U.S. DEPARTMENT OF ENERGY

Lithium-Ion Battery Recycling Prize

OFFICIAL RULES

The Lithium-Ion Battery Recycling Prize is designed to address critical material supply issues for lithium-ion batteries by accelerating U.S. lithium-ion battery recycling innovation through a series of prize competitions.

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PROGRAM SUMMARY

1. INTRODUCTION

There is a growing demand for lithium-ion batteries (LIBs) in a variety of applications, including consumer electronics, stationary storage, large industrial applications, and electric vehicles (EVs). Current LIB cathodes contain a substantial amount of cobalt, a critical material that is both expensive and dependent on foreign sources for production. The Democratic Republic of the Congo supplies 58% of the world's cobalt, and China is the world's leading producer of refined cobalt and a leading supplier of cobalt imports to the United States.[1] Other valuable materials include components of the cathode (lithium, nickel, and manganese), anode (graphite), and electrolyte.

Unlike lead-acid batteries, which are collected and recycled at a rate of 99%, LIBs are only collected and recycled at a rate of less than 5%. With a 90% recovery rate, recycled material could potentially provide one third of our cathode material needs for LIBs by 2025.[2]

- The Department of Energy (DOE) Lithium-Ion Battery Recycling Prize (Prize) is designed to motivate American innovators to develop and demonstrate profitable business and technology strategies to achieve a lithium-ion battery recovery rate of 90%. This might be accomplished by (1) increasing collection, (2) implementing cost-effective, automated methods or technologies for separation and sorting of various collected battery types and sizes, (3) developing cost-effective methods or technologies that will render lithium-based batteries safe or inert during storage and transport, (4) optimizing the efficiency of logistics, or (5) designing an entirely unanticipated solution. Regardless of the starting point, the ultimate aim is to have an end-to-end solution, i.e. one that moves spent lithium-ion batteries from consumers to recyclers.

- The Prize will award $5.5 million in cash prizes to participants across three phases over approximately three years including: **Phase I: Concept Development and Incubation** (six months, $1 million); **Phase II: Prototype and Partnering** (12 months, $2.5 million); and **Phase III: Pilot Validation** (15 months, $2 million).

[1] USGS Mineral Commodities Summary 2018 https://minerals.usgs.gov/minerals/pubs/mcs/2018/mcs2018.pdf
[2] Department of Energy Announces $80 Million Investment in Advanced Vehicle Technologies Research https://www.energy.gov/articles/department-energy-announces-80-million-investment-advanced-vehicle-technologies-research

2. BACKGROUND

DOE's Office of Energy Efficiency and Renewable Energy (EERE) supports early-stage research to significantly reduce the cost of EV batteries while reducing battery charge time and increasing EV driving range. The Energy Information Administration (EIA) projects that U.S. light-duty battery EV sales will reach 1.4 million by 2030[3] and others project even higher sales growth. Global EV sales are expected to reach 30 million by 2030, up from 1.1 million in 2017.[4] This growth in EV sales, as well as increased demand for consumer, stationary, and industrial applications are expected to double the demand for LIBs by 2025 and quadruple it by 2030.[5] Demand for global production of battery materials, such as lithium, cobalt, nickel, manganese, and graphite, will grow at similar rates.[6]

Currently, LIBs contain a substantial amount of cobalt, which is the largest material contributor to their cost. The Department of Interior, in accordance with Executive Order 13817, "The Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals,"[7] the Government considers cobalt a critical mineral due to supply risk and importance to a variety of energy technologies, among other technologies.[8] Cobalt has been subject to considerable price fluctuation (average annual cobalt prices more than doubled in 2017) and the United States is dependent on foreign sources for production. The growth in demand for LIBs for EVs is expected to establish EVs as the largest end user of cobalt and lithium, and, in turn, could potentially create a cobalt and lithium supply risk. To mitigate potential LIB critical materials supply risks, EERE's Vehicle Technologies Office (VTO) has established the strategic program goal of reducing these concerns.

The Prize will incentivize American innovators and businesses to find novel solutions to the challenges associated with ***collecting***, ***sorting***, ***storing***, and ***transporting*** spent LIBs safely and economically for eventual recycling. The solutions can include developing and implementing novel business models and logistics processes; hardware to render batteries/materials safe for transport; machine vision sorting processes; and education, promotion, and outreach to increase LIB recycling across users. The Prize is sponsored by VTO and the Advanced Manufacturing Office (AMO). The National Renewable Energy Laboratory (NREL) will serve as the Prize Administrator.

The Prize is a competition with a series of three progressive phases that will incentivize the nation's innovators and entrepreneurs to **develop and demonstrate processes that, when scaled, have the potential**

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[3] EIA Annual Energy Outlook 2019, https://www.eia.gov/outlooks/aeo/pdf/aeo2019.pdf

[4] http://cii-resource.com/cet/AABE-03-17/Presentations/BRMT/Pillot_Christophe.pdf

[5] http://cii-resource.com/cet/AABE-03-17/Presentations/BRMT/Pillot_Christophe.pdf

[6] https://about.bnef.com/electric-vehicle-outlook/

7 82 FR 60835 (Dec. 26, 2017).

[8] 83 FR 23295 (May 18, 2018).

to profitably achieve a recovery rate of 90%[9] of all LIB technologies in the United States, covering consumer electronics, stationary, and transportation applications (referred to below as the Prize Goal)**.** The Prize will strengthen and foster critical connections that accelerate and sustain American innovation in LIB recycling. DOE will provide opportunities to potential participants to learn about the challenges and benefits of battery recycling through a variety of approaches such as webinars, seminars, and workshops. This will be accomplished by a prize structure allowed under the America COMPETES Reauthorization Act, as amended (15 U.S.C. § 3719).

3. SUBMISSION TRACKS

The current national recycling rate of lithium-ion batteries is low for a number of challenging reasons, including collection, safety concerns, evolving variability in battery chemistry and structure, and logistics. To stimulate recycling at rates that address material supply concerns, this Prize seeks innovative solutions that address those challenges.

Recognizing that the path from collecting batteries to delivering to recyclers is complex (it may require highly varied knowledge and expertise, and coordinated action amongst a variety of partners) the Prize has been organized into Submission Tracks – i.e., areas of interest identified by EERE that may help solve the challenge of recycling lithium ion batteries. They represent potential opportunities within the solution space but are not the only way to potentially solve lithium-ion battery recycling. For this reason, tracks not only include *Collection*, *Separating and Sorting*, *Safe Storage and Transportation*, and *Reverse Logistics*,[10] but additionally, *Other Ideas* (see Figure 1). Concepts that do not fit in the first four tracks and have the potential to achieve the Prize Goal are highly encouraged to submit to 'Other Ideas.'

For a submission, participants are required to select one of the five tracks (further explained below) that their solution addresses. Participants are limited to one solution per submission. Participants should not submit duplicate submissions under different tracks. Duplicate submissions will only be reviewed once. DOE reserves the right to reassign submissions to a different track designated by a participant. All ideas will compete against the full pool of entries regardless of the selected submission track. Regardless of track, submissions should consider cost-efficacy, safety, sustainability, and regulatory compliance. It is important to emphasize that the eventual Prize Goal is an end-to-end solution. Review Criteria for submissions are on page 19, under "How We Score."

[9] 90% recovery means 90% of individual batteries produced: out of 10 batteries produced, 9 are recovered and delivered to a recycler.

[10] Reverse logistics is the process of moving goods from their typical final destination for the purpose of capturing value, or proper disposal.

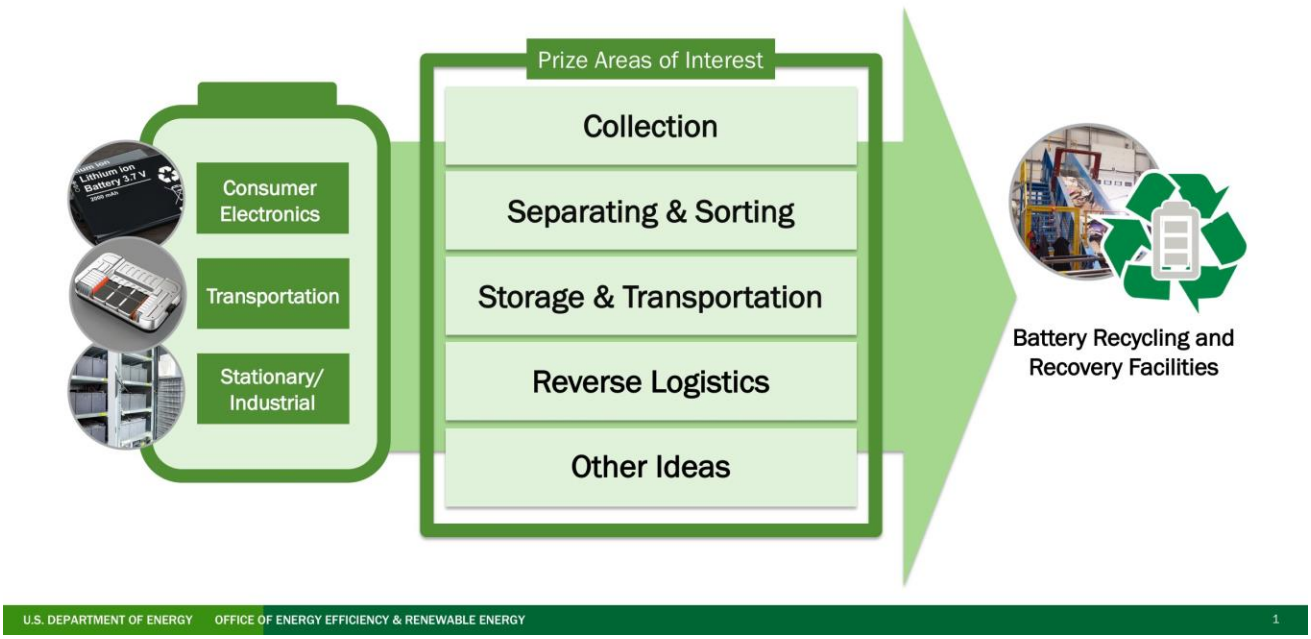

Figure 1. Examples of applications[11] and tracks of Interest to this Prize

Track 1 Collection

Context: Effective LIB recycling is contingent on batteries making it to recycling centers. There are a number of barriers to the successful collection of these batteries, including, in particular, a lack of infrastructure and awareness that would be necessary to encourage widespread collection.

- **Infrastructure**: At present, some state and local jurisdictions may have regulations regarding disposal; however, other states do not.[12] City and municipal waste management centers may offer drop-off opportunities, but drop-off centers may be underutilized due to proximity, or limited budgets to advertise and/or educate. Certain box stores like Best Buy, Home Depot, Staples, and Lowes (see more here) offer consumers the opportunity to drop off and recycle batteries of certain

[11] Examples of consumer electronics are smart phones, laptops, power tools, or any other device that uses cylindrical, prismatic, or pouch cells for potable power. Cells in these devices are usually less than 6 amp-hours (Ah). Examples of transportation are passenger, commercial, or military electric or hybrid electric vehicles. Stationary application energy storage systems used for backup power, in grid or micro-grid to support distributed generation. These systems can use small or large cells in parallel-series combinations.

[12] https://www.call2recycle.org/recycling-laws-by-state/

types and sizes. Cities, municipalities, and box stores do not collect curbside due to the hazards of LIBs.

- **Awareness**: On top of accessibility challenges, consumer awareness of both the ability and importance of proper LIB recycling is still somewhat low. As of 2016, 40% of U.S. adults were unaware of the ability to recycle consumer electronics[13] - echoing previous consumer assessments.[14] In some cases labeling on many batteries may not be clear to consumers. As a result, some consumers may not realize LIBs should not be deposited in the trash; others may misconstrue symbols to mean LIBs can be curbside recycled. This kind of inappropriate disposal not only removes valuable materials from the recycling stream for reuse, it also represents a serious occupational and environmental hazard in the solid waste system.[15]

For a summary of the LIB issues check out this U.S. Environmental Protection Agency YouTube Video and find the slides here.

Challenge: Limited infrastructure and awareness act as barriers to recycling efforts. How can this challenge be overcome? Participants are encouraged to devise a system or systems to incentivize recycling: this can include development of infrastructure, or devising a new business model, among other strategies.

Track 2. Separation and Sorting

Context: As an evolving technology, LIBs come in a variety of shapes (pouches, cells, packs), degrees of embeddedness (embedded in consumer electronics or removable), and chemistries (Table 1 shows typical LIB cathode compositions). Such a highly comingled waste stream poses a significant technical and economic barrier to recycling (this is in addition to avoiding comingling of non-LIBs like NiMh, alkaline, and even lead-acid batteries). Recycling processes are not so advanced yet as to efficiently and selectively recover multiple valuable materials using a single generalizable process. As such, it is useful to sort by cathode prior to the recycling process. Cathode active material constitutes a significant portion of the material value, and about 30%–40% of the weight of the electrochemical cell. Sorting prior to recycling may improve the efficiency of material recovery, and subsequently increase economic returns. [16]

[13] Study conducted by the Consumer Technology Association. http://www.cta.tech/cta/media/policyimages/reuse-recycle-2016.pdf
[14] https://www.staples.com/sbd/cre/marketing/old-gadgets-new-clutter/oldgadgets-newclutter.pdf
[15] Timpane, 2018. Lithium Ion Batteries in the Solid Waste System. EPA.
[16] Wang, X., Gaustad, G., & Babbitt, C. W. (2016). Targeting high value metals in lithium-ion battery recycling via shredding and size-based separation. Waste Management, 51, 204-213.

Table 1. Typical cathode compositions[17] in lithium-ion battery technologies.

Battery Technology	**Lithium nickel manganese cobalt oxide (NMC 111)**	**Lithium cobalt oxide (LCO)**	**Lithium manganese oxide (LMO)**	**Lithium iron phosphate (LFP)**	**Lithium nickel cobalt aluminum oxide (NCA)**
Composition	$LiNiMnCoO_2$	$LiCoO_2$	$LiMn_2O_4$	$LiFePO_4$	$LiNiCoAlO_2$
Cathode Active Material[18] (mass % of battery)	34.1	35.3	40.1	32.2	30.4
Elemental Mass (mass %)					
Lithium (Li)	7.86	7.09	3.84	4.40	7.22
Nickel (Ni)	20.13	0.0	0.0	0.0	48.87
Cobalt (Co)	20.21	60.21	0.0	0.0	9.20
Applications	electric vehicles, power tools, grid energy storage	mobile phones, tablets, laptops, digital cameras, avionics	power tools, medical devices, electric powertrains	electric and hybrid vehicles, grid, power tools	medical devices, industrial, electric powertrains, electric vehicles

To address sorting, a variety of identification methods indicating cathode composition on battery outer-casings have been proposed; however, in practice LIBs largely remain unlabeled.[19] As such, most commercial methods of separation largely overlap with other battery recycling pretreatment processes. Separation and pretreatment methods that include mechanical shredding or crushing and combined pyro- and hydrometallurgical processes[20,21] are destructive techniques. These in particular increase the risk of exposure to a variety of hazards, including exothermic reactions and exposure to the electrolyte.[22]

[17] Gaines, L., Richa, KJ. Spangenberger. "Key issues for li-ion battery recycling," MRS Energy & Sustainability, vol. 5, 2018, https://doi.org/10.1557/mre.2018.13

[18] Gaines et al. 2018

[19] Gaines et al. 2018

[20] "Our recycling process." Umicore. Accessed 1/7/2019. https://csm.umicore.com/en/recycling/battery-recycling/our-recycling-process

[21] J. Heelan et al. "Current and Prospective Li-Ion Battery Recycling and Recovery Processes," JOM, vol. 28, pp. 2632-2638, 2016.

[22] Gaines et al. 2018

Existing nondestructive techniques range from highly rudimentary—e.g., hand sorting for different chemistries—to more advanced, including sensors that induce a magnetic field, photo-recognition systems, and X-rays.[23] However, these are slightly older techniques, not widely used, and often still include manual presorting of batteries based on size and form.[24,25] Significant discoveries and important developments in chips, sensor technologies, robotics, artificial intelligence, and signal processing have the potential to overcome these hurdles.[26] For example, machine vision has been deployed in numerous industries—e.g., pharmaceutical, automotive, food processing, and metal finishing—for visual inspection, process control, parts identification, and robotic guidance.[27]

Challenge: Waste stream variability poses a large technical and economic hurdle for battery recycling, and it is unlikely that the complexity of this challenge will decline. Nondestructive methods of cathode identification and separation increase the efficiency and efficacy of recycling. Participants are encouraged to devise a system of automated sorting that is more effective (faster, more accurate, cheaper) than current technologies. The system should safely separate out and sort LIBs based on cathode materials.

Track 3. Safe or Inert Storage and Transportation

Context: LIBs are an amazing source of energy. However, that energy, once released (via short circuit, overcharge, over-discharge, mechanical blow, and/or heat) can be a hazard. While most LIBs are considered safe when used for their specified purpose in non-extreme environments, they can present a problem if damaged. Current means of waste and recycling collection expose batteries to conditions that increase the likelihood of damage and in turn, thermal runaway. Thermal runaway is a complex combinations of reactions that occur within a cell when some stimulus causes the internal temperature to rise such that it uncontrollably releases energy to the environment. This has caused multiple fires in garbage trucks, at landfills, and even at recycling facilities.

Due to this risk, LIBs are categorized as Class 9 miscellaneous hazardous materials for transportation purposes. As a result, there are clearly defined shipping, packaging, documentation, and labeling standards for moving them domestically or internationally.[28] This adds considerable cost at the end of life of LIBs.

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[23] Bernardes, A.M., Espinosa, D.C.R., Tenório, J.S., 2004. Recycling of batteries: a review of current processes and technologies. J. Power Sources 130 (1), 291–298.
[24] Bernardes, et al. 2004
[25] Winslow, K. M., Laux, S. J., & Townsend, T. G. (2018). A review on the growing concern and potential management strategies of waste lithium-ion batteries. Resources, Conservation and Recycling, 129, 263-277.
[26] Gundupalli, S. P., Hait, S., & Thakur, A. (2017). A review on automated sorting of source-separated municipal solid waste for recycling. Waste management, 60, 56-74.
[27] Malamas, E. N., Petrakis, E. G., Zervakis, M., Petit, L., & Legat, J. D. (2003). A survey on industrial vision systems, applications and tools. Image and vision computing, 21(2), 171-188.
[28] Lithium ion batteries are listed as a Hazard class 9 material in the Hazardous Materials table in DOT regulations at 49 CFR 172.101. In addition, 49 CFR 173.185 contains specific instructions/requirements for transport of Lithium cells or batteries.

Designing cost-effective solutions that could allow LIBs to be shipped safely without the risk of thermal runaway could potentially reduce the transportation costs dramatically. Furthermore, methods to make batteries externally electrochemically inactive – e.g. ensuring tabs are electrically insulated, or otherwise rendering electrochemically inert – have wide applicability to many different industries.

At present, most measures focus on preventing thermal runaway from becoming a bigger problem. Many of these options contain both the battery and associated flames and fumes via thermal cases, bags, or boxes.[29] However, once thermal runaway occurs, only the elemental value of those battery materials can be recovered. In order to potentially recover cathode materials as well as other battery components—e.g., electrolyte and the anode materials—it is desirable to prevent thermal runaway.

Current methods of rendering batteries inert either seek to put the lithium in an unreactive state or discharge any remaining capacity. In the former case, recyclers or researchers will cryogenically cool batteries via immersion in liquid nitrogen to achieve -196 Celsius (C). In some cases, researchers have used dischargers to achieve less than 0.1 V; however, this method runs the risk of thermal runaway if the current is not kept low enough. Other researchers have used a 5%–10% NaCl solution for bulk treatment of spent LIBs;[30] however, if their voltage is above the electrolysis voltage of water, hydrogen and oxygen gases will be produced, necessitating ventilation.[31] Likewise, Li et al. found elevated levels of Na, Al, and Fe in the NaCl solution following treatment, which potentially indicates the need for treatment under environmental regulations.

Challenge: LIBs are difficult to safely and cost-effectively store and transport. Participants are encouraged to devise a cost-effective solution that renders LIBs externally electrochemically inactive for safe transport and/or storage. Applicants should design solutions that consider any and all waste streams from their processes.

Track 4. Reverse Logistics

Context: Due to the Class 9 miscellaneous hazardous materials classification, LIBs face significantly higher transportation costs. However, complying with regulations isn't the only cost driver. In addition to safety, several other factors with varying degrees of uncertainty complicate the economic and technological logistical challenge. These factors include battery structure (shape, embeddedness, chemistry, and capacity), ownership (households, businesses, and other institutions like public utilities), and distribution. The latter comprises geographic, volumetric, and temporal factors (the origin and quantity of batteries being recycled

[29] Some of these are used by drone hobbyists, others by consumer or commercial shippers
[30] Yao, Y., Zhu, M., Zhao, Z., Tong, B., Fan, Y., & Hua, Z. (2018). Hydrometallurgical Processes for Recycling Spent Lithium-Ion Batteries: A Critical Review. ACS Sustainable Chemistry & Engineering, 6(11), 13611-13627.
[31] Lisbona, D., & Snee, T. (2011). A review of hazards associated with primary lithium and lithium-ion batteries. Process Safety and Environmental Protection, 89(6), 434-442.

over time). This combination heavily influences how, where, and when batteries are collected, transported, stored, and ultimately recycled. Optimizing this flow of materials poses a large challenge to battery recycling.

To date, there has been a great deal of research, development, and commercialization of reverse logistics infrastructure generally and for e-waste recycling specifically.[32] Reverse logistics is the process of moving used products from the waste stream to recapture valuable materials and proper disposal. As the use of LIBs continues to grow, there is increasing focus on reverse logistics for LIBs. In part, this may be due to the rare but major product recalls. In other cases, the increasing focus is in the interest of recycling. Unfortunately, however, this work is principally in the research phase and there is not yet a systematic solution to the current LIB logistics challenge.[33]

Finally, there have also been innovations in supply chains more generally that could optimize logistics including the deployment of blockchain, sensors and tagging solutions, last-mile delivery, warehouse automation, and autonomous vehicles. Thus, while there are a great deal of research and commercial activities, none has been integrated in a cost-effective, holistic, and comprehensive way with the challenge of recycling LIBs.

Challenge: Devise a solution that minimizes the cost of moving batteries from consumers to recyclers and smooths the reverse supply chain (e.g., better anticipates the flow of materials). Participants should consider scenarios in which batteries are categorized as Class 9 miscellaneous hazardous materials or rendered inert such that theoretically they do not fall under Class 9. Participants should consider both scenarios in their solution design.

Track 5. Other Ideas

Context: Safely, sustainably, and cost-effectively collecting and transferring 90% of LIBs from consumers, businesses, and other organizations to recyclers, such that the overall recycling proposition is profitable, is a vexing singular problem *OR* series of problems. Do you have a radical idea that addresses the challenge? Do you have a solution to part of the challenge that was overlooked? Disruptive, bold, and rogue ideas are welcomed.

Challenge: Help us address the Prize Goal and discover market spurring innovations for LIB recovery.

4. CONTESTS

The contest will consist of 3 phases – Concept Development and Incubation, Prototype and Partnering, and Pilot Validation – which will fast-track efforts to identify, develop, and test disruptive solutions to meet battery recycling needs. Each stage will include a contest period when participants will work to rapidly

[32] https://www.sciencedirect.com/science/article/pii/S0921344918302015
[33] http://iopscience.iop.org/article/10.1088/1748-9326/10/1/014011/pdf

advance their solutions. In Phase I, participants will begin in a particular submission track, but by Phase III have a full end-to-end pilot for demonstration. DOE invites anyone eligible, individually or as a team, to compete to transform a conceptual solution into product reality.

The Three Contests:

1. **Phase I: Concept Development and Incubation** – During this phase, participants will demonstrate – via concept proposal – that they have identified a clear business model and technology plan toward profitably solving a selected submission track. In addition, participants will describe their vision for expanding beyond their initial submission tracks, and for how they might develop a prototype and conduct a pilot. Any eligible person or team can compete in the Phase I contest. To compete, participants are required to register and submit a submission. Participants are limited to one solution per submission. Participants may not submit duplicate submissions under different tracks. Awards for up to 25 participants totaling up to $1.0M will be distributed evenly with a minimum of $40,000 in cash. Only Phase I winners may compete in Phase II.

2. **Phase II: Prototype and Partnering –** During Phase II, the 25 eligible participants (or fewer) will develop a prototype of their concept proposal, proof of concept for their end-to-end solution, and detailed plans for conducting a pilot. Participants will also have the opportunity to develop relationships with partners. Awards for up to 10 participants totaling up to $2.5M will be distributed evenly among winners with minimum prize of $250,000 in cash. Only Phase II winners may compete in Phase III.

3. **Phase III: Pilot Validation** – During Phase III, the ten or fewer eligible participants will work to conduct a full end-to-end pilot scale solution for demonstration. Awards for up to 4 participants totaling up to $2M will be distributed evenly among winners with minimum prize of $500,000 in cash.

   This set of three phases of the contest offers a total of $5.5 million in cash prizes (see Figure 2). This document includes the official rules for Phase I. **The official rules for Phase II and III will be released prior to the opening of Phase II and III, respectively.**

Contest	Winners	Prizes
1. Phase I: Concept Development & Incubation	Up to 25	Up to $1,000,000 distributed equally among the winners in cash prizes (minimum of $40,000; maximum of $200,000 per winner)

2. Phase II: Prototyping and Partnering	Up to 10	Up to $2,500,000 distributed equally among the winners in cash prizes (minimum of $250,000; maximum of $500,000 per winner)
3. Phase III: Pilot Validation	Up to 4	Up to $2,000,000 distributed equally among the winners in cash prizes (minimum of $500,000; maximum of $1,000,000 per winner)

Figure 2. Total cash prizes.

To learn more and sign up for the Prize go to https://www.herox.com/BatteryRecyclingPrize

5. IMPORTANT DATES

- Announcement of Prize: January 17, 2019
- Prize Launch: Phase I Begins and Registration Opens: February 15, 2019
- Registration Closes: June 30, 2019, 8:00 PM EST
- Phase I Contest Submission Deadline: August 1, 2019, 5:00 PM EST
- Phase I Winners (Phase II Eligible Participants) Expected Announcement: September 30, 2019
- Phase II Contest Begins: October 1, 2019
- Phase II Contest Submission Deadline: October 1, 2020
- Phase II Winners (Phase III Eligible Participants) Expected Announcement: October 30, 2020
- Phase III Contest Begins: November 1, 2020
- Phase III Contest submission deadline: Estimated date of February 1, 2022
- Winners of Phase III Contest selected: Estimated March 2022

All dates are subject to change including contest openings, deadlines, and announcements. Sign up for updates at https://www.herox.com/BatteryRecyclingPrize

PHASE I: CONCEPT DEVELOPMENT & INCUBATION CONTEST RULES

1. INTRODUCTION

Phase I Contest Prizes

- Up to 25 winners
- $1,000,000 distributed equally among winners in cash prizes (minimum of $40,000 per winner)

The Prize is a three-contest $5.5 million cash prize competition designed to address critical material supply issues for battery applications, including electric vehicles, energy storage, and consumer electronics. Supporting entrepreneurs as they develop transformative approaches and technology ideas to efficiently and safely collect, sort, store and transport spent batteries for eventual recycling and recovery of critical materials, is the first step to set American entrepreneurs on a pathway of accelerated innovation.

Anyone eligible can participate in and submit a submission package (or more than one **separate submission**) to compete in the Phase I Contest, but participants must register first. Note that only winners of this contest can officially participate in Phase II. Participants are required to select a submission track and are limited to one solution per submission. Participants may not submit duplicate submissions under different tracks. The following rules are for participants participating in the Phase I Contest. "You" and "your" reference participants in the contest.

2. GOAL

Due to the techno-economic and organizational complexity of lithium-ion battery recycling, it is expected that a wide range of skills, knowledge, expertise, and experience, will likely be required to solve this challenge end-to-end. As the submission tracks indicate, there are already robust communities within particular fields or sectors working to advance the state of the art; however, exposure of these communities to the specific challenge of lithium-ion battery recycling is less developed. Increased exposure, interaction and collaboration across communities may stimulate revolutionary approaches and innovations.

The Concept Development & Incubation portion of the Prize aims to attract and introduce these communities to each other, and to unfamiliar aspects of the challenge. The goal is to garner innovative, evidence-based proposals from a wide range of participants, including those traditionally involved in recycling and/or lithium ion batteries, to those with no prior experience. The emphasis during Phase I is on strongly motivated and robustly supported ideas, in addition to well-documented and analyzed concept feasibility and practical potential. Submissions for Phase I should substantially improve upon existing solutions or represent entirely

novel solutions to one of the submission tracks. Submissions should describe a vision for scale-up (prototype, pilot) and how their idea addresses the Prize Goal and an end-to-end solution.

3. PRIZES TO WIN

The Phase I Contest offers up to 25 equal cash prizes, with a minimum cash prize of $40,000 and a maximum of $200,000. DOE reserves the right to select up to 25 winners. If five winners or less are selected each winner will receive $200,000. If more than five winners are selected, each winner's prize amount will be $1,000,000 equally divided by the number of winners.

4. HOW TO ENTER

Complete a submission package online at https://www.herox.com/BatteryRecyclingPrize

5. WHAT TO SUBMIT

Format Guidelines:

- Submit all components in English.
- Submit files in unlocked, searchable PDF form
- Submit all files in the following format: **Team-Name_BRP_Phase I.pdf**
- Confidential Business Information (CBI) should **not** be included in publicly facing documents (Video, Cover page, and Summary Slide); any CBI included in the Proposal is subject to and should follow instructions in Section VI.9. A complete submission package for the Phase I Contest should include the following items:

a. **Video**: Make a 90-second (maximum) video showcasing your submission. Focus on emphasizing the novelty or advantage(s) of your idea, and potential impact. Explain your approach and how it will integrate within a full end-to-end solution. Post your video ***UNLISTED*** to YouTube. Include your link in your submission. Note that your video will not be made public until after the submission deadline for Phase I.

b. **Cover page**: A template can be found at https://www.herox.com/BatteryRecyclingPrize

- Team Name
- Team Leader (point of contact) and Members (names, contact details)
- Submission Title

- Submission Track: Choose one (1) of the five (5) tracks above that the proposal addresses
- <100 word abstract.

c. Summary Slide: Make a public-facing, one-slide submission summary that contains technically specific details but can be understood by most people. The slide should include 1) Participant or Team Name and Team Leader, 2) Submission Title, 3) Submission Track, 4) Concept, 5) Approach, and 6) Potential Impact. Please make any text readable in a standard printout and conference room projection. A summary slide template can be found on: https://www.herox.com/BatteryRecyclingPrize

d. Proposal: Submit a 5–10 page proposal that includes the following components. All assumptions used in documentation, analysis, modeling, and simulation must be explicitly stated. The cover sheet will not count toward page limits.

Executive Summary

Team Composition and External Support: Individual member biographies and team experience and qualifications, external advisers (e.g., a board), or external sponsorship.

Solution: Describe proposed solution (including stage of development, intellectual property, and any validation to date) as well as the competitive landscape (describe competing solutions or technologies and how your solution differs from existing or proposed solutions in concrete details, e.g., in terms of cost or improved efficiency). Detail and quantify projected value or impact with credible supporting information.

Market Validation and Analysis: Lithium-ion battery recycling represents a complicated challenge necessitating a systems level solution. Which aspect are you solving? Contextualize your solution within the overall challenge—estimate the impact of your solution to the overall problem. Within this, describe relative market size, targeted segments, customers, and potential partners. Include or reference any evidence supporting this information or analysis.

Planned Execution and Allocation of Funds: Assuming you continue to the final stage of the contest, describe your business plan and your vision for scaling up. These plans should include milestones that are specific, measurable, achievable, relevant, and timely (SMART) outcome-based goals, not activity-based, so that a neutral third-party can validate them (if possible). For example: Set a definitive achievement of progress (e.g., "X letters of interest signed" or "achieve X% efficiency"). Identify future risks.

Detailed Technical Explanation: Describe your solution and approach beyond an initial overview. Show how when scaled, your solution could lead to a 90% recovery rate[34] of all lithium ion batteries.

34. 90% recovery means 90% of individual batteries produced: out of 10 batteries produced, 9 are recovered and delivered to a recycler.

This substantiation should include any and all assumptions and calculations and/or reference supporting data and/or literature. It can include schematics, drawings, or sketches if applicable. Bibliography/citations will not count toward total.

Please read and comply with additional requirements about your submission in SECTION VI. A cover sheet may be warranted if your submission contains CBI. PARTICIPANTS THAT DO NOT COMPLY WITH THESE REQUIREMENTS MAY BE DISQUALIFIED.

6. HOW WE SCORE

Advisory Review: The reviewers will score submissions based on their innovativeness, impact, feasibility, and technical approach. The scoring for each of the categories is on a 1 to 5 scale. These categories, along with their weighting, are discussed in more detail below.

Federal Consensus Panel: All Panel Members will review all submissions and the outcomes of the Advisory Review's scoring along with their individual evaluations. The Panel will then make selections and recommendations to the Selection Official based on the advisory reviews and expertise of the federal panel.

Selection Official: Final determination of winners by a Selection Official will take 1) Federal Consensus Panel recommendations, 2) Advisory Review scores, and 3) program policy factors (see SECTION VI.14) into account.

Submission Scoring Categories (Weights)

1. **Innovativeness (35%) –** Represents a unique, innovative approach regardless of whether the solution is entirely novel or significantly advances an existing idea or technology. Submission demonstrates documented understanding of current state of the art and substantiated differentiation of concept and approach.

2. **Impact (25%) –** Likelihood of making a substantial contribution toward the submission track being addressed, as well as the overarching DOE goal of achieving a 90% recovery rate for lithium-ion batteries. How well is the value and necessity of the solution within track demonstrated and how well developed is a plan for extending to an end-to-end solution?

3. **Feasibility (25%) –** Degree to which scale-up plan is credible. Submission should address the following questions within the Proposal: Is a there a plan for technological validation (e.g. demonstration or simulation)? Are necessary resources (e.g. instrumentation or facilities) identified? Does team background / composition reflect needed expertise? How well does the proposal describe a profitable business model? Is market context acknowledged? If not, are there plans to address these outstanding issues? Finally, have the major risks or uncertainties associated with the idea been identified and addressed?

4. **Technical Approach (15%) –** Demonstrates a high-level of technical merit for the proposed

approach and is grounded in sound scientific or engineering principles.

7. WHO CAN WIN (Eligibility Requirements)

To win the Phase I Contest, participants must comply with the following eligibility requirements. By uploading a submission package, a participant certifies that they comply with the eligibility requirements below. As soon as the Prize Administrator becomes aware that a participant is not eligible to win the Phase I Contest, the participant may be disqualified.

- A participant may constitute an individual or a team comprised of individuals (identified as team members in the submission package), or organization or entity based on the following:
    - Individuals must be a United States citizen or a US permanent resident.
    - Organizations must be an entity incorporated in and maintaining a primary place of business in the United States.
    - Teams must be comprised of otherwise eligible individuals or organizations, and led by an eligible individual or organization, designated as the team leader. The team leader will serve as the primary point of contact and designated submitter.
- Team leadership may be transferred to another individual during the course of the Prize, provided the individual is eligible.
- Team members may be added to the team during the course of the Prize. For a particular Phase, team members are defined as those identified in the respective Phase submission package.
- DOE employees and DOE support service contractors, individuals who have been employed by DOE, or working for DOE as a support service contractor within six months prior to the submission deadline of the Phase I Contest are not eligible to participate in any prize contests in this program.
- NREL employees directly involved in the administration of this prize are not eligible to participate in any prize contest in this program; however, NREL and other national lab employees including laboratory researchers may participate as private individuals. They can also win a prize contest provided they are not competing in their official capacity.
- Non-DOE Federal entities and Federal employees are also not eligible to win any prize contests in this program.
- Federal grantees may not use federal funds to develop submissions.

- Federal contractors may not use federal funds from a contract to develop prize competition submissions or to fund efforts in support of a prize competition submission.

- A participating entity shall not be deemed ineligible because the entity used Federal facilities or consulted with Federal employees during a competition if the facilities and employees are made available to all entities participating in the competition on an equitable basis.

8. GENERAL SUBMISSION REQUIREMENTS

Only submissions relevant to the goals of this program are eligible to compete. The Prize Administrator must conclude that all of the following statements are **true** when applied to your submission:

- The proposed solution is related to lithium-ion battery recycling.

- Activities that are described in and support the submission package must be performed in the United States.

- The proposed solution represents an innovation that will move the lithium-ion battery recycling industry beyond its current state.

- The proposed solution does not involve the lobbying of any federal, state, or local government office.

- 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 is based on fundamental technical principles and is consistent with a basic understanding of the U.S. market economy.

9. ADDITIONAL REQUIREMENTS

Please read and comply with additional requirements in SECTION VI. PARTICIPANTS THAT DO NOT COMPLY WITH THESE REQUIREMENTS IN SECTION VI MAY BE DISQUALIFIED.

SECTION VI

ADDITIONAL TERMS AND CONDITIONS

1. UNIVERSAL CONTEST REQUIREMENTS

Your submission for the Phase I, Phase II, and Phase III Contest is subject to following terms and conditions:

- You must complete registration at https://www.herox.com/BatteryRecyclingPrize to participate in the Prize by the registration deadline.
- You must post the final content of your submission or upload the submission form online at https://www.herox.com/BatteryRecyclingPrize before the Phase I, Phase II, and Phase III Contests close. Late submissions or any other form of submission do not qualify.
- The video submission, summary slide, and cover page will be made public.
- The proposal is not intended to be made public; however, see section VI.10 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. Participants may be given an opportunity to rectify submission errors due to technical challenges.
- Your submission must be in English and in a format readable by Microsoft Word. Scanned hand written submissions will be disqualified.
- Submissions will be disqualified if they contain 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 proceed to register for any of the contests described in this document, these rules will form a valid and binding agreement between you and the U.S. Department of Energy and is 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 only apply to the contests described here and no other contests on the HeroX platform or anywhere else.
- The Prize Administrator, when feasible, may give participants an opportunity to fix non-substantive mistakes or errors in their submission packages.

2. VERIFICATION FOR PAYMENTS

The Prize Administrator will verify the identity and the role of a participant potentially qualified to receive the prizes. Receiving a prize payment is contingent upon fulfilling all requirements contained herein. The Prize Administrator will notify winning participants using provided email contact information after the date that results are announced. Each participant will be required to sign and return to the Prize Administrator, within 30 days of the date the notice is sent, 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 participant will be disqualified from the competition and receive no prize funds if: (i) the person/entity cannot be contacted; (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.

3. TEAMS AND SINGLE ENTITY AWARDS

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

4. SUBMISSION RIGHTS

By submitting materials to the Ideation program, submitters agree to allow their submissions to be released to the public under a Creative Commons Attribution 4.0 International License (see http://creativecommons.org/licenses/by/4.0/).

The public videos in this contest must be submitted and released to the public under a Creative Commons Attribution 4.0 International License (see http://creativecommons.org/licenses/by/4.0/).

By making a submission and consenting to the rules of the contest, a participant 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 submissions, 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 DOE, the administrator, and the reviewers for purposes of the contests, including but not limited to screening and evaluation purposes. The Prize Administrator and any third parties acting on its behalf will also have the right to publicize indefinitely a participant’s name and, as applicable, the names of the participant’s team members and organization on the contest website.

By entering, Participant represents and warrants that:

1. Participant's entire submission is an original work by participant and participant has not included third-party content (such as writing, text, graphics, artwork, logos, photographs, dialogue from plays, 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 participant in the submission and (ii) participant 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 participant 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 participant to work on the submission or who appear in the Submission in any manner have:

    a. Given participant 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; participant may be asked by 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.

5. COPYRIGHT

Each participant represents and warrants that the participant is the sole author and copyright owner of the submission; that the submission is an original work of the applicant or that the applicant 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 upon any other third party rights of which the applicant is aware; and that the submission is free of malware.

6. 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 awards are contingent upon the availability of appropriations.

7. 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.

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 participant. 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. Participants and potential winners may be required to show proof of being the authorized account holder.

8. PUBLICITY

The 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.

9. LIABILITY

Upon registration, all participants agree to assume and, thereby, have assumed any and all risks of injury or loss in connection with or in any way arising from participation in this contest and development of any submission. 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.

Participants in Phase II and III shall be required to obtain liability insurance for $1,000,000 by the Department of Energy, for claims by—

- Third parties for death, bodily injury, or property damage, or loss resulting from an activity carried out in connection with participation in a prize competition, with the Federal Government named as an additional insured under the registered participant’s insurance policy and registered participants agreeing to indemnify the Federal Government against third party claims for damages arising from or related to prize competition activities; and
- Federal Government for damage or loss to Government property resulting from such an activity.

10. RECORDS RETENTION AND FOIA

All materials submitted to DOE as part of a submission become DOE records, subject to the Freedom of Information Act (FOIA).

The purpose of the FOIA is to afford the public the right to request and receive agency records unless those agency records are protected from disclosure under one or more of the nine FOIA exemptions. Decisions to disclose or withhold information received from the applicant are based upon the applicability of one or more of the nine FOIA exemptions, not on the existence or nonexistence of protective markings or designations. Only the agency's designated FOIA Officer may determine if information received from the applicant may be withheld pursuant to one of the nine FOIA exemptions. All FOIA requests received by DOE are processed in accordance with 10 C.F.R. Part 1004.

In general, EERE will only use data and other information contained in submissions for evaluation purposes, unless such information is generally available to the public or is already the property of the Government.

Applicants should not include trade secrets or commercial or financial information that is privileged or confidential in their submission unless such information is necessary to convey an understanding of the proposed project or to comply with a requirement in the FOA.

If the submission contains trade secrets or confidential commercial or financial information, such Confidential Business Information (CBI), should be designated at the time of submission in the following manner:

- The cover sheet must identify the specific pages containing CBI and include the following language:

  "Notice of Restriction on Disclosure and Use of Data: Pages [list applicable pages] of this document may contain CBI – trade secrets or commercial or financial information that is privileged or confidential and is exempt from public disclosure. Such information shall be used or disclosed only for evaluation purposes. The Government may use or disclose any information that is not appropriately marked or otherwise restricted, regardless of source. [End of Notice]"

- The header and footer of every page that contains trade secrets or commercial or financial information that is privileged must be marked as follows: "CBI".

- In addition, each line or paragraph containing trade secrets or commercial or financial information that is privileged or confidential must be enclosed in brackets.

However, applicants should be aware that the use of protective markings is not dispositive as to whether information will be publicly released pursuant to the Freedom of Information Act, 5 U.S.C. §552, et. seq., as amended by the OPEN Government Act of 2007, Pub. L. No. 110-175.

11. 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.

12. 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 indicates in the Phase I, Phase II, and Phase III Contests that it will select up to several winners for each contest, DOE reserves the right to only select participants that are likely to achieve the goals of the program. If, in DOE's determination, no participants are likely to achieve the goals of the program, DOE will select no participants to be winners and will award no prize money.

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

13. PROGRAM POLICY FACTORS

While the scores of the judges will be carefully considered, it is the role of the Prize Administrator to maximize the impact of contest funds. Some factors outside the control of participants and beyond the independent judges' scope of review may need to be considered to accomplish this goal. The following is a list of such factors. In addition to the judge's scores, the program policy factors below may be considered in determining winners:

- Geographic diversity and potential economic impact of projects in a variety of markets.
- Whether the use of additional DOE funds and provided resources continue to be non-duplicative and compatible with the stated goals of this program and the DOE mission generally.
- Entity diversity from individuals, to teams, to small businesses, to large corporations.
- The degree to which the submission exhibits technological or programmatic diversity when compared to the existing DOE project portfolio and other participants.
- 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, productivity, and manufacturing in the United States or provide other economic benefit to U.S. taxpayers.

- 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 efforts or projects, which, when taken together, will best achieve the research goals and objectives.

- 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 submissions to facilitate technology transfer.

14. DEFINITIONS

Prize Administrator means both the Alliance for Sustainable Energy operating in its capacity under the Management and Operating Contract for the National Renewable Energy Laboratory (NREL), and the U.S. Department of Energy Vehicle Technologies Office (VTO) and the Advanced Manufacturing Office (AMO). When the Prize Administrator is referenced in this document, it refers to staff from both the Alliance for Sustainable Energy, VTO, and AMO. Ultimate decision making authority regarding contest matters rests with the Director of the Vehicle Technologies Office.