREL. Not only will these stakeholders work to identify talent and support participants in the contests; they will also partner with NREL to envision and execute a long-term, sustainable strategy for scaling the impact of the Solar Desal Prize. Power Connectors are ineligible for all recognition awards. Power Connectors will be rewarded for efforts that:

- Increase the number of new, high-quality competitors;
- Expand the network of partners, resources, and tools;
- Increase the number of entities partnering with competitors;
- Produce engaging and well-attended national events as needed by the program;
- Expand the scope of solar desalination technological challenges addressed by the program;

Entities interested in participating as Power Connectors can visit the following site for details:

<https://americanmadechallenges.org/solardesalination/network>.

## 8. HOW TO ENTER

Submission packages should be completed and submitted before each contest's closing date listed in Section I.4 at <https://www.herox.com/SolarDesalination>.

## 9. ADDITIONAL TERMS AND CONDITIONS

See [Section VI](#) for additional requirements. Competitors that do not comply with the additional requirements in [Section VI](#) may be disqualified.

## II. INNOVATION CONTEST RULES & REQUIREMENTS

### 1. INTRODUCTION

The Innovation contest is the first in the four-contest Solar Desal Prize. The Solar Desal Prize is a series of contests to design, develop, and demonstrate desalination systems that use solar-thermal energy to generate fresh water from salt water or wastewater. The produced fresh water can be used for drinking water, agricultural and industrial uses, or low-cost surface discharge. The following rules are for competitors in the Innovation contest. “You” and “your” refer to competitors in the contest.

#### INNOVATION Contest Prizes

Each winner receives \$50,000 cash and an invitation to participate in the Teaming Contest.

### 2. GOAL

Identify impactful technology innovations that will likely result in a successful operational prototype of a solar-thermal desalination system.

### 3. PRIZES

Competitors who win the Innovation contest will receive cash prizes of \$50,000, access to the American-Made Network, an invitation to participate in a teaming event, and the ability to compete in the Teaming contest. Winners of this contest will be referred to as quarterfinalists.

### 4. HOW TO ENTER

Complete a submission package online at <https://www.herox.com/SolarDesalination> before the contest closing date listed in Section I.4.

### 5. CONTEST PROCESS

The Innovation contest consists of four steps:

1. **Preparation and Submission** – Competitors identify and describe an impactful innovation that can be incorporated into an operational prototype of a solar-thermal desalination system. Additional emphasis in Round 2 is placed on innovations related to energy storage or solar collectors that support solar desalination. Competitors are also encouraged to engage the American-Made Network<sup>14</sup> to gain help and support in developing their submissions. Finally,

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<sup>14</sup> The Prize Administrator has dedicated approximately \$400,000 to recognize members of the American-Made Network who help competitors advance through all four contests.

competitors must complete their submission package by the posted deadline to be considered for a prize.

2. **Assessment** – Submissions will be assessed, scored, and selected based on the following concepts:<sup>15</sup>
  - a. **Novel** – This contest seeks innovations that apply to solar-thermal desalination technology. Innovative new thermal desalination technologies are welcome, as are ideas and innovations that integrate solar heat into existing thermal desalination technologies. Emphasis is placed on innovations related to energy storage or solar collectors that support solar desalination. This contest will accept ideas ranging from innovations that apply to individual components of a solar desalination system to a complete, novel solar desalination system.
  - b. **Technically Feasible** – Submissions should identify credible engineering pathways to advance the proposed solution to an operational prototype. The submission must adequately describe a sound understanding of the innovation’s fundamental physical principles.
  - c. **Impactful** – The proposed solution should enable key performance enhancements or cost targets that will advance the technology toward broad commercial adoption of solar-thermal desalination.
3. **Announcement** – Approximately two months after the Innovation contest closes, the Prize Administrator will notify all competitors with the results of the review and request the necessary information to distribute cash prizes to the quarterfinalists. The Prize Administrator will then publicly announce the quarterfinalists, who will continue to develop their solutions and build their team in the Teaming contest.

## 6. WHAT TO SUBMIT

A complete submission package for the Innovation contest should include the following:

- 90-second video (publicly accessible online)
- Cover page, including a team name
- Technical narrative providing answers to three questions explaining how your innovation is *novel, technically feasible, and impactful*
- Summary PowerPoint slide (publicly accessible)
- Letters of commitment or support (optional)

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<sup>15</sup> The Prize Administrator will screen all completed submissions and assign subject-matter-expert reviewers to independently score the content of each submission. Reviewers will be DOE staff, contractors, and, potentially, independent reviewers from industry and academia. Final selections will be determined by the prize judge.

### Online public video – What is your innovation, in 90 seconds?

#### Suggested content:

- Your proposed idea
- How your idea works
- Why your idea is innovative
- Who you are and why you have a competitive edge

Post your publicly accessible video online (e.g., YouTube, Vimeo, etc.). Be creative and produce a video that conveys the required information in interesting ways, but do not focus on time-consuming elements that improve only production values (e.g., décor, lighting, cinematic techniques). The American-Made Network may be able to help you create your video.

### Cover page – List basic information about your submission

- Project title
- Team name
- Short description
- Link to your 90-second video online
- Key project members (names, contacts, and, if possible, links to their LinkedIn profiles)
- Keywords that best describe your solution (e.g., *heat exchanger, heat transfer fluid, solar collector design*)
- Your city, state, and 9-digit zip code
- If applicable, up to three Connectors<sup>16</sup> that significantly helped you advance your solution and the major items with which they helped. Include a short description of the assistance provided. Connectors may receive financial recognition for helping competitors succeed.
  - Other partners (if any)

You should answer each of the following three questions. The content bullets are only suggestions to guide your responses; you decide where to focus your answers. Responses to these questions must not exceed 2,500 words in total. You may include images, figures, or graphs in the narrative. Content that is over the word or time limit will not be reviewed.

Reviewers will score your narrative based on the content you have provided, as well as your video submission. Reviewers and the prize judge will evaluate submissions by agreeing or disagreeing with assigned statements on a 1-6 scale, as shown below.

1	2	3	4	5	6
strongly disagree	disagree	slightly disagree	slightly agree	agree	strongly agree

<sup>16</sup> See description of Connector in I. Program Summary

## Technical Narrative

**Question 1: *Novel*** - Does your submission describe a novel solution that can deliver desalinated water using solar-thermal energy?

### Suggested content:

- Describe how your proposed solar-thermal technology will function, highlighting how it represents an innovation beyond existing thermal desalination technology, *or*
- Describe how your idea will use solar heat and integrate novel technology into an existing thermal desalination system.
- Describe why your idea is innovative. Highlight cost reduction and performance enhancements over state-of-the-art thermal desalination technology.

### Each statement is scored on a 1-6 scale.

- The competitor's innovation represents a significant advancement in solar-thermal desalination technology.
- The competitor's innovation will contribute to the successful operation of an innovative prototype solar-thermal desalination system.
- The competitor's innovation has a high likelihood of reducing cost and/or increasing the performance of solar-thermal desalination technology.

**Question 2: *Technically Feasible*** – Is your solution technically feasible?

### Suggested content:

- Describe the key technical aspects of your innovation and how it is thermodynamically valid, including heat and mass balances, as relevant.
- Describe the supporting body of knowledge that provides confidence that an engineering pathway exists to arrive at a product that reduces cost and enhances performance of solar thermal desalination technology.
- Describe the critical technical accomplishments needed to retire risks for your idea to contribute to an operational prototype of a solar-thermal desalination system.

### Each statement is scored on a 1-6 scale.

- The submission presents a technically valid concept (thermodynamically accurate) that is well supported and based on reasonable assumptions and lessons learned from other notable efforts in this space.
- The submission outlines appropriate technical milestones that need to be accomplished for this idea to be incorporated into an operational prototype.
- The stated goals are ambitious, reduce risks, and show a commitment to an accelerated development cycle.
- Meeting the stated goals will demonstrate critical progress toward developing, testing, and validating the functionality and market demand of this innovation.

**Question 3: *Impactful*** – Will your proposed solution be impactful?

**Suggested content:**

- Describe how your proposed solution will enable performance improvements or cost reductions that will advance solar-thermal desalination toward broad commercial adoption.

**Each statement is scored on a 1-6 scale.**

- The solution represents a notable improvement over existing state-of-the-art competing technologies and will attract interest from investors, customers, and commercial partners.
- This innovation should be strongly considered for an Innovation contest prize (score only a 1 or a 6).

**PowerPoint Summary Slide (to be made public)**

Create a public-facing one-slide submission summary that contains technically specific details but can be understood by a nontechnical audience. There is no template, so you may present the information as you see fit. Please make any text readable for a standard printout and conference-room projection.

**Letters of Commitment or Support (optional)**

Attach one-page letters of support, intent, or commitment from relevant entities (e.g., potential users of the proposed innovation) to provide context. Letters of support from partners or others that are critical to the success of your proposed solution may increase your chances of winning. General letters of support from parties that are not critical to the execution of your solution will likely not impact selection of your submission. Please do not submit multipage letters.

## 7. HOW WINNERS ARE DETERMINED – INNOVATION CONTEST

**Expert Reviewer Panel Scoring:** Submissions will be scored as follows:

Each bullet point listed in the review criteria for the three questions will receive a score from 1 to 6. The bullet points have equal weight, so questions that have more bullets have a greater influence on the final score. The final score from an individual expert reviewer equals the sum of the scores for all the bullets. All reviewers' scores will be averaged for a final reviewer score for the submission package. The prize judge will consider reviewer scores when determining the winners.

Expert reviewers will also provide comments on submissions. The Prize Administrator intends to provide comments to competitors after the winners of the Innovation contest are announced. These comments are intended to help competitors continue to improve and iterate on their submissions. The comments are the opinions of the expert reviewers and do not represent the opinions of the DOE.

**Interviews:** The Prize Administrator, at its sole discretion, may decide to interview some of the Innovation contest competitors. The interviews would be held before the winners are announced and would serve to help clarify questions the judge may have. Participating in interviews is not required. Being contacted for an interview is not an indication of winning.

**Final Determination:** The judge's final determination of Innovation contest winners will take into account reviewer scores, interview findings (if applicable), and program policy factors listed in [Section VI – Additional Terms & Conditions](#).

**Announcement:** After the contest closes, the Prize Administrator notifies the selected winners and requests the necessary information to distribute cash prizes. The Prize Administrator will then publicly announce the winners as quarterfinalists.

## 8. WHO CAN WIN

To win the Innovation contest, competitors must comply with the following requirements.

- By uploading a submission package, a competitor certifies that they comply with the participant eligibility requirements in [Section I – Program Summary](#). As soon as the Prize Administrator becomes aware that a competitor is not eligible to win the Innovation contest, the competitor may be disqualified.
- A single competitor or team may submit a maximum of three submissions. If more than three submissions are received from a single competitor or team, only the three most recent submissions will be considered.

## 9. FIND HELP

Visit <https://americanmadechallenges.org/solardesalination/network> to review and contact members of the American-Made Network that have signed up to help competitors succeed.

## 10. ADDITIONAL REQUIREMENTS

Please read and comply with additional requirements in [Section VI – Additional Terms & Conditions](#). Competitors who do not comply with these requirements in [Section VI](#) may be disqualified.

# III. TEAMING CONTEST RULES & REQUIREMENTS

## 1. INTRODUCTION

The Teaming contest is the second in the four-contest Solar Desal Prize. The Solar Desal Prize is a series of contests to design, develop, and demonstrate desalination systems that use solar-thermal energy to generate fresh water from salt water or wastewater. The produced fresh water can be used for drinking water, agricultural and industrial uses, or low-cost surface discharge. The following rules are for competitors in the Teaming contest. “You” and “your” refer to competitors in the contest.

### TEAMING Contest Prizes

Each winner receives \$250,000 cash and a \$100,000 voucher, and an invitation to participate in the Design Contest.

## 2. GOAL

Identify cross-functional teams that can develop and successfully validate an operational prototype of a solar-thermal desalination system.

## 3. PRIZES

Competitors who win the Teaming contest will receive cash prizes of \$250,000, a \$100,000 voucher to use at National Laboratories and/or qualified partner facilities to further develop their solution, access to the American-Made Network, and the ability to compete in the Design contest. Winners of this contest will be referred to as semifinalists.

## 4. HOW TO ENTER

Complete a submission package online at <https://www.herox.com/SolarDesalination> before the contest closing date listed in Section I.4.

## 5. CONTEST PROCESS

The Teaming contest consists of three steps:

1. **Advance the Technology, Team Building, and Submission** – Competitors develop a transformative solution pathway for their solar-thermal desalination innovation and form an expert team to make the idea a reality. Competitors may also engage the American-Made

Network for help and support.<sup>17</sup> Finally, competitors complete their submission packages and submit them online before the Teaming contest closes.

2. **Teaming Event** – All quarterfinalists will be invited to attend an event to showcase their submissions. The purpose of this event is to provide a space where technology developers can connect with potential team members, test facilities/testing locations, investors, and end users of solar-thermal desalination technology. When the Teaming Contest launches, the Prize Administrator will indicate whether this event will be held virtually or in-person.
3. **Assessment** – Submissions will be assessed, scored,<sup>18</sup> and selected based on the following concepts:
  - a. **Team** – Competitors must assemble a team that includes the necessary experience, expertise, and access to resources required to develop the proposed technology concept into an operational prototype of a solar-thermal desalination system.
  - b. **Impact** – Competitors should include an LCOW analysis, work scope, and schedule that is based on reasonable assumptions and would generate interest from potential commercial end users.
  - c. **Target Performance Metrics** – Competitors should refer to the Solar Desal Prize website for technical requirements and describe technical goals that are aggressive but achievable and will significantly advance the state of the art. These metrics may include but are not limited to:
    - Calculated levelized cost of water (LCOW)
    - Thermal energy consumption
    - Capital cost estimate
    - Operating cost estimate
    - Recovery ratio
    - Annualized solar-to-desalination thermal efficiency
  - d. **Planning and Documentation** – Competitors must demonstrate their ability to develop an operational prototype of a solar-thermal desalination system by showing a comprehensive understanding of the documentation requirements and approvals necessary for construction or system installation. This should include a preliminary schedule and a summary of all required permits, schematics, equipment lists, and process diagrams.

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<sup>17</sup> The Prize Administrator has dedicated approximately \$400,000 to recognize members of the American-Made Network who help competitors advance through the contests.

<sup>18</sup> The Prize Administrator will screen all completed submissions and assign subject-matter-expert reviewers to independently score the content of each submission. Reviewers will be DOE staff, contractors, and, potentially, independent reviewers from industry and academia. Final selections will be determined by the prize judge.

4. **Announcement** – Approximately two months after the contest closes, the Prize Administrator notifies all competitors with the results of the review and request the necessary information to distribute cash prizes to the semifinalists. The Prize Administrator will then publicly announce the selected teams. Those teams will be encouraged to develop their solutions in accordance with their plan to compete in the Design contest.

## 6. WHAT TO SUBMIT

A complete submission package for the Teaming contest should include the following items:

- 90-second video (publicly accessible)
- Cover page
- Technical narrative providing answers to four questions about your *team, impact, target performance metrics, and planning and documentation*
- Environmental Questionnaire 1
- Summary PowerPoint slide (publicly accessible)
- Résumés
- Technical assistance request (publicly accessible)
- Letters of commitment or support (optional)

**Online public video** – Describe your team and why it will be successful in 90 seconds.

**Suggested content:**

- Introduce your team
- Introduce your end user
- Show how your technology will help your end user
- Details about the team and why it will be successful

Post your publicly accessible video online (e.g., YouTube, Vimeo, etc.). Be creative and produce a video that conveys the required information in exciting and interesting ways, but do not focus on time-consuming elements that improve only production values (e.g., décor, lighting, and cinematic techniques). The American-Made Network may be able to help you create your video.

### Cover page – List basic information about your submission

- |   |  |
|---|--|
| <ul style="list-style-type: none"><li>• Project title</li><li>• Short description</li><li>• Link to your 90-second video online</li><li>• Key project members<br/>(names, contacts, and, if possible, links to their LinkedIn profiles)</li></ul> | <ul style="list-style-type: none"><li>• Keywords that best describe your solution (e.g., <i>heat exchanger</i>, <i>heat transfer fluid</i>, <i>solar collector design</i>)</li><li>• Your city, state, and 9-digit zip code</li><li>• If applicable, up to three Connectors<sup>19</sup> that significantly helped you advance your solution and the major items with which they helped. Include a short description of the assistance provided. Connectors may receive financial recognition for helping competitors succeed.</li><li>• Other partners (if any)</li></ul> |
|---|--|

You should answer each of the following four questions. The content bullets are only suggestions to guide your responses; you decide where to focus your answers. Responses to these questions must not exceed 5,000 words in total. You may also include supporting images, figures, or graphs in the narrative. The reviewers will score the questions based on the content you have provided in your submission package. Content that is over the word, time, or page limit will not be reviewed.

Reviewers and the prize judge will evaluate submissions by agreeing or disagreeing with assigned statements on a 1-6 scale, as shown below.

1	2	3	4	5	6
strongly disagree	disagree	slightly disagree	slightly agree	agree	strongly agree

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<sup>19</sup> See description of Connector in [Section I – Program Summary](#).

## Technical Narrative

**Question 1: *Team*** – Does the team have the necessary experience, expertise, and access to resources required to develop an operational prototype of a solar-thermal desalination system?

### Suggested content:

- Introduce your team, explain how it came together, and highlight the knowledge and skills that make it uniquely capable of achieving success.
- Demonstrate that your team has the required expertise and access to resources that will be needed for success.
- Detail the location options for installing the prototype, including the capabilities of each location and the status of your communications with location managers about this project.
- Describe your end users, their water needs, and details of your interactions with them about this project to date.
- Describe key components you will need from vendors and details of your interactions with them to date.

### Each statement is scored on a 1-6 scale.

- The background, experience, and track record of this team are well matched to address the tasks required to develop an operational prototype of a solar-thermal desalination system.
- The team has identified and engaged one or more test facilities that have the capability and interest to host an operational prototype of a solar-thermal desalination system.
- The team has identified the necessary vendors to provide the key components for the proposed operational prototype.
- The team has adequately engaged with end users to ensure the proposed technology will be relevant, useful, and meet a commercial need.

**Question 2: *Impact*** – Will your LCOW analysis, work scope, and schedule generate interest from potential commercial end users?

### Suggested content:

- Describe how your proposed solution will enable commercially relevant outcomes for specific end users.
- Describe how your proposed solution represents performance improvements or cost reductions over existing commercial products, solutions, or technologies.
- Describe the projected LCOW for your proposed solution, including a summary of the expected costs for materials, fabrication, construction, and operation of the full-scale, commercial solution.
- Identify potential markets and a pathway to commercialization for the innovation.

### Each statement is scored on a 1-6 scale.

- The solution represents a significant improvement over existing state-of-the-art competing technologies sufficient to attract interest from investors, customers, and commercial partners.
- The team has identified a commercial end use where the technology is relevant, well-suited to the technical need, and represents a meaningful advancement over the state of the art.
- This innovation should be strongly considered for a Teaming contest prize (score only a 1 or a 6).

**Question 3: Target Performance Metrics** – Are your technical goals both aggressive and achievable, and will they significantly advance the state of the art?

**Suggested content:**

- Describe the technical milestones that need to be accomplished to develop an operational prototype of a solar-thermal desalination system. Please provide specific, measurable, achievable, relevant, and timely (SMART) outcome-based goals, so that a neutral third party can validate them (if possible). For example:
  - Technical milestones should describe a definitive achievement of progress (e.g., “achieved X% efficiency”);
  - Technical milestones should **not** describe work activities such as drafting reports, talking to customers, or performing experiments.
- Define the values for the performance metrics that will be tested by the operational prototype system and why they are relevant to the target commercial end user.

**Each statement is scored on a 1-6 scale.**

- The submission accurately outlines the technical milestones that need to be accomplished for this project to be successful.
- The proposed performance metrics and technical milestones are ambitious relative to the state of the art, reduce technology risk, and can be realistically achieved by the proposed technology.

**Question 4: Planning & Documentation** – Does the submission include high-quality plans, schedules and other necessary documents?

**Suggested content:**

- Provide a comprehensive list of tasks and a list of required engineering documents needed to install an operational prototype of a solar-thermal desalination system at a proposed test location. Include detailed schematics, equipment lists, and process diagrams.
- Provide preliminary drafts of your designs, cost estimates, engineering and construction drawings, and schedule, as appropriate, including justification of engineering strategies to show that you have the expertise and experience to complete the proposed operational prototype.
- Provide a summary of all permits, approvals, and contracts necessary to install and operate the prototype system, and a preliminary schedule to finalize those documents.
- Present projections of commercial impacts that the innovation might have against competing technologies

**Each statement is scored on a 1-6 scale.**

- The submission package provides confidence that an engineering pathway exists to install and operate the proposed prototype while meeting its target performance metrics.
- The submission package provides confidence that a permitting and approval pathway exists to install and operate the proposed prototype while meeting its target performance metrics at a proposed test site.

**PowerPoint Summary Slide (to be made public)**

Create a public-facing one-slide submission summary that contains technically specific details but can be understood by a nontechnical audience. There is no template, so feel free to present the information as you see fit. Please make any text readable for a standard printout and conference-room projection.

**Letters of Commitment or Support (optional)**

Attach one-page letters of support, intent, or commitment from other relevant entities (e.g., potential users of the proposed innovation) to provide context. Letters of support from partners or others that are critical to the success of your proposed solution may increase your chances of winning. General letters of support from parties that are not critical to the execution of your solution will likely not impact selection of your submission. Please do not submit multipage letters.

### Résumés

Please provide two-page résumés for all key project contributors. There is no limit on the number of résumés you may submit. Résumés longer than two pages will not be reviewed.

### Environmental Questionnaire 1

Completing the Environmental Questionnaire (EQ-1) will provide detailed information about your proposed project. The information in the EQ-1 is required for the DOE National Environmental Policy Act (NEPA) review. You may download the EQ-1 instructions and Environmental Questionnaire on the HeroX website under the “resources” tab.

### Technical Assistance Request (two pages, including images, to be made public)

Provide a two-page description of the unique challenges that a National Lab, private facility, and/or member of the American-Made Network might help you resolve if you advance to the Design contest. The Prize Administrator will make this request broadly available so members of the American-Made Network can understand your needs and assist you through the voucher program or otherwise.

## 7. HOW WINNERS ARE DETERMINED – TEAMING CONTEST

**Expert Reviewer Panel Scoring:** Submissions will be scored as follows:

Each bullet point listed in the review criteria for the three questions will receive a score from 1 to 6. The bullet points have equal weight, so questions with more bullets have a greater influence on the final score. The final score from an individual reviewer equals the sum of the scores for all the bullet points. All reviewers' scores will be averaged for a final reviewer score for the submission package. The prize judge will consider reviewer scores when determining the semifinalists.

Expert reviewers will also provide comments on submissions. The Prize Administrator intends to provide comments to competitors after the semifinalists are announced. These comments are intended to help competitors continue to improve and iterate on their submissions. The comments are the opinions of the expert reviewers and do not represent the opinions of the DOE.

**Interviews:** The Prize Administrator, at its sole discretion, may decide to interview some of the Teaming contest competitors. The interviews would be held before the contest winners are

announced and would serve to help clarify questions the judge may have. Participating in interviews is not required. Being contacted for an interview is not an indication of being selected as a winner.

**Final Determination:** The judge's final determination of winners will take into account reviewer scores, interview findings (if applicable), and program policy factors listed in [Section VI – Additional Terms & Conditions](#).

**Announcement:** After the contest closes, the Prize Administrator notifies winners and requests the necessary information to distribute cash prizes. The Prize Administrator will then publicly announce the winners as semifinalists.

## 8. WHO CAN WIN

To win the Teaming contest, competitors must comply with the participant requirements in [Section I – Program Summary](#). Only competitors who were selected to advance from the Innovation contest may compete in the Design contest. By uploading a submission package, a competitor certifies that they comply with the applicable eligibility requirements. As soon as the Prize Administrator becomes aware that a competitor is not eligible to win this contest, the competitor may be disqualified.

Note: As previously specified in the Participant Eligibility section of the Summary, individuals cannot win the Teaming contest.

## 9. FIND HELP

Visit <https://americanmadechallenges.org/solardesalination/network> to review and contact the members of the American-Made Network that have signed up to help competitors succeed.

## 10. ADDITIONAL REQUIREMENTS

Please read and comply with additional requirements in [Section VI – Additional Terms & Conditions](#). Competitors who do not comply with these requirements in [Section VI](#) may be disqualified.

# IV. DESIGN CONTEST RULES & REQUIREMENTS

## 1. INTRODUCTION

The Design contest is the third in the four-contest Solar Desal Prize. The Solar Desal Prize is a series of contests to design, develop, and demonstrate desalination systems that use solar-thermal energy to generate fresh water from salt water or wastewater. The produced fresh water can be used for drinking water, agricultural and industrial uses, or low-cost surface discharge. The following rules are for competitors in the Design contest. “You” and “your” refer to competitors in the contest.

### DESIGN Contest Prizes

Each winner receives \$750,000 cash and a \$100,000 voucher, and an invitation to participate in the Test Contest.

## 2. GOAL

Competitors will work to complete a detailed design of their proposed prototype that can generate at least 100 m<sup>3</sup> of fresh water per day (see notes below), achieve the cost and performance targets that their end users require, and demonstrate that they are “shovel-ready” for a site in the United States or U.S. territories.

Notes: The intent of specifying 100 m<sup>3</sup> per day of fresh water production as the required capacity is to encourage innovations beyond the lab scale, such that the innovation could be moved to a commercial product as the next logical step for the technology. Given the wide variety of innovations that might be proposed, consider the following guidance:

1. The 100 m<sup>3</sup> of water per day is the rate at which fresh water must be produced at a sustained rate. Teams are not required to produce 100 m<sup>3</sup> of water in a day.
2. If the innovation targets a market where the full-scale commercial version of the innovation has a capacity of less than 100 m<sup>3</sup> per day, then the capacity of the team’s innovation can be limited to the full-scale capacity.

Innovations centered on thermal energy storage or solar collectors for solar desalination systems should be of an approximate size to support a desalination system that produces approximately 100 m<sup>3</sup> per day.

## 3. PRIZES

Competitors that win the Innovation contest will receive cash prizes of \$750,000, a \$100,000 voucher that may be redeemed at National Laboratories and/or qualified partner facilities to further develop their solution, access to the American Made Network, and the ability to compete in the Test contest. Winners of this contest will be referred to as finalists.

## 4. HOW TO ENTER

Complete a submission package online at <https://www.herox.com/SolarDesalination> before the contest closing date listed in Section I.4.

## 5. CONTEST PROCESS

The Design contest consists of three steps:

1. **Plan, Obtain Approvals, Letter of Intent, and Submission** – Competitors develop a pathway to obtain all required documents and approvals to begin making an operational prototype of a solar-thermal desalination system. Competitors may also engage the American-Made Network<sup>20</sup> for support. At least one month prior to submission, competitors must submit a letter of intent to the Prize Administrator documenting that a submission is forthcoming. The letter of intent will allow time for the Prize Administrator to coordinate a review of the submission. Then, once all required documents and approvals are obtained and all barriers to construction are resolved, competitors can submit their submission package. The selected finalists should then be able to immediately begin installing their operational prototype of a solar-thermal desalination system.
2. **Assessment** – Submissions will be assessed, scored,<sup>21</sup> and selected based on the following concepts:
  - a. **Project Readiness** – Provide a complete and convincing package that includes all required documents, quotes, agreements, approvals, proof of adequate funding (excluding the prize), and evidence that all other barriers to installing the operational prototype have been retired. The package must convince a panel of industry experts that the team is ready to begin assembling the system at the identified location as soon as prize funding is awarded.
  - b. **Validated Performance Metrics** – Identify metrics for commercially relevant performance of the proposed system, as well as testing plans to validate the success values of those metrics with the operational prototype. Competitors should demonstrate that the identified metrics have been thoroughly refined and validated by potential end users and will retire the key technical risks of the proposed solar-thermal desalination system. Successful competitors are likely to consider calculations for LCOW, product-water quality, thermal energy consumption, capital costs, operational costs, recovery ratio, annualized solar-to-desalination thermal efficiency, and impact on the environment, and make a comparison to the state of the art.

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<sup>20</sup> The Prize Administrator has dedicated approximately \$400,000 to recognize members of the American-Made Network who help competitors advance through the contests.

<sup>21</sup> The Prize Administrator will screen all completed submissions and assign subject-matter-expert reviewers to independently score the content of each submission. Reviewers will be DOE staff, contractors, and, potentially, independent reviewers from industry and academia. Final selections will be determined by the prize judge.

3. **Announcement** – Approximately one month after the Design contest submission is received, the Prize Administrator will notify the competitor with the results of the review and request the necessary information to distribute cash prizes, if applicable. The Prize Administrator will then publicly announce the winner, who will then begin to install their prototype solar-thermal desalination facility.

## 6. WHAT TO SUBMIT

A complete submission package for the Design contest should include the following items:

- 120-second video (publicly accessible)
- Cover page
- Technical narrative providing answers to two questions about *project readiness* and *validated performance metrics*
- Summary PowerPoint slide (publicly accessible)
- Letters of commitment or support (optional)
- Technical assistance request

### Online public video – What is your innovation, in 120 seconds?

#### Suggested content:

- The real-world problem you have solved that has prevented this solution's existence
- Your solution and why it's transformational
- Who you are and why you have a competitive edge
- An overview of the site at which the operational prototype will be installed, highlighting unique capabilities or features of the location

Post your publicly accessible video online (e.g. YouTube, Vimeo, etc.). Be creative and produce a video that conveys the required information in exciting and interesting ways, but do not focus on time-consuming elements that improve only production values (e.g., décor, lighting, and cinematic techniques). The American-Made Network may be able to help you create your video.

Cover Page – List basic information about your submission	
<ul style="list-style-type: none"> <li>• Project title</li> <li>• Short description</li> <li>• Link to your 120-second video online</li> <li>• Key project members (names, contacts, and, if possible, links to their LinkedIn profiles)</li> </ul>	<ul style="list-style-type: none"> <li>• Keywords that best describe your solution (e.g., <i>heat exchanger, heat transfer fluid, solar collector design</i>)</li> <li>• Your city, state, and 9-digit zip code</li> <li>• If applicable, up to three Connectors<sup>22</sup> that significantly helped you advance your solution and the major items with which they helped. Include a short description of the assistance provided. Connectors may receive financial recognition for helping competitors succeed</li> <li>• Other partners (if any)</li> </ul>

You should answer each of the following two questions. The content bullets are only suggestions to guide your responses; you decide where to focus your answers. Responses to these questions must not exceed 7,500 words in total. You may also include supporting images, figures, or graphs in the narrative. The reviewers will score the questions based on the content you have provided. Content that is over the word limit and time limit will not be reviewed.

Reviewers and the prize judge will evaluate submissions by agreeing or disagreeing with assigned statements on a 1-6 scale, as shown below.

1	2	3	4	5	6
strongly disagree	disagree	slightly disagree	slightly agree	agree	strongly agree

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<sup>22</sup> See description of Connector in [Section I – Program Summary](#).

## Technical Narrative

**Question 1: *Project Readiness*** – Is the solar-thermal desalination prototype system ready and approved to begin installation as soon as the Design contest prize is awarded?

### Suggested content:

- Describe the operational principles of the proposed prototype solar-thermal desalination system and how it de-risks the team's key engineering innovations.
- Provide evidence that you have completed all of the steps necessary to begin installation of an operational prototype of a solar-thermal desalination system that can achieve the cost and performance targets required by identified end users.

*Note: The below documents can be provided as an appendix and are not subject to the word limit.*

- Building permits and all necessary permits of operation (environmental and other);
- Completed NEPA determination
- Proof of sufficient funding to complete the proposed work (funding contingent on prize award is acceptable)
- All documentation required to initiate construction. This may include but is not limited to: construction plans, fabrication drawings, subcontracts (draft), material requisitions (unawarded, if necessary), permits, site surveys, detailed schedules, work-breakdown structures, detailed scope and cost estimates, material procurement plans (including estimated lead times, delivery times, and on-site need dates), construction quantities, start-up and energization plans, and test protocols (with acceptance criteria).
- Key calculations of system performance and engineering design
- Any additional required documentation to support the assertion that the project is ready to begin construction

### Each statement is scored on a 1-6 scale.

- The submission package provides convincing and comprehensive evidence that the team is ready and approved to begin installing the operational prototype system at the identified location as soon as prize funding is awarded.
- The proposed test location is able and has agreed to provide the necessary facility services for the proposed operation of the prototype system, including but not limited to input-water conditions, cooling requirements, discharge capability, and thermal and electrical power.

## Technical Narrative

**Question 2: Validated Performance Metrics** – Has the competitor identified commercially relevant performance metrics and a well-defined testing plan?

### Suggested content:

- Provide performance metrics, including a validation and testing plan, and justify that those metrics are relevant to identified commercial end users and differentiated from the existing state of the art.
- Describe how the values tested by the operational prototype will be extrapolated to commercial systems.
- Provide complete and convincing evidence that, once built, the operational prototype desalination facility, and the associated validation and testing, will provide the results partners need to continue toward broad commercial success. Include the work your team has done over the contest period to support demand for the output of the proposed solution. Identify any potential customers and end users that your team engaged.
- Provide documentation on the status and outcomes of the work funded by the voucher awarded in the Teaming contest and how it improved your likelihood of success.

### Each statement is scored on a 1-6 scale.

- The team has articulated high-quality, industry-relevant performance metrics with testing plans, which provide confidence that the team will assemble an operational prototype of a solar-thermal desalination system that will continue to be developed toward broad commercial impact.
- The proposed testing plan uses solar-thermal energy to drive the desalination process or can realistically simulate the full range of thermal input conditions relevant to a solar-thermal desalination system.
- This innovation should be strongly considered for a Design contest prize (score only a 1 or a 6).

## PowerPoint Summary Slide (to be made public)

Create a public-facing one-slide submission summary that contains technically specific details but can be understood by a nontechnical audience. There is no template, so feel free to present the information as you see fit. Please make any text readable for a standard printout and conference-room projection.

## Letters of Commitment or Support (optional)

Attach one-page letters of support, intent, or commitment from other relevant entities (e.g., potential users of the proposed innovation) to provide context. Letters of support from partners or others that are critical to the success of your proposed solution may increase your chances of winning. General letters of support from parties that are not critical to the execution of your solution will likely not materially impact the selection of your submission. Please do not submit multipage letters.

### Technical Assistance Request (two pages, including images, to be made public)

Provide a two-page description of the unique challenges that a National Laboratory, private facility, and/or member of the American-Made Network could help you resolve if you advance beyond the Design contest. The Prize Administrator will make this request broadly available so members of the American-Made Network can understand your needs and assist you through the voucher program or otherwise.

## 7. HOW WINNERS ARE DETERMINED – DESIGN CONTEST

**Expert Reviewer Panel Scoring:** Submissions will be scored as follows:

Each bullet point listed in the review criteria for the three questions will receive a score from 1 to 6. The bullet points have equal weight, so questions with more bullets have a greater influence on the final score. The final score from an individual reviewer equals the sum of the scores for all the bullets. All reviewers' scores will be averaged for a final reviewer score for the submission package. The prize judge will consider reviewer scores when determining winners of the contest.

Expert reviewers will also provide comments on the submissions. The Prize Administrator intends to provide comments to competitors after the winners are announced. These comments are intended to help competitors continue to improve and iterate on their submissions. The comments are the opinions of the expert reviewers and do not represent the opinions of the DOE.

**Interviews:** The Prize Administrator, at its sole discretion, may decide to interview some of the Design contest competitors. The interviews would be held before the winner is announced and would serve to help clarify questions the judge may have. Participating in interviews is not required. Being contacted for an interview is not an indication of being selected as a winner.

**Final Determination:** The judge's final determination of finalists will take into account reviewer scores, interview findings (if applicable) and program policy factors listed in [Section VI – Additional Terms & Conditions](#).

**Announcement:** After the contest closes, the Prize Administrator notifies the finalists and requests the necessary information to distribute cash prizes. The Prize Administrator will then publicly announce the winners as finalists.

## 8. WHO CAN WIN

To win the Design contest, competitors must comply with the participant eligibility requirements in [Section I – Program Summary](#). Only competitors who won the Teaming contest may compete in the Design contest. By uploading a submission package, a competitor certifies that they comply with the

eligibility requirements. As soon as the prize Administrator becomes aware that a competitor is not eligible to win a contest, the competitor may be disqualified.

## 9. FIND HELP

Visit <https://americanmadechallenges.org/solardesalination/network> to review and contact the members of the American-Made Network that have signed up to help competitors succeed.

## 10. ADDITIONAL REQUIREMENTS

Please read and comply with additional requirements in [Section VI – Additional Terms & Conditions](#). Competitors who do not comply with these requirements in [Section VI](#) may be disqualified.

# V. TEST CONTEST RULES & REQUIREMENTS

## 1. INTRODUCTION

The Test contest is the fourth and final contest in the four-contest Solar Desal Prize. The Solar Desal Prize is a series of contests to design, develop, and demonstrate desalination systems that use solar-thermal energy to generate fresh water from salt water or wastewater. The produced fresh water can be used for drinking water, agricultural or industrial uses, or low-cost surface discharge. In this contest, teams will compete on commercial viability (LCOW, financial merits, etc.), performance (efficiency, capacity, water quality, etc.), and other tangible and intangible benefits (environmental benefits, wastewater reduction, technology development to address niche markets, etc.). The competitors' real-world results will be evaluated against the plans they developed as part of the Innovation, Teaming, and Design contests as well as the performance of their prototype. The following rules are for competitors in the Test contest. "You" and "your" refer to competitors in the contest.

TEST Contest Prizes
The winner receives \$1 million cash.

## 2. GOAL

Validate the successful operation of the solar-thermal desalination system prototype with a capacity of at least 100 m<sup>3</sup> of fresh water per day. Additionally, competitors will secure a binding agreement with a partner to fund the ongoing commercial development of the technology validated by the prototype.

## 3. PRIZES

Winners of the Test contest will receive a cash prize of \$1 million.

## 4. HOW TO ENTER

DOE will accept submissions to the Test Contest once per year on the second Monday of March. Competitors are eligible to provide a submission on or before any of the three Test submission opportunities after they win the Design contest. However, once a team provides a submission, they are no longer eligible to apply to subsequent opportunities.

Test competitors can complete a submission package online at <https://www.herox.com/SolarDesalination> before the contest closing date listed in Section I.4.

## 5. CONTEST PROCESS

The Test contest consists of two steps containing several components:

1. **Complete an operational prototype and submit** – Competitors complete the installation of their solar-thermal desalination innovation. Sixty (60) days prior to the Test contest deadline submission, competitors must submit a letter of intent to the Prize Administrator documenting that a submission will be submitted. The letter of intent will allow time for the Prize Administrator to organize a review panel, schedule travel, and expedite the review and decision process. Competitors then submit their submission package to be considered for the Test prize by the annual deadline.
2. **Assessment** – DOE and/or Prize Administrator staff will attend a test demonstration of the operational prototype and determine whether water samples met or exceeded the validated technical specifications from the Design contest. Submissions will be assessed, scored,<sup>23</sup> and selected based on the following concepts:
  - a. **Successful Testing** – Meet or exceed your testing plan from the Design contest and explain any variances.
  - b. **On-site Demonstration** – Operate the solar-thermal desalination prototype in the presence of representatives from the Prize Administrator and the committed commercialization partner(s).
  - c. **Committed Commercialization Partner** – Demonstrate a firm commitment from a partner to help continue the advancement of your prototype desalination system to the next logical stage of development, with the eventual goal of commercial sales. This could be financial backing of the next stage of technology development, commitment to purchase a product, or investment in the competitor’s organization.
3. **Announcement** – Approximately one month after the site visit, the Prize Administrator will notify all competitors with the results of the review and request the necessary information to distribute cash prizes to the winner. The Prize Administrator will then publicly announce the winner.

*Note: Competitors will be required to deliver a separate final technical report to DOE summarizing the lessons learned and technical accomplishments from all four contests of the Solar Desal Prize.*

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<sup>23</sup> The Prize Administrator will screen all completed submissions and assign subject-matter-expert reviewers to independently score the content of each submission. Reviewers will be DOE staff, contractors, and, potentially, independent reviewers from industry and academia. Final selections will be determined by the prize judge.

## 6. WHAT TO SUBMIT

A complete submission package for the Test contest should include the following items:

- 180-second video (publicly accessible)
- Cover page
- Technical narrative providing answers to three questions related to *successful testing*, *on-site demonstration*, and *committed commercialization partner*
- Summary PowerPoint slide (publicly accessible)
- Letter of commitment (mandatory)
- Letters of Support (optional)
- Final Technical Report

### Online public video – What is your innovation, in 180 seconds?

#### **Suggested content:**

- The real-world problem you have solved that has prevented this solution's existence
- Show your facility operating and provide a summary of the important technical results
- Discuss your commercial partner and the next steps you plan to pursue after winning the Test contest.

Post your publicly accessible video online (e.g. YouTube, Vimeo, etc.). Be creative and produce a video that conveys the required information in exciting and interesting ways, but do not focus on time-consuming elements that improve only production values (e.g., décor, lighting, and cinematic techniques). The American-Made Network may be able to help you create your video.

Cover page – List basic information about your submission	
<ul style="list-style-type: none"> <li>• Project title</li> <li>• Short description</li> <li>• Link to your 180-second video online</li> <li>• Key project members (names, contacts, and, if possible, links to their LinkedIn profiles)</li> </ul>	<ul style="list-style-type: none"> <li>• Keywords that best describe your solution (e.g., <i>heat exchanger, heat transfer fluid, solar collector design</i>)</li> <li>• Your city, state, and 9-digit zip code</li> <li>• If applicable, up to three Connectors<sup>24</sup> that significantly helped you advance your solution and the major items with which they helped. Include a short description of the assistance provided. Connectors may receive financial recognition for helping competitors succeed.</li> <li>• Committed Commercial Partner and Other partners (if any)</li> </ul>

You should answer each of the following three questions. The content bullets are only suggestions to guide your responses; you decide where to focus your answers. Responses to these three questions must not exceed 10,000 words in total. You may also include supporting images, figures, or graphs integrated into the narrative. The reviewers will score the questions based on the content you have provided in your narrative and your video submission. Content that is over the word or time limit will not be reviewed.

Reviewers and the prize judge will evaluate submissions by agreeing or disagreeing with assigned statements on a 1-6 scale, as shown below. These statements are the criteria.

1	2	3	4	5	6
strongly disagree	disagree	slightly disagree	slightly agree	agree	strongly agree

<sup>24</sup> See description of Connector in [Section I – Program Summary](#).

<b>Technical Narrative</b>	
<b>Question 1: <i>Successful Testing</i></b> – Does the competitor show they have met or exceeded their testing plan from the Design contest, and did they include detailed explanation of any variances?	
<p style="text-align: center;"><b>Suggested content:</b></p> <ul style="list-style-type: none"> <li>• Include a detailed description of the results of the testing plan that was provided as part of your Design contest submission. Explain and justify any process changes or performance deviations from the original performance targets and testing plan.</li> <li>• Compare the performance of the hypothetical full-scale effort (e.g., LCOW, thermal energy consumption in kWh/m<sup>3</sup>, capital costs, operating costs, recovery ratio, annualized solar to desalination thermal efficiency) against the full-scale estimate, after considering test results.</li> <li>• Justify that the validated performance of the developed technology will have a high-impact on U.S. water security challenges.</li> </ul>	<p style="text-align: center;"><b>Each statement is scored on a 1-6 scale.</b></p> <ul style="list-style-type: none"> <li>• The competitor has met or exceeded the testing plan from the Design contest.</li> <li>• Deviations from the original performance targets and testing plan are justified and show relevance to a high-impact commercial end use targeted by the competitor.</li> </ul>

<b>Technical Narrative</b>	
<b>Question 2: <i>On-site Demonstration</i></b> – Does the operation of the solar-thermal desalination prototype in the presence of representatives from the Prize Administrator and the committed partner(s) show the facility meets or exceeds all critically technical goals?	
<p style="text-align: center;"><b>Suggested content:</b></p> <ul style="list-style-type: none"> <li>• Provide a detailed site-visit agenda that will allow the Prize Administrator and expert reviewers to observe the critical aspects and performance of the prototype solar-thermal desalination facility.</li> <li>• Provide an update on the status and outcomes of the work funded by the voucher awarded in the Teaming and the Design contests.</li> </ul>	<p style="text-align: center;"><b>Each statement is scored on a 1-6 scale.</b></p> <ul style="list-style-type: none"> <li>• The proposed site-visit agenda shows the competitor has confidence in the performance of their system and allowed the Prize Administrator and expert reviewers to observe the critical aspects and performance of the prototype solar-thermal desalination facility.</li> </ul>

## Technical Narrative

**Question 3: *Committed Commercialization Partner*** – Has the competitor demonstrated a firm commitment from a partner to advance the prototype solar-thermal desalination system to the next logical stage of development?

### Suggested content:

- Describe the path forward from prototype solar-thermal desalination facility to commercially viable product, producing water at market costs. Specifically detail: a business plan for how the preliminary results shown by the operational prototype solar-thermal desalination facility will be leveraged to move the technology forward, the schedule containing planned key technical milestones with one or more commercial partner(s), and the level of commitment of the commercialization partner(s) as evidenced by letters of commitment or similar.
- Provide details and documentation on the extent of funding in place to continue the commercial development of the prototype solar-thermal desalination facility.
- Provide preliminary designs for the next iteration of the solar-thermal desalination facility that will be pursued in collaboration with the committed partner.

### Each statement is scored on a 1-6 scale.

- The competitor has demonstrated a firm commitment from a partner to pursue the next logical step required for the commercial development of the prototype solar-thermal desalination system.
- This innovation meets the goals and intent of the prize and should win this competition (score either 1 or 6).

## PowerPoint Summary Slide (to be made public)

Create a public-facing one-slide submission summary that contains technically specific details but can be understood by nontechnical audience. There is no template, so feel free to present the information as you see fit. Please make any text readable for a standard printout and conference-room projection.

### Letters of Commitment (mandatory) and Support (optional)

Competitors must attach letters of commitment in support of Question 3: Committed Commercialization Partner from relevant entities (i.e., end users of the proposed solution or investors in the competitor) as an appendix.

Competitors may also attach one-page letters of support or intent from other relevant entities (e.g., potential users of the proposed innovation). Letters of support from partners or others that are critical to the success of your proposed solution will likely increase your score. General letters of support from parties that are not critical to the execution of your solution will likely not factor into your score. Please do not submit multipage support letters.

### Final Technical Report

Provide a final report detailing the technical progress made and the key lessons learned for the effort being considered for the Test contest prize. In addition to summarizing technical milestones and the engineering knowledge that has been gained, competitors should describe remaining cost and performance challenges that must be retired for commercial acceptance of their technology. If proprietary information is included, the competitor should also provide a redacted version of the report for public release.

## 7. HOW WINNERS ARE DETERMINED – TEST CONTEST

**Expert Reviewer Panel Scoring:** Submissions will be scored as follows:

Each bullet listed in the review criteria for the three questions will receive a score from 1 to 6. The bullet points have equal weight, so questions that have more bullets have a greater influence on the final score. The final score from an individual reviewer equals the sum of the scores for all the bullets. All reviewers' scores will be averaged for a final reviewer score for the submission package. The prize judge will consider reviewer scores when deciding the winners of the contest.

Expert reviewers will also provide comments on the submissions. The Prize Administrator intends to provide comments to competitors after the winners are announced. These comments are intended to help competitors continue to improve and iterate on their submissions. The comments are the opinions of the expert reviewers and do not represent the opinions of the DOE.

**Interviews:** The Prize Administrator, at its sole discretion, may decide to interview some of the Test contest competitors. The interviews would be held before the winners are announced and would serve to help clarify questions the judge may have. Participating in interviews is not required. Being contacted for an interview is not an indication of winning.

**Final Determination:** The judge's final determination of the winner will take into account reviewer scores, interview findings (if applicable) and program policy factors listed in [Section VI – Additional Terms & Conditions](#).

**Announcement:** After the site visit, the Prize Administrator notifies the winner and requests the necessary information to distribute cash prizes. The Prize Administrator will then publicly announce the winner.

## 8. WHO CAN WIN

To win the Test contest, competitors must comply with the participant eligibility requirements in [Section I – Program Summary](#). Only competitors who won the Design contest may compete in the Test contest. By uploading a submission package, a competitor certifies that they comply with the eligibility requirements below. As soon as the Prize Administrator becomes aware that a competitor is not eligible to win the Test contest, the competitor may be disqualified.

## 9. FIND HELP

Visit <https://americanmadechallenges.org/solardesalination/network> to review and contact the members of the American-Made Network that have signed up to help competitors succeed.

## 10. ADDITIONAL REQUIREMENTS

Please read and comply with additional requirements in [Section VI – Additional Terms & Conditions](#). Competitors who do not comply with these requirements in [Section VI](#) may be disqualified.

## VI. ADDITIONAL TERMS AND CONDITIONS

### 1. UNIVERSAL CONTEST REQUIREMENTS

Your submissions to the Innovation, Teaming, Design, and Test contests are subject to following terms and conditions:

- You must post the final content of your submission or upload the submission form online at <https://www.herox.com/SolarDesalination> before the relevant contest closes. Any other form of submission will not be accepted. Late submissions will not be accepted.
- By clicking submit in HeroX the competitor is agreeing to make their video submission, summary slide, and technical assistance request public.
- The cover page, narrative, technical documentation, letters of commitment/support, EQ-1, and résumés are not intended to be made public, however, see [Section VI – Additional Terms & Conditions](#) regarding the Freedom of Information Act.
- You agree to release your submission video under a Creative Commons Attribution 4.0 International License (see <http://creativecommons.org/licenses/by/4.0/>).
- You must include all the required submission's elements. The Prize Administrator may disqualify your submission after an initial screening if you fail to provide all required submission elements. Competitors may be given an opportunity to rectify submission errors due to technical challenges or to fix non-substantive mistakes or errors in their submission packages.
- Your submission must be in English and in a format readable by Microsoft Word or a PDF viewer. Handwritten submissions will be disqualified.
- Submissions and competitors will be disqualified if any engagement with the Solar Desal Prize – included but not limited to the submission, the HeroX forum, or emails to the Prize Administrator – contains any matter that, in the sole discretion of DOE or NREL, is indecent, obscene, defamatory, libelous, lacking in professionalism, or demonstrates a lack of respect for people or life on this planet.
- If you click "Accept" on the HeroX platform and register for any of the contests described in this document, you are agreeing to be bound by these rules in addition to the existing HeroX Terms of Use for all purposes relating to these contests. You should print and keep a copy of these rules. These provisions apply only to the contests described here and no other contests on the HeroX platform or anywhere else.

## 2. VOUCHER PAIRING SYSTEM

The Prize Administrator will coordinate with the other DOE National Laboratories and cultivate relationships with private fabrication facilities that are willing to work with competitors. All Teaming and Design contest semifinalists and finalists will have their public materials (video pitch, technical assistance request, and summary slide) distributed to facilities that may be interested in helping competitors. Facilities in the American-Made Network interested in working with competitors may submit a one-slide proposal to the Teaming and Design contest semifinalists and finalists for consideration.

Semifinalists and finalists can choose to use their voucher funding at a National Laboratory or relevant private facility that is part of the American-Made Network. In the case of a National Laboratory, the funds will be provided directly to the lab on behalf of the winner to conduct a mutually agreed upon scope of work between the lab and the winner. When vouchers are used at a facility that is not a National Laboratory, the semifinalists and finalists will be provided with funding for qualifying work. Vouchers may not be redeemed for cash, transferred to another party, or used as cost share for another federal award. Further details about the voucher process and working with National Labs are provided on the voucher website:

<https://americanmadechallenges.org/solardesalination/vouchers>.

## 3. VERIFICATION FOR PAYMENTS:

The Prize Administrator will verify the identity and role of all competitors before distributing any prizes. Receiving a prize payment is contingent upon fulfilling all requirements contained herein. The Prize Administrator will notify winning competitors using provided email contact information for the individual or entity that was responsible for the submission. Each competitor will be required to sign and return to the Prize Administrator, within 30 days of the date on the notice, a completed [NREL Request for ACH Banking Information](#) form and a completed W9 form (<https://www.irs.gov/pub/irs-pdf/fw9.pdf>). In the sole discretion of the Prize Administrator, a winning competitor will be disqualified from the competition and receive no prize funds if: (i) the person/entity does not respond to notifications; (ii) the person/entity fails to sign and return the required documentation within the required time period; (iii) the notification is returned as undeliverable; (iv) the submission or person/entity is disqualified for any other reason as specified in eligibility section I.5 or universal content section VI.1.

In the event of a dispute as to any registration, the authorized account holder of the email address used to register will be deemed to be the competitor. The "authorized account holder" is the natural person or legal entity assigned an email address by an Internet access provider, online service provider, or other organization responsible for assigning email addresses for the domain associated with the submitted address. All competitors may be required to show proof of being the authorized account holder.

## 4. TEAMS AND SINGLE ENTITY AWARDS

The Prize Administrator will award a single dollar amount to the designated primary submitter, whether consisting of a single or multiple entities. The primary submitter is solely responsible for allocating any prize funds among its member competitors or teammates as they deem appropriate. The Prize Administrator will not arbitrate, intervene, advise on, or resolve any matters or disputes between team members or competitors.

## 5. SUBMISSION RIGHTS

By making a submission and consenting to the rules of the contest, a competitor is granting to DOE, the Prize Administrator, and any other third parties supporting DOE in the contest, a license to display publicly and use the parts of the submission that are designated as “public” for government purposes. This license includes posting or linking to the public portions of the submission on the Prize Administrator or HeroX applications, including the contest website, DOE websites, and partner websites, and the inclusion of the submission in any other media worldwide. The submission may be viewed by the DOE, Prize Administrator, and judges and reviewers for purposes of the contests, including but not limited to screening and evaluation purposes. The Prize Administrator and any third parties acting on their behalf will also have the right to publicize competitors’ names and, as applicable, the names of competitors’ team members and organization, which participated in the submission on the contest website indefinitely.

By entering, the competitor represents and warrants that:

1. Competitor’s entire submission is an original work by competitor and competitor has not included third-party content (such as writing, text, graphics, artwork, logos, photographs, likeness of any third party, musical recordings, clips of videos, television programs or motion pictures) in or in connection with the submission, unless (i) otherwise requested by the Prize Administrator and/or disclosed by competitor in the submission, and (ii) competitor has either obtained the rights to use such third-party content or the content of the submission is considered in the public domain without any limitations on use.
2. Unless otherwise disclosed in the submission, the use thereof by Prize Administrator, or the exercise by Prize Administrator of any of the rights granted by competitor under these rules, does not and will not infringe or violate any rights of any third party or entity, including, without limitation, patent, copyright, trademark, trade secret, defamation, privacy, publicity, false light, misappropriation, intentional or negligent infliction of emotional distress, confidentiality, or any contractual or other rights;
3. All persons who were engaged by the competitor to work on the submission or who appear in the submission in any manner have:
  - a. Given the competitor their express written consent to submit the submission for exhibition and other exploitation in any manner and in any and all media, whether now existing or hereafter discovered, throughout the world;

- b. Provided written permission to include their name, image, or pictures in or with the submission (or, if a minor who is not competitor's child, competitor must have the permission of the minor's parent or legal guardian) and the competitor may be asked by the Prize Administrator to provide permission in writing;
- c. Not been and are not currently under any union or guild agreement that results in any ongoing obligations resulting from the use, exhibition, or other exploitation of the submission.

## 6. COPYRIGHT

Each competitor represents and warrants that the competitor is the sole author and copyright owner of the submission; that the submission is an original work of the competitor or that the competitor has acquired sufficient rights to use and to authorize others, including DOE, to use the submission, as specified throughout the rules; that the submission does not infringe upon any copyright or any other third-party rights of which the competitor is aware; and that the submission is free of malware.

## 7. CONTEST SUBJECT TO APPLICABLE LAW

All contests are subject to all applicable federal laws and regulations. Participation constitutes each participant's full and unconditional agreement to these Official Contest Rules and administrative decisions, which are final and binding in all matters related to the contest. This notice is not an obligation of funds; the final award is contingent upon the availability of appropriations.

## 8. RESOLUTION OF DISPUTES

The U.S. Department of Energy is solely responsible for administrative decisions, which are final and binding in all matters related to the contest.

Neither the U.S. Department of Energy nor the Prize Administrator will arbitrate, intervene, advise on, or resolve any matters between team members or among competitors.

## 9. PUBLICITY

The quarterfinalists, semifinalists, finalists, and winners of these prizes (collectively, "winners") will be featured on the DOE and NREL websites.

Except where prohibited, participation in the contest constitutes each winner's consent to DOE's and its agents' use of each winner's name, likeness, photograph, voice, opinions, and/or hometown and state information for promotional purposes through any form of media worldwide, without further permission, payment, or consideration.

## 10. LIABILITY

Upon registration, all participants agree to assume any and all risks of injury or loss in connection with or in any way arising from participation in this contest. Upon registration, except in the case of willful misconduct, all participants agree to and, thereby, do waive and release any and all claims or causes of action against the federal government and its officers, employees, and agents for any and all injury and damage of any nature whatsoever (whether existing or thereafter arising, whether direct, indirect, or consequential, and whether foreseeable or not), arising from their participation in the contest, whether the claim or cause of action arises under contract or tort.

In accordance with the delegation of authority to run this contest delegated to the director of the Solar Energy Technologies Office, the director has determined that no liability insurance naming DOE as an insured will be required of competitors to compete in this competition per 15 USC 3719(i)(2). Competitors should assess the risks associated with their proposed activities and adequately insure themselves against possible losses.

## 11. RECORDS RETENTION AND FREEDOM OF INFORMATION ACT

All materials submitted to DOE as part of a submission become DOE records and are subject to the Freedom of Information Act. The following applies only to portions of the submission not designated as public information in the instructions for submission. If a submission includes trade secrets or information that is commercial or financial, or information that is confidential or privileged, it is furnished to the Government in confidence with the understanding that the information shall be used or disclosed only for evaluation of the application. Such information will be withheld from public disclosure to the extent permitted by law, including the Freedom of Information Act. Without assuming any liability for inadvertent disclosure, DOE will seek to limit disclosure of such information to its employees and to outside reviewers when necessary for review of the application or as otherwise authorized by law. This restriction does not limit the Government's right to use the information if it is obtained from another source.

Submissions containing confidential, proprietary, or privileged information must be marked as described below. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise. The U.S. Government is not liable for the disclosure or use of unmarked information, and may use or disclose such information for any purpose.

The submission must be marked as follows and identify the specific pages containing trade secrets, confidential, proprietary, or privileged information:

### **Notice of Restriction on Disclosure and Use of Data:**

Pages [list applicable pages] of this document may contain trade secrets, confidential, proprietary, or privileged information that is exempt from public disclosure. Such information shall be used or disclosed only for evaluation purposes. [End of Notice]

The header and footer of every page that contains confidential, proprietary, or privileged information must be marked as follows: "Contains Trade Secrets, Confidential, Proprietary, or Privileged Information Exempt from Public Disclosure." In addition, each line or paragraph containing proprietary, privileged, or trade secret information must be clearly marked with double brackets.

Competitors will be notified of any Freedom of Information Act requests for their submissions in accordance with 29 C.F.R. § 70.26. Competitors may then have the opportunity to review materials and work with a FOIA representative prior to the release of materials.

## **12. PRIVACY**

If you choose to provide HeroX with personal information by registering or completing the submission package through the contest website, you understand that such information will be transmitted to DOE and may be kept in a system of records. Such information will be used only to respond to you in matters regarding your submission and/or the contest unless you choose to receive updates or notifications about other contests or programs from DOE on an opt-in basis. DOE and NREL are not collecting any information for commercial marketing.

## **13. GENERAL CONDITIONS**

DOE reserves the right to cancel, suspend, and/or modify the contest, or any part of it, at any time. If any fraud, technical failures, or any other factor beyond DOE's reasonable control impairs the integrity or proper functioning of the contests, as determined by DOE in its sole discretion, DOE may cancel the contest.

Although DOE may indicate that it will select up to several quarterfinalists, semifinalists, finalists and winners for each contest, DOE reserves the right to only select competitors that are likely to achieve the goals of the program. If, in DOE's determination, no competitors are likely to achieve the goals of the program, DOE will select no competitors to be quarterfinalists, semifinalists, finalists, or winners and will award no prize money.

**ALL DECISIONS BY DOE ARE FINAL AND BINDING IN ALL MATTERS RELATED TO THE CONTEST.**

## 14. PROGRAM POLICY FACTORS

While the scores of the expert reviewers will be carefully considered, it is the role of the prize judge to maximize the impact of contest funds. Some factors outside the control of competitors and beyond the independent expert reviewer scope of review may need to be considered to accomplish this goal. The following is a list of such factors. In addition to the reviewers' scores, the below program policy factors may be considered in determining quarterfinalists, semifinalists, finalists, and winners:

- Geographic diversity and potential economic impact of projects.
- Whether the use of additional DOE funds and provided resources are non-duplicative and compatible with the stated goals of this program and the DOE mission generally.
- The degree to which the submission exhibits technological or programmatic diversity when compared to the existing DOE project portfolio and other competitors.
- The level of industry involvement and demonstrated ability to accelerate commercialization and overcome key market barriers.
- The degree to which the submission is likely to lead to increased employment and manufacturing in the United States or provide other economic benefit to U.S. taxpayers.
- The degree to which the activities described in the submission package to this contest have been or will be performed in the United States.
- The degree to which the submission will accelerate transformational technological, financial, or workforce advances in areas that industry by itself is not likely to undertake because of technical or financial uncertainty.
- The degree to which the submission supports complementary DOE funded efforts or projects, which, when taken together, will best achieve the goals and objectives of DOE.
- The degree to which the submission expands DOE's funding to new competitors and recipients who have not been supported by DOE in the past.
- The degree to which the submission enables new and expanding market segments.
- Whether the project promotes increased coordination with nongovernmental entities for the demonstration of technologies and research applications to facilitate technology transfer.
- Whether submission content sufficiently confirms the competitor's intent to commercialize early-stage technology and establish a viable U.S.-based business in the near future.
- The extent to which the submission is a solution to the climate emergency.

- Location in a Qualified Opportunity Zone or otherwise advancing the goals of Qualified Opportunity Zones, including spurring economic development and job creation in distressed communities throughout the United States.
- Representation of diverse types and sizes of applicant organizations.
- The degree to which the submission exhibits team member diversity and the inclusion of underrepresented groups, with participants including but not limited to graduates and students of historically black colleges and universities (HBCUs) and other minority serving institutions (MSIs) or members operating within Qualified Opportunity Zones or other disadvantaged communities.<sup>25</sup>

## 15. NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) COMPLIANCE

DOE's administration of the American Made Challenges: Solar Desalination Prize is subject to NEPA (42 USC 4321, et seq.). NEPA requires federal agencies to integrate environmental values into their decision-making processes by considering the potential environmental impacts of their proposed actions. For additional background on NEPA, please see DOE's NEPA website, at <http://nepa.energy.gov/>.

While NEPA compliance is a federal agency responsibility and the ultimate decisions remain with the federal agency, all participants in the Design Contest will be required to assist in the timely and effective completion of the NEPA process in the manner most pertinent to their participation in the prize competition. Participants may be asked to provide DOE with information on fabrication and testing of their device such that DOE can conduct a meaningful evaluation of the potential environmental impacts.

## 16. RETURN OF FUNDS

As a condition of receiving a prize, competitors agree that if the prize was made based on fraudulent or inaccurate information provided by the competitor to DOE, DOE has the right to demand that any prize funds or the value of other non-cash prizes be returned to the government.

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<sup>25</sup> DOE defines "disadvantaged communities" as areas that most suffer from a combination of economic, health, and environmental burdens, such as poverty, high unemployment, air and water pollution, and presence of hazardous wastes, as well as high incidence of asthma and heart disease. Examples include but are not limited to: economically distressed communities identified by the Internal Revenue Service as Qualified Opportunity Zones; communities identified as disadvantaged communities by their respective States; communities identified on the Index of Deep Disadvantage referenced at <https://news.umich.edu/new-index-ranks-america-100-most-disadvantaged-communities/>, and communities that otherwise meet the DOE definition of a disadvantaged community.

## 17. REQUEST TO WAIVE THE “DOMESTIC OWNERSHIP AND CONTROL” ELIGIBILITY REQUIREMENT

If an entity seeking to compete as the registered competitor does not have domestic ownership and control, the entity should include a waiver request that addresses the following waiver criteria and content requirements below along with their submission. EERE may consider issuing a waiver of that eligibility requirement where the entity submits a compelling justification; the entity is incorporated in and maintains a primary place of business in the United States; and the entity otherwise meets the eligibility criteria. There are no rights to appeal EERE’s decision on the waiver request.

### Waiver Criteria

Entities seeking a waiver must demonstrate to the satisfaction of EERE that its participation: (1) has a high likelihood of furthering the objectives of this prize competition and (2) aligns with the best interest of the U.S. industry and U.S. economic development.

### Content for Waiver Request

A waiver request must include the following information:

- a. Entity’s name and place of incorporation;
- b. The location of the entity’s primary place of business;
- c. A statement describing the extent the entity is owned or control by a foreign government, agency, firm, corporation, or person who is not a citizen or permanent resident of the United States, including the applicable percentage of ownership/control;
- d. A compelling justification that addresses the waiver criteria stated above;
- e. A description of the project’s anticipated contributions to the U.S. economy;
- f. A description of how the entity has benefitted U.S. research, development and manufacturing, including contributions to employment in the United States and growth in new U.S. markets and jobs; and
- g. A description of how the entity has promoted domestic manufacturing of products and/or services.

Requests should be submitted through the HeroX portal.

# Technical Appendix: Performance Metrics

The Solar Desal Prize requires all competitors to present performance metrics for their innovation. Competitors should perform calculations for levelized cost of water, thermal energy consumption, capital costs, operational costs, recovery ratio, annualized solar-to-desalination thermal efficiency, and impact on the environment, for comparison to the state-of-the-art technologies.

The specific performance metrics of solar-thermal desalination that will be competitive with incumbent technologies depends on the target market (i.e., municipal water systems, agricultural uses, industrial uses, or purification of produced waters). The solution space is therefore dependent on the competing technologies, requirements appropriate for the use, and the cost drivers in that market space.

These performance metrics will depend on the equipment included in the scope of the project. While desalination typically consumes most of the energy that a treatment process requires for highly saline water, competitors should consider and account for other processes, as necessary. Figure A1, below, illustrates a typical water treatment facility for an industrial plant.

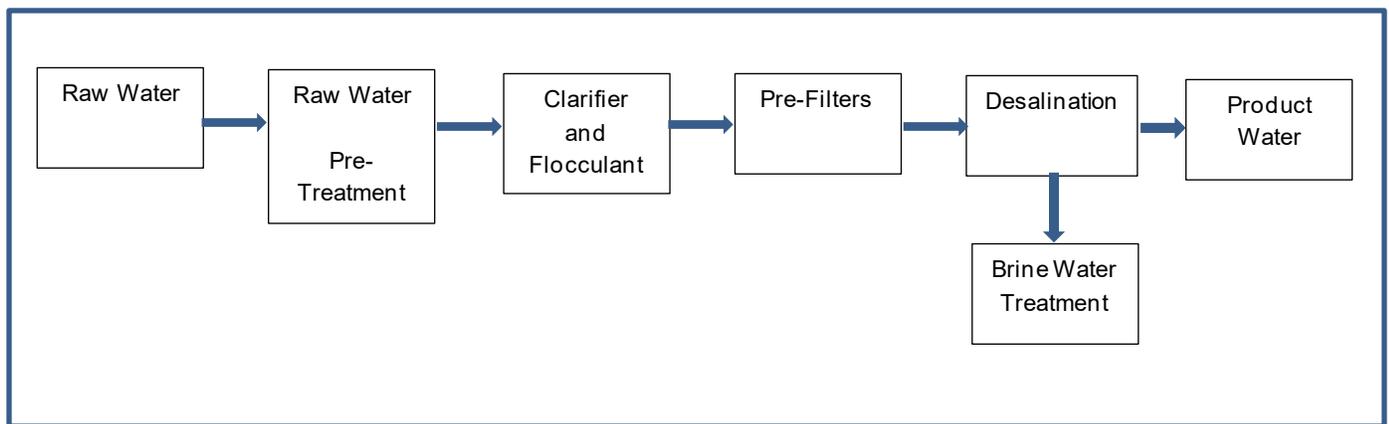


Figure A1: Simplified block diagram for a water treatment plant

Competitors should present their performance metrics for the full-scale, commercial version of their innovation, including all equipment—beyond just the desalination subsystem—to treat raw input water from its initial quality to the purity customers require, as well as wastewater treatment and handling. For the pilot-scale version of their innovation, competitors should present performance metrics only for the technologies that will be demonstrated, including any equipment (aside from the desalination subsystem) that will make the concept operable at the specific host facility.

## Levelized Costs of Water (LCOW) and Heat (LCOH) Calculations

The LCOW is the chief metric to describe the cost-competitiveness of different water purification technologies, given the same characteristics of input water and the level of purification achieved. For thermal desalination, a key submetric is the cost of the heat necessary to drive the desalination process, also known as the LCOH. You are required to use the following calculations for LCOW and LCOH:

Calculate the LCOW using the following formula, in which “O&M” represents operations and maintenance:

$$LCOW = \frac{\text{overnight capital cost} * \text{capital recovery factor} + \text{fixed O\&M cost}}{8760 * \text{capacity factor} * \text{desalination plant capacity per hour}} + \text{variable O\&M cost} \quad (1)$$

Where

$$\text{Capital Recovery Factor (CRF)} = \frac{i(1+i)^n}{(1+i)^n - 1}$$

Calculate the LCOH using this formula:

$$LCOH = \frac{\text{overnight capital cost} * \text{CRF} + \text{fixed O\&M cost}}{8760 * \text{capacity factor} * \text{solar plant energy capacity per hour}} + \text{variable O\&M cost} \quad (2)$$

Note that for technology comparison purposes, LCOW and LCOH can be used only for processes that produce similar-quality fresh water or produce heat at similar temperatures, respectively.

Presenting more detailed versions of these calculations in addition to those used above is optional.

You must justify capital costs for each major portion of the project, including installation costs.

The CRF is the ratio of a constant annuity to the present value of receiving that annuity for a given length of time;  $n$  is the number of annuities received. This is related to the annuity formula, which gives the present value in terms of the annuity, the interest rate, and the number of annuities.

Overnight capital cost is measured in dollars per unit of volume of water produced ( $\$/m^3$ ) and should include all capital costs required for solar-thermal collection, storage, and desalination. Fixed operation O&M costs are measured in dollars per unit of volume of water produced annually ( $\$/m^3\text{-yr}$ ), and variable O&M costs are measured in dollars per unit of volume of water produced ( $\$/m^3\text{-hr}$ ).

The denominator is 8760 (the number of hours in a year), and capacity factor is a fraction between 0 and 1, representing the portion of a year that the desalination facility is operating.

For O&M costs, each team should perform a cost estimate of the fixed and variable annual operating costs, which includes labor for operations, maintenance, chemical usage, utilities, etc.

To calculate the LCOW, use Table A1, below, to perform standardized comparisons between technologies:

**Table A1: Economic Evaluation Assumptions**

Parameter	Units	Value
Periods, $n$	Years	30
Discount rate, $i$	%	7.01 (nominal)
Inflation rate	%/year	2.5
Capacity factor	%	By competitor
Fixed O&M costs	$\$/m^3\text{-yr}$	By competitor
Variable O&M costs	$\$/m^3\text{-hr}$	By competitor
Cost escalation rate (above inflation)	%	2.5
Contingency (to be applied to all costs)	%	10
Site improvement cost	$\$/m^2$	By competitor
EPC/owner cost	%	9% of direct costs
Land area	acres	By competitor, at a cost of \$10,000 per acre
Taxes, federal and state	%	35% federal; 5% state
Insurance	%	0 (excluded)
Salvage rate	%	0 (excluded)
Financed (% debt)	%	50

### Capital Cost Estimate

The capital costs of the project should include a summary of the expected material, as well as fabrication and construction costs of the full-scale, commercial solution. For the full-scale commercial estimate, the entire water treatment system should be considered, as described above. For the pilot-scale innovation, the scope can be limited to the specific requirements of the effort at the host facility where it will be installed.

An American Association of Cost Engineers (AACE) Class 4 cost estimate or similar should be prepared using equipment factored or parametric costs.

### O&M Cost estimate

This is an estimate of all the ongoing annual costs of the innovation, including chemical usage, labor, maintenance, etc. For the full-scale commercial version, this should estimate the O&M costs of the entire water treatment system. For the pilot-scale innovation, this should include only the equipment needed to make the system operable at the specific host facility.

### Thermal Energy Consumption

This is the amount of thermal energy consumed per volume of water produced. The thermal energy is the amount of heat transferred to the brine.

### Recovery Ratio

This is the ratio of product water to input water flow, expressed as a percentage:

Recovery Ratio = product water flow / input water flow x 100

### Annualized Solar Thermal Efficiency

To calculate the annualized solar thermal efficiency, use the following general formula:

$$\eta_{thermal,annual} = \frac{\sum_{8760} Q_{net}}{Aperture\ Area_{solar\ field} \sum_{8760} DNI} \quad (3)$$

$\eta_{thermal, annual}$  = annualized solar thermal efficiency

$Q_{net}$  = net heat flux transferred from System 1 to System 2 (e.g., the amount of heat transferred from solar incident energy to inlet brine), on an hourly basis summed over the year

DNI = direct normal incidence

### Environmental Benefits and Management

Brine discharge or other salt concentrate from the water desalination process will need to be managed effectively and according to environmental regulations. Developing zero or near-zero liquid discharge technologies may be critical to creating highly efficient desalination systems with wide geographic applicability. In addition, desalination systems should not introduce biological or chemical contaminants, such as unregulated or nontraditional constituents, like boron. This competition encourages brine management strategies that address both the economic and environmental cost of brine diffusion, disposal, or other applications. Competitors should consider specific strategies that are robust across a variety of feedwater types. Another key factor might be the trade-off between concentrating brine

recovery versus brine volume and determining an optimal level of water production to resource recovery. Finally, truly innovative brine reuse methods or application are of interest.

### Zero Liquid Discharge

Zero liquid discharge (ZLD) is discussed separately, here, as the systems and unit operations associated with its use are somewhat different than those relevant to conventional desalination, and the input salinity is typically much higher than that of conventional desalination systems.

Early ZLD systems were typically based on a series of thermal processes. In thermal ZLD systems, the feed wastewater undergoes a pretreatment step involving multiple unit operations that use clarifiers, filter presses, and ultrafiltration. This pretreatment step reduces the potential for scaling and is concentrated sequentially by unit operations of brine concentration and a crystallization or use of an evaporation pond. The distilled liquid generated by the brine concentrator and crystallizer units is reused as clean product water, whereas the solids produced are either stored in evaporation ponds, further processed for landfill disposal, or repurposed and reused.

Brine concentrators commonly use mechanical vapor compression (MVC) for water evaporation. MVC brine concentrators are still very energy-intensive and require high-grade electric energy, typically 20–25 kilowatt-hour electric per cubic meter ( $\text{kWh}_e/\text{m}^3$ ) of treated feedwater, with higher values (up to  $39 \text{ kWh}_e/\text{m}^3$  of feedwater) reported in the literature. Brine concentrators can reach salinity concentrations of 250,000 mg/L with 90–98% water recovery and produce high-quality product water with total dissolved solids (TDS) < 10 mg/L. However, MVC capital costs are high because MVC requires expensive materials, such as titanium and stainless steel, to prevent corrosion by the boiling brine.

The concentrated brines produced by brine concentrators are usually sent to a brine crystallizer, where the remaining water is further recovered. Similar to brine concentrators, vapor compressors in crystallizers supply the heat for water evaporation. The viscous brine is pumped through submerged heat-exchanger tubes under pressure, thereby preventing boiling and subsequent scaling inside the tubes. Crystallizers consume energy at a rate as high as 52–66  $\text{kWh}_e/\text{m}^3$  of treated feedwater, which is nearly three times that consumed by MVC brine concentrators. This dramatic energy increase is inevitable because crystallizers treat feed brines with much higher salinity and viscosity.

Evaporation ponds can be competitive alternatives to brine crystallizers because they use solar energy and have a lower operation cost. But they can treat only small volumes at locations with a high evaporation rate and inexpensive land. Their high capital cost and environmental concerns about potential hazardous-waste leakage further hinder widespread application.

Thermal ZLD has been attempted with reverse osmosis (RO) preconcentration.

Despite their limitations, brine crystallizers or evaporation ponds are still indispensable for ZLD processes. Therefore, the focus of ZLD technology has been on reducing the volume of concentrated brine entering the brine crystallizers or evaporation ponds. However, applying RO to ZLD has two limitations: membrane fouling or scaling, and the upper level of salinity (~75,000 TDS) that can be treated. Membrane fouling or scaling reduces water permeability and the lifespan of RO membranes.

Three membrane-based processes—electrodialysis (ED), forward osmosis (FO), and membrane distillation (MD)—have emerged as potential alternative ZLD technologies to brine concentrators to further concentrate the wastewater after RO. The brine produced from these processes feeds the crystallizer or evaporation pond. ED is purely electricity-driven and not of interest in this competition, but FO and MD processes are of interest because they could significantly reduce thermal energy consumption.