The United States Department of Energy
Office of Fossil Energy's

Science-informed Machine-learning to Accelerate Real Time (SMART) Visualization Platform (VP) Prize Challenge

OFFICIAL RULES

The U.S. Department of Energy (DOE) Office of Fossil Energy's (FE's) *Science-informed Machine-learning to Accelerate Real Time (SMART) Visualization Platform (VP) Prize Challenge* focuses on bringing the subsurface environment to life through the development of an innovative, user-friendly, intuitive and attractive visualization solution that can be readily accessible by scientists, engineers, subsurface operators, and decision makers, and that works in unison with the DOE's SMART Initiative.

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A. PRIZE CHALLENGE SUMMARY

1. INTRODUCTION AND BACKGROUND

This prize challenge (also referred to as a competition) is part of the U.S. Department of Energy's (DOE's) SMART Initiative — Science-informed Machine-learning to Accelerate Real Time Decisions in the Subsurface.

The SMART Initiative is led by DOE's Office of Fossil Energy (FE), and it consists of this prize and multiple research efforts conducted by technical teams of scientists and engineers across 15 different research organizations. The SMART Initiative targets innovative and novel breakthroughs in understanding the subsurface environment through machine learning. The technical teams are developing machine learning based methods to extract knowledge from data, and the prize will be awarded to challengers that develop the platform for conveying this knowledge.

Many aspects serve as the driver for the SMART Initiative. Decisions on subsurface operations are hindered by the inherent uncertainty and complexity in subsurface systems. By developing an intuitive and deeper understanding of these subsurface systems, a decision maker can choose options that reduce risk and increase efficiency in the utilization of resources such as unconventional hydrocarbon reservoirs or saline formations for the long-term storage of CO_2. Such decisions may be better informed through an experiential visualization environment that facilitates an understanding of (i) the characteristics of the subsurface at multiple scales, (ii) the predicted behavior of the subsurface in response to human actions such as injection or extraction of fluids through wellbores, and (iii) the way(s) in which multiple subsurface phenomena may interact. Current approaches to visualizing subsurface data present information in formats traditionally used by scientists and engineers as part of a rigorous, physics-based analytical workflow. These formats require expert training to extract insights, and the workflows are time consuming and costly. These latter limitations are being addressed by the technical efforts in the SMART Initiative through new machine-learning based workflows to extract knowledge from data. The prize is intended to address limitations requiring significant training and expertise by users by presenting the extracted knowledge in an accessible and intuitive way.

We envision an innovative, immersive, and experiential visualization tool (a "visualization platform") that non-expert decision makers can use to interact directly with subsurface data. Further, this visualization platform can be used by technical experts to enhance their analysis and interpretations.

Expertise in the software development and visualization realm is sought to bring these enormous datasets and new computational realizations to life with a modern-day visualization platform. The resulting platform will provide intuitive insights into subsurface features and processes at multiple scales (ranging from submeter to 100-kilometers).

2. PRIZE CHALLENGE PURPOSE

The purpose of the SMART VP prize challenge is to create a comprehensive experiential visualization solution (a "visualization platform") for the subsurface environment that can be readily accessible by experts and non-experts — i.e., by scientists, engineers, subsurface operators, and by other decision makers such as landowners. The platform must work in unison with the data and knowledge output by the machine learning workflows being developed by the technical teams in the SMART Initiative, where the data and knowledge relate to subsurface features of interest. The successful visualization platform will convey an intuitive understanding of how these features of interest vary spatially and temporally. A key aspect of the solution will be to convey how these features of interest vary in response to different decisions related to injection/extraction of fluids over time. To achieve this, the visualization platform developed by the challenger(s) will utilize data streams from the machine-learning workflows created by the technical teams in the SMART Initiative, while at the same time allowing user interaction, such as changing settings, adjusting inputs, or requesting different outputs.

Challengers are called on to be creative and innovative in inventing new ways to visualize/experience subsurface data that is multi-scale, disparate, and time dependent. The new platform should be intuitive and simple to understand. It should facilitate communication between experts (who derive subsurface knowledge from data) and non-expert decision makers (who must take an action based on the knowledge). It should be capable of visualizing multiple scenarios, displaying uncertainty, toggling on and off sets of data and overlays, and more.

Subsurface features of interest include (i) static geologic data such as lithologies and various rock properties, (ii) static geologic features such as faults and fracture networks, (iii) wellbores, (iv) dynamic processes such as fluid flow, evolution of subsurface plumes, and changes in reservoir properties (e.g., changes in the amount or type of fluid within a given volume of rock or changes in fluid pressure), and (v) difficult to visualize concepts such as time-varying stress fields or the distribution and magnitude of point events like microseismicity. Importantly, the uncertainty associated with any of the above properties or features must be readily available to users. These features may exhibit a range in detail at different scales. Examples of intuitive insights that might be conveyed by the platform include (a) how features of interest vary spatially and temporally at scales ranging from submeters to 100 kilometers, (b) how decisions on changing the rates or locations of fluid injection/extraction change features of interest, or (c) how subsurface features and processes may correlate and/or interact.

This visual platform should help users gain insight into key questions for field operations such as the following:

- How do fluids flow (or not) between various wells that penetrate a reservoir in response to injection/extraction at the wells?
- What are the characteristics of wells in the vicinity of a subsurface operation? These characteristics might include physical attributes that may vary along the

well, change over time, and/or include a single attribute for the well, such as risk of failure.

- What are the characteristics of the reservoir at different scales? How do these characteristics impact fluid flow within the reservoir?
- How does the reservoir behave in response to the injection/extraction of fluids at various wells? Where is the best place to drill a new injection/extraction well to optimize fluid-flow in the reservoir, where optimization might tie to drainage of existing fluids in a reservoir, minimization of pressure changes, or other physical characteristics?
- How does the subsurface environment respond to processes like injection/extraction of fluids in a reservoir or earth tides? Responses might range from point events such as microseismicity to physical events tied to discrete features, such as changes in a fracture network, to spatial events, such as changes in a stress or pressure field.
- What is the most efficient strategy for collecting additional field data, where the goal might consist of lowering uncertainty in subsurface characteristics, improving predictions on subsurface behavior, or ensuring environmental compliance, such as protection of underground sources of drink water?
- The Challenge will focus on bringing the subsurface to life through the development of an innovative, user-friendly, intuitive and attractive visualization platform. While DOE/National Energy Technology Laboratory (NETL) has access to world-class simulation and modeling tools, the challenge of putting the science and the insights into a single visualization platform is complex. Software development expertise found primarily outside the public sector is needed to create a new visualization platform that will assist in making subsurface insights accessible to a wider range of users and stakeholders.

3. PRIZE CHALLENGE SCOPE

The SMART VP prize challenge is designed around the following two-phased approach:

- ***Phase 1*** will consist of a 4–5-month independent partial development/prototype challenge in which challengers will show their expertise by designing a prototype platform and/or mock-up and explaining its innovative and user-friendly features.
- ***Phase 2*** will be a 10-month long collaborative effort between the winners of Phase 1 and DOE's SMART tech team to develop a complete visualization solution. Multiple workshops (e.g., involving the SMART tech team and Phase 2 challenge participants) through online forums and webinars will assist the Phase 2 challengers in developing a fully operational visualization platform.

PHASE 1

Challengers will demonstrate that they are best suited to develop a visualization platform that can incorporate the data types and algorithms being developed with the SMART Team by submitting materials (in the form of videos, written materials, and computer

models) that show how they intend to visualize and otherwise represent (e.g., auditorily) features and events using supplied data sets and completing a minimum set of feature requirements.

The participants will receive a Docker image that includes several publicly available data sets involving static physical properties of realistic geologic systems, as well as synthetic data sets and dynamic scripts and images that represent important flows, relevant to both carbon storage and oil and gas recovery. The Docker image will have Python Application Programming Interface (API) and Command Line Interfaces which deliver the datasets and subsurface models in need of visualization. The API will build and run numerical simulations of fluid flow through permeable media in the subsurface. It will also build and run approximations of these flow simulations and include code for constructing a synthetic geologic model to represent the "true" subsurface. These models will include geologic structures (i.e., their shapes and physical properties) including rock layers/wells, geo-bodies, faults, and fractures. This API will also construct a series of "proposed" geologic models to attempt to fit the "true" model output, as an example of what the current visualization capabilities are. It will then perform parameter estimation, sensitivity analysis for forecasting, as well as construction and optimization of decision networks. Challengers may develop their code (e.g., in a modified version of the Docker image provided in Python or by making API calls in another programming language) and make it easily sharable in a code repository of their choosing (e.g., Docker, GitHub). The Docker image that is provided will include the necessary information needed to build a visualization of these 3D fluid flow models as a proof of concept with a set of **required** and **recommended** capabilities defined below.

Phase 1 entries will be judged by two distinct levels of capabilities within their platform: **required** capabilities, which all entries must demonstrate or describe; and **recommended** capabilities, which are optional due to the challenging or in-depth nature of these capabilities.

Required Capabilities for Phase 1

Successful Phase 1 entries MUST provide a mock-up and/or prototype platform showing clearly how the final platform will demonstrate the following **required** capabilities:

- Visualize the 3D fluid flow models provided (in the Docket container), demonstrating the ability to display parameters that are:
    - In the form of scalar, vector, or tensor fields.
    - Static or time variant.
    - Discrete (rock layers may be classified from a list of numbered rock types such as "shale" or "sandstone") or continuous (porosity is a floating-point number between 0 and 1).
    - Discrete events in space and time (microseismic events, fracturing events).
- Visualize or demonstrate (in a prototype code or through detailed description and visualization) at least two of the following:
    - At least one static field variable/feature using the provided examples(s).

This may be rendered in 3D by using any visually intuitive method, such as heat maps, isosurfaces, or collections of 2D slices.
    - User selection of discrete objects, which may include points, lines, surfaces or volumes.
    - User editing of parameters such as transparency or colorscale and the ability to "hide" certain geologic structures or attributes from the user's field of view.
    - User interrogation of the value of discrete points within the model, such as reading coordinates and/or physical property.
- Describe how uncertainties of static and dynamic properties will be represented.

A successful Phase 1 submission also MUST include:

- A description of the minimum hardware requirements (e.g., memory, CPU speed, graphic cards) for satisfactory performance of the software as a function of the volume of the input data and number of output options.
- A software utilization plan that describes how (e.g., open source license) the final software produced at the end of Phase 2 will be made available to DOE and others. The software product must be available to the U.S. government, academic institutions, and non-profit institutions for modification and use at no additional cost.

Recommended Capabilities for Phase 1

Successful Phase 1 entries MAY also describe how the visual platform will achieve the following **recommended** capabilities:

- The ability to distill time-variant 3D data down to a 1D time-series that can be compared to sensor data at specific points in space.
- Interaction with the provided Python API to construct and run fast surrogate model simulations on local machines.
- The ability to either edit subsurface parameters and control variables, or graphically draw and design a new conceptual model.
- Visualization of ensembles of reservoir models in a meaningful way that highlights commonalities and differences. This visualization should make a distinction between the most important differences while minimizing commonalities or information deemed unimportant by sensitivity analysis.
- Visualization of large and complex decision networks.
- Visualization of the uncertainty associated with different subsurface properties and how the uncertainty level and distribution changes with different operational or measurement scenarios.

PHASE 2

Winners from Phase 1 of the Challenge will develop a complete visualization platform solution in Phase 2. Challengers will work to develop the visualization platform prototyped in Phase 1 into a fully operational beta version that will be presented and submitted. Visual Platform submissions will be scored based on the required and recommended

capabilities as defined below, and the judging criteria as defined in Section B.2. The final software product must be made available to the U.S. government, academic institutions and non-profit institutions for modification and use at no additional cost. We foresee the developed platform being used to visualize data for a number of next generation technology field and research projects, even beyond just the SMART initiative, in the future. The Phase 2 winner may also have an opportunity to enter into an agreement to work further with the SMART Initiative team after the Challenge is over (this decision is solely within the discretion of DOE; DOE reserves the right not to pursue an agreement with the Phase 2 winner for additional work; however, if DOE decides to pursue an agreement, all applicable Federal laws and regulations will be followed).

Phase 2 Workshops: Workshops will be held on virtual platforms and will be recorded and made available to all Phase 2 participants. Challengers are strongly encouraged, but not required, to participate in the workshops, where they will interact and receive both direction and feedback from the SMART Initiative team. Workshops may consist of online forums and/or resources and will be designed to promote fairness and maintain the integrity of the competition. A forum may be available for questions and conversation between workshop dates.

Phase 2 entries will be judged by two distinct levels of capabilities within their platform: required capabilities, which all entries must demonstrate or describe and recommended capabilities, which are optional due to the challenging or in-depth nature of these capabilities.

Required Capabilities for Phase 2

Successful Phase 2 entries MUST provide a beta version of a platform showing the following **required** capabilities:

- Visualize the 3D fluid flow models provided, demonstrating the ability to display parameters that are:
    - In the form of scalar, vector, or tensor fields.
    - Static or time variant.
    - Discrete (rock layers may be classified from a list of numbered rock types such as “shale” or “sandstone”) or continuous (porosity is a floating-point number between 0 and 1).
    - Discrete events in space and time (microseismic events, fracturing events).
- Visualize or demonstrate the following:
    - Static field variables/features using the provided examples(s). This may be rendered in 3D by using any visually intuitive method, such as heat maps, isosurfaces, or collections of 2D slices.
    - User selection of discrete objects, which may include points, lines, surfaces or volumes.
    - User editing of parameters such as transparency or colorscale and the ability to “hide” certain geologic structures or attributes from the user’s field of view.

    - User interrogation of the value of discrete points within the model, such as reading coordinates and/or physical property.
- Describe how uncertainties of static and dynamic properties will be represented.

A successful Phase 2 submission also MUST include:

- A description of the minimum hardware requirements (e.g., memory, CPU speed, graphic cards) for satisfactory performance of the software as a function of the volume of the input data and number of output options.
- A software utilization plan that describes how (e.g., open source license) the final software produced at the end of Phase 2 will be made available to DOE and others. The software product must be available to the U.S. government, academic institutions, and non-profit institutions for modification and use at no additional cost.

Recommended Capabilities for Phase 2

Successful Phase 2 entries may demonstrate the following **recommended** capabilities:

- The ability to distill time-variant 3D data down to a 1D time-series that can be compared to sensor data at specific points in space.
- Interaction with the provided Python API to construct and run fast surrogate model simulations on local machines.
- The ability to either edit subsurface parameters and control variables, or graphically draw and design a new conceptual model.
- Visualization of ensembles of reservoir models in a meaningful way that highlights commonalities and differences. This visualization should make a distinction between the most important differences while minimizing commonalities or information deemed unimportant by sensitivity analysis.
- Visualization of large and complex decision networks.
- Visualization of the uncertainty associated with different subsurface properties and how the uncertainty level and distribution changes with different operational or measurement scenarios.

Examples of responsive entries include the following: PC Software Visualization with or without the use of virtual reality headset systems, Cloud-based Visualization systems for remote access of stored data on PCs or tablets, system components and operating systems that are commonly accessible.

Examples of non-responsive entries include the following: Software that does not meet the Required capability requirements as defined; a written proposal detailing an intended platform without supporting video or code base; an entry that requires specialized hardware that could not be accessible to an average user in an office environment (e.g., supercomputer, CAGE); or software with licensing proposal (Software Utilization Plan) that does not allow the DOE, academic institutions, and non-profits to freely use and modify the code.

4. PRIZES TO WIN AND PRIZE STRUCTURE

The SMART VP prize challenge is expected to award up to $1.5 million in total cash prizes, as follows:

- Phase 1:
  - The first phase will award up to five prizes, valuing up to a total of $600,000 (prize amount equally distributed amongst all winners).
  - Anticipated Duration: September 2020 through January 2021.
- Phase 2:
  - The second phase will award one prize winner, valuing up to $900,000.
  - Anticipated Duration: March 2021 through January 2022.

DOE may award one, multiple, or no prizes as a result of this competition.

5. IMPORTANT DATES AND DEADLINES

Participants must register at https://netl.doe.gov/challenges/SMARTVisualizationPlatform by 8:00 p.m. Eastern Time (ET) on January 22, 2021, to submit a prize entry. Participants will receive an automatic email confirmation upon successful registration. Entries must be submitted by 8:00 p.m. ET on January 29, 2021.

Prize Challenge Announced:	*September 25, 2020*
Registration Begins:	*September 29, 2020*
Phase 1 Registration/Questions Deadline:	*January 22, 2021, at 8:00 p.m. ET*
Phase 1 Submission Entry Deadline:	*January 29, 2021, at 8:00 p.m. ET*
Phase 1 Winners Announced:	*April 16, 2021*
Phase 2 Quarterly Workshops:	*April 2021; June 2021; September 2021; December 2021*
Phase 2 Questions Deadline:	*January 21, 2022, at 8:00 p.m. ET*
Phase 2 Submission Entry Deadline:	*January 28, 2022, at 8:00 p.m. ET*
Phase 2 Winner Announced:	*April 15, 2022*

All dates are subject to change including prize challenge openings, deadlines, and announcements.

6. QUESTIONS

For questions about the SMART VP prize challenge, contact: SMARTVPChallenge@netl.doe.gov.

Questions and comments concerning this prize challenge must be submitted no later than **January 22, 2021, for Phase 1 and January 21, 2022, for Phase 2**. Questions submitted after that date may not allow the Government sufficient time to respond.

B. OFFICIAL PRIZE RULES

1. HOW TO ENTER PRIZE CHALLENGE

Participants must register at https://netl.doe.gov/challenges/SMARTVisualizationPlatform, no later than 8:00 p.m. ET on January 22, 2021, to be eligible to submit an entry. Once registration is complete, participants will receive a confirmation email with submission instructions and the identification (ID) number assigned to the entry (email could take up to one business day).

Phase 1 Entries: Entries must be submitted by **8:00 p.m. ET on January 29, 2021** to be considered eligible to participate in Phase 1 of the prize challenge.

Phase 2 Entries: Entries must be submitted by **8:00 p.m. ET on January 28, 2022** to be considered eligible to participate in Phase 2 of the prize challenge. Only winning entries selected from the Phase 1 submission are eligible to participate in Phase 2 of the prize challenge.

Participants may enter more than one submission; however, each submission must be unique and not be duplicative or redundant of another submission entered by the Participant.

2. SUBMISSION SPECIFICS

PHASE 1 SUBMISSION REQUIREMENTS

All participants must submit the following items using the Submission Template provided at https://netl.doe.gov/challenges/SMARTVisualizationPlatform in order to be considered eligible to win a Phase 1 prize:

a. **Cover page:**
   - Title of submission.
   - Name (person or entity) of participant(s).
   - Type of entity, if applicable (*e.g.* individual, academia, industry).
   - Contact information (mailing address, phone number and email address) of the point of contact for the submission.

b. **Public Abstract:** The abstract must contain a summary of the proposed idea suitable for public dissemination, preferably with minimal technical jargon. The abstract must be 500 words or less and contain no graphics. This document must not include any proprietary or sensitive business information as DOE may make it available to the public if a prize is made.

c. **Written Narrative:** The narrative must be no more than 10 pages, following the format described below (an outline of the narrative with further description is provided in the appendix):
   - **Technical narrative:** This section will serve to augment the video in describing the final visualization platform and how it works, including the

functionalities that you plan to develop, the software design approach that you plan to use, and a proposed timeline and milestones for model development. Hardware and software requirements will also be described in this section.
    - **Software utilization plan (SUP):** This section will describe how the Participant plans to enable the SMART Initiative Team and others to use and modify the final software (e.g., open source license).
    - **Participant Qualifications and Role(s):** This section will describe the qualifications and roles to be performed for all key personnel. Brief bios for each of the key personnel, if applicable, may be attached in an appendix that will not count against the page limit.

d. **Video:** Participants must provide a link to a video presentation (e.g., YouTube, Vimeo) of no more than ten minutes in length that explains the vision for the full version of the platform and a clear description of the features developed in the prototype. The video must clearly demonstrate how the entry addresses the **required** and **recommended** capabilities as defined in Section A, Part 3. The video should also include key unique features of the proposed visualization platform, how portable the software will be, what types of data formats it uses, explain the software utilization plan (SUP), as well as the possibility to expand the software to include immersive visualization (IV), virtual reality (VR), and/or Augmented Reality (AR) in Phase 2.
e. **Code Repository:** Participants must provide access to a code repository (e.g., Docker image, GitHub, Android app) of the completed prototype/partial development of the visualization platform to date. The code submitted at the end of Phase 1 should be sufficient to demonstrate capabilities to perform the plans described in the written narrative and video. The code does not need to be fully functional in Phase I. Only the code repository that has been submitted in response to Phase 1 will be judged. Any altering of the code in the repository subsequent to the final submission will not be considered for Phase 1 judging.

Additional Requirements: Written narrative, video, and code repository should not include any sensitive Personally Identifiable Information (PII) (*i.e.*, information that can be used to distinguish or trace an individual's identity). All pages must be formatted to fit on 8.5 x 11-inch paper with margins not less than one inch on every side. Use a font size of 11 point or larger. Stated page limits shall include all text, index, graphs/charts, images, logos, appendices, etc., except where specifically noted otherwise.

[End of Phase 1 Submission requirements]

PHASE 2 SUBMISSION REQUIREMENTS

Winning entries selected from the Phase 1 submission, who elect to participate in Phase 2 of the prize challenge, must submit the following items in order to be considered eligible to win a Phase 2 prize:

a. **Demonstration:** A live WebEx presentation of the completed visualization platform that has been developed.
b. **User manual and/or User tutorials:** Complete technical documentation,

including system requirements, installation, and functionality of the completed visualization platform written for a non-technical user. Additionally, a complete submission will provide user tutorial video(s) detailing functionality and demonstrating use of the completed visualization platform.

c. **Code repository:** Access to a code repository (e.g., Docker image) with all software and licenses necessary to run in a stand-alone way, the completed development of the visualization platform that works with the data sets, and algorithms identified during Phase 2.
d. **Updated public abstract**: The abstract must contain a summary of the visual platform solution suitable for public dissemination. The abstract must be 500 words or less and contain no graphics. This document must not include any proprietary or sensitive business information as DOE may make it available to the public if a prize is awarded.
e. **Updated software utilization plan (optional)**: This section will describe how the Participant plans to enable the SMART Initiative Team and others to use the final software (e.g., open-source license). If an updated software utilization plan is not submitted in Phase 2, the software utilization plan submitted in Phase 1 will be assumed to remain unchanged.

[End of Phase 2 Submission requirements]

NOTE: Entering your submission to the prize challenge will constitute your acceptance of the Official Rules and your assertion of eligibility. Participants must register in accordance with Section B.1 prior to submitting an entry.

3. JUDGING CRITERIA

Submissions will be screened for compliance with the Official Rules. The eligible submissions will be evaluated and scored by a panel of judges on a scale of 0-100 points (one hundred being the highest) using the scoring criteria described below. Phase 1 and Phase 2 submissions will be subject to separate judging criteria as described below.

PHASE 1 CRITERIA

The following judging criteria will be applied to Phase 1 submissions:

1. FUNCTIONALITY (up to 35 points)
   a. Degree to which the submission demonstrates how the final software will be able to manipulate images and interrogate the model relative to static field properties of the system, including uncertainty.
   b. Degree to which the submission demonstrates how the final software will be able to visualize dynamic flows and changes of other variables within the system.
   c. Degree to which the submission demonstrates how the final software will be able to interface with defined input data types and handling capabilities.
   d. Degree to which the submission demonstrates how it will meet other **required** and **recommended** capabilities described in Section A, Part 3, above.
   e. The ease of approach to share the final software product with DOE, its partners

and others as described in the software utilization plan.

2. USER-FRIENDLINESS AND VISUAL APPEAL (up to 30 points)
   a. Degree to which the submission demonstrates ease of use and intuitiveness of navigating controls and features of the platform.
   b. Degree to which the submission demonstrates ease of use and intuitiveness relative to manipulation of visualizations.
   c. Degree to which the submission demonstrates ease of use with regard to data input and output.
   d. Visual appeal of the entire proposed system, including features and overlays, color schemes, and overall look and feel.

3. INNOVATION (up to 20 points)
   a. Degree to which the submission displays the application of novel visualization techniques (e.g., techniques not typically used in visualizing geologic data).
   b. Degree to which the submission displays innovation in the organization and handling of data and algorithms.
   c. Use of combined visual and/or non-visual techniques to demonstrate uncertainty.
   d. Uniqueness of vision for final visual platform.

4. PARTICIPANT CREDENTIALS (up to 15 points)
   a. Degree to which the participant or participant team has credentials, capabilities, and experience in software development and sub-surface technologies.
   b. Evidence of other software builds that demonstrate potential for success in Phase 2.

PHASE 2 CRITERIA

The following judging criteria will be applied to Phase 2 submissions:

1. FUNCTIONALITY (up to 40 points)
   a. Ability to manipulate images and interrogate the model relative to static field properties of the system, including uncertainty.
   b. Ability to visualize dynamic flows and changes of other variables within the system.
   c. Ability to interface with defined input data types and handling capabilities.
   d. Degree to which software meets other required and recommended capabilities described in Section A, Part 3, above.
   e. The approach to share software with DOE, its partners, and others as laid out in the most up-to-date software utilization plan.

2. USER-FRIENDLINESS AND VISUAL APPEAL (up to 35 points)
   a. Ease of use and intuitiveness of navigating controls and features of the platform.
   b. Ease of use and intuitiveness relative to manipulation of visualizations.
   c. Ease of use with regard to data input and output.
   d. Degree to which the user-guide and/or video describes the platform in a simple,

easy to understand, and repeatable manner.

e. Visual appeal of the entire system, including features and overlays, such as color schemes and overall look and feel.

3. INNOVATION (up to 25 points)
   a. Degree to which the submission displays the application of novel visualization techniques (e.g., techniques not traditionally used in visualizing geologic data).
   b. Degree to which the submission displays innovation in the organization and handling of data and algorithms, especially to increase speeds.
   c. Use of combined visual and/or non-visual techniques to demonstrate uncertainty.

By participating in the SMART VP Prize Challenge, each Participant acknowledges and agrees to be bound by the final decisions of DOE.

The judging scores will not be posted. Feedback will not be provided to entrants that are not selected as Winner(s).

If any potential Winner is found to be ineligible, has not complied with these Official Rules, Terms and Conditions, or declines the applicable cash prize for any reason prior to award, such potential Winner will be disqualified, and an alternate Winner may be selected.

C. TERMS AND CONDITIONS

By submitting an entry in the SMART VP Prize Challenge, the Participant acknowledges and agrees to the following Terms and Conditions. Participant acknowledgement of these Terms and Conditions may require documentation. Participants must register prior to submitting an entry.

DOE reserves the right to require additional documentation at any time to demonstrate a Participant's compliance with the SMART VP Prize Challenge rules, including the Terms and Conditions, and will disqualify any Participant who is unable to satisfactorily demonstrate compliance to DOE.

1. ELIGIBILITY

Eligibility is subject to verification before monetary prizes are awarded. To be eligible to win, a Participant (individual or group) must comply with the following requirements, at the time of submission:

a. Participant must have complied with all requirements set forth in the Official Rules for the SMART VP prize challenge.
b. Individual(s), whether participating singly or in a group, must be a U.S. citizen or a U.S. permanent resident and be 18 years or older.
c. A private entity must be incorporated in and maintain a primary place of business in the United States.
d. A Participant may not be a Federal entity or a Federal employee.
e. DOE support service contractors, individuals who have been employed by DOE, or who have worked for DOE as a support service contractor within six months prior to the submission entry deadline, are not eligible to participate.
f. Federally Funded Research and Development Centers (FFRDCs) and National Laboratories (NL) are not eligible to participate.
g. A Participant may not be a current or former individual member of the SMART Initiative.
h. A Participant may not be a Federal financial assistant awardee or contractor using Federal funds to participate.

A Participant will not be disqualified for using Federal facilities or consulting 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.

By submitting an entry, a Participant certifies compliance with the eligibility requirements described above. As soon as DOE becomes aware that a Participant is not eligible to win the SMART VP Prize Challenge, the Participant will be disqualified.

2. PARTICIPANT REPRESENTATIONS AND WARRANTIES

Upon submission, the Participant hereby represents and warrants that:

a. It is the sole author and copyright owner of the submission; that the submission is

an original work of the Participant and that the Participant has sufficient rights to use and to authorize others, including DOE, to use the submission, as specified throughout the Official Rules; that the submission does not infringe upon any copyright or upon any other third party rights of which the Participant is aware; and that the submission is free of malware.

b. The submission, and any use thereof by DOE and others, is not defamatory or libelous in any manner; does not constitute or result in any misappropriation or other violation of the publicity rights or right of privacy of any person or entity, or any other rights of any person or entity.
c. It is free to enter this competition without the consent of any third party or alternatively has written permission of such third party, and has the capability to fully perform its obligations under the SMART VP Prize Challenge Rules.
d. In the case of a submission from an individual, the individual is a U.S. citizen or a U.S. permanent resident, and 18 years or older.
e. It is not a party to (and it agrees that it shall not become a party to) any agreement, obligation, or understanding that is inconsistent with the SMART VP Prize Challenge Rules, or Terms and Conditions or might limit or impair DOE's rights or the Participant's obligations under the SMART VP Prize Challenge Rules, or Terms and Conditions.
f. There is no suit, proceeding, or any other claim pending or threatened against the Participant, nor does any circumstance exist, to its knowledge, which may be the basis of any such suit, proceeding, or other claim, that could limit or impair the Participant's performance of its obligations pursuant to the SMART VP Prize Challenge Rules, or Terms and Conditions.
g. It will not infringe, violate, or interfere with the intellectual property, publicity, privacy, contract or other right of any third party in performing under the Terms and Conditions of this prize challenge, or cause DOE or others to do any of the same.
h. It will comply with all applicable laws, rules, and regulations in performing under these Terms and Conditions.
i. It otherwise meets the eligibility requirements set forth in 15 U.S. Code § 3719. Prize Competitions and provided in Rules section C.1.

3. VERIFICATION FOR PAYMENTS

DOE will verify the identity and the role of a Participant potentially qualified to receive a prize. Receiving a prize payment for Phase 1 and/or for Phase 2 of the competition is contingent upon fulfilling all requirements contained herein. DOE will notify each Winner using provided email contact information after the date that results are announced. Winners who submitted as an entity must register with the U.S. government's System for Award Management (SAM) at https://www.SAM.gov in order to receive payment. Winners who submitted as an individual will be required to sign and return to DOE, within 30 days of the date the notice is sent, a completed Request for ACH Banking Information form. At the sole discretion of DOE, a winning Participant may be disqualified from the competition and receive no prize funds if:

a. the individual/entity cannot be contacted;
b. the individual/entity fails to sign and return the required documentation within the required time period;
c. the notification is returned as undeliverable; or
d. the submission or individual/entity is not otherwise compliant with the Rules.

Prizes awarded under this competition will be paid by electronic funds transfer and may be subject to federal income taxes. DOE will comply with the Internal Revenue Service withholding and reporting requirements, where applicable.

4. GOVERNMENT REPRESENTATIONS AND WARRANTIES

Any and all information provided by or obtained from the Federal Government is without any warranty or representation whatsoever, including but not limited to its suitability for any particular purpose.

5. RECORDS RETENTION AND FOIA

The use of protective markings such as “Do Not Publicly Release – Trade Secret” or “Do Not Publicly Release – Confidential Proprietary Business Information” in the Header or Footer of the Submission is strongly encouraged where appropriate. However, Participants should be aware that the use of protective markings is not dispositive as to whether information will be released publicly pursuant to a request for records under the Freedom of Information Act (FOIA), 5 U.S.C. § 552, as amended by the OPEN Government Act of 2007, Pub. L. No. 110-175. Information received from the Participant is considered to be a federal agency record, and as such, subject to public release under FOIA. Participants should therefore use care in only submitting information that is necessary for purposes of this competition.

Decisions to disclose or withhold information received from a Participant are based on the applicability of one or more of the nine FOIA exemptions codified at 5 U.S.C. § 552(b), not on the existence or nonexistence of protective markings. The agency’s designated FOIA Officer(s) determination that information sought under a FOIA request will be withheld pursuant to one or more of the nine FOIA exemptions may be challenged by the requestor to a higher authority. For more information on the DOE’s FOIA process and regulations, please see 10 CFR Part 1004 and/or visit the DOE’s FOIA website here: https://www.energy.gov/management/office-management/operational-management/freedom-information-act.

6. USE OF DATA

All data, including software, submitted under the SMART VP prize challenge will be made available to DOE and parties authorized to act on behalf of DOE. By accepting these Terms and Conditions, the Participant consents to the use of data submitted to DOE for evaluation purposes and for any other purpose consistent with these rules. All materials submitted to DOE as part of a submission become DOE records and cannot be returned.

7. RELATIONSHIP OF THE PARTIES

Nothing contained in these Rules, or Terms and Conditions is intended to create or constitute a relationship between DOE and the Participant. Participation in the SMART VP prize challenge does not imply any form of sanction, endorsement, or support of the Participant by DOE, nor does it grant either party any authority to act as agent, nor assume or create any obligation, on behalf of the other party. Participants may not use the DOE official seal or the NETL logo in their submissions.

8. LIABILITY AND INSURANCE

Upon registration at https://netl.doe.gov/challenges/SMARTVisualizationPlatform, the Participant agrees to assume and, thereby, has assumed any and all risks of injury or loss in connection with or in any way arising from participation in this competition, or development of any submission. Upon registration, except in the case of willful misconduct, the Participant agrees to and thereby waives and releases any and all claims or causes of action against the Federal Government and its officers, employees, and agents for any and all injury or damage of any nature whatsoever (whether existing or thereafter arising, whether direct, indirect, or consequential and whether foreseeable or not), arising from its participation in the competition, whether the claim or cause of action arises under contract or tort.

Further, upon registration, the Participant agrees to indemnify the Federal Government against third party claims for damages arising from or related to prize challenge activities.

Based on the subject matter of the SMART VP prize challenge, the type of work that it will require, as well as the unlikeliness of claims for death, bodily injury, property damage, or loss potentially arising from or related to participation in the SMART VP prize challenge, no individual or entity participating in the prize challenge is required to obtain liability insurance or demonstrate financial responsibility in order to participate as determined by the DOE prize administrator (as delegated).

9. JUDGES

Each submission will be judged by a qualified panel of experts selected by DOE at its sole discretion. A judge may not (A) have personal or financial interests in, or be an employee, officer, director, or agent of any entity that is a registered Participant in this competition; or (B) have a familial or financial relationship with a registered Participant.

The panel will judge the submissions based on the evaluation criteria identified above and determine a final score for each submission to be used for DOE’s final determination of Winners.

10. RESOLUTION OF DISPUTES

Official Rules and Terms and Conditions are final and binding in all matters related to the competition. The final scores of the panel and the final determination of Winners, inclusive of Phase 1 and Phase 2, is final and binding, and may not be challenged by the Participants.

11. PUBLICITY

The Winners, inclusive of Phase 1 and Phase 2, of the SMART VP Prize Challenge may be featured on DOE social media sites, newsletters, and other similar forms of media. Except where prohibited by law, participation in the competition constitutes each Winner's, inclusive of Phase 1 and Phase 2, consent to DOE's and its agents' use of each Winner's name, likeness, photograph, voice, opinions, and/or city and state information, and abstract of each Winner's submission for promotional purposes through any form of media, worldwide, without further permission, payment or consideration.

12. GENERAL CONDITIONS

DOE reserves the right to cancel, suspend, and/or modify the competition, or any part of it, for any or no reason, including if any fraud, technical failure, or any other factor beyond DOE's reasonable control impairs the integrity or proper functioning of the competition, as determined by DOE in its sole discretion. DOE is not responsible for, nor is it required to accept, incomplete, late, misdirected, damaged, unlawful, or illicit submissions, nor will DOE reimburse any costs associated with participation in this challenge if it is cancelled for any reason.

13. SUBMISSION LICENSE

Each entrant retains title to, and full ownership of, its submission. The entrant expressly reserves all intellectual property rights not expressly granted under this agreement. By participating in the SMART VP Prize Challenge, the Phase 2 winner hereby irrevocably grants a license to DOE to store, access and modify submissions in perpetuity that may be reproduced or distributed in the future. Refer to the Rules section C.14 Intellectual Property of Submissions for further information regarding rights to submissions.

14. INTELLECTUAL PROPERTY (IP) OF SUBMISSIONS

In general, each Participant shall retain ownership of any intellectual property rights created as a result of participating in the SMART VP prize challenge.

As part of acceptance of the Phase 1 cash prize, each Finalist must submit a software utilization plan that proposes an approach that will grants to DOE and its designees a license to the final software. DOE reserves the right to negotiate the disposition of the final license agreement with the Finalist. For DOE, an ideal agreement would be for the Phase 2 Winner to grant(s) to DOE and its designees a worldwide, non-exclusive, sub-

licensable, transferable, fully paid-up, irrevocable license to use, reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, its Phase 2 submission and other data submitted, in any media now known or hereafter developed, for any purpose whatsoever, without further approval by or payment to the Winner, and represents that he/she/it has the unrestricted right to grant that license.

Refer to the Rules section C.13 Submission License for further information regarding rights to submissions.

Definitions

Participant: An individual or entity applying to the prize challenge; also, an individual or entity who is participating in the prize challenge (after they have registered/entered).

Winner: An individual or entity selected to receive a prize under this prize challenge.

Authority to Administer and Award the Prize

Section 24 of the Stevenson-Wydler Technology Innovation Act of 1980 (Pub. L. No. 96-480), as added by section 105(a) of the America COMPETES Reauthorization Act of 2010 (Pub. L. No. 111-358) (the "COMPETES Act"), as amended by section 401 of the American Innovation and Competitiveness Act (Pub. L. No. 114-329) (codified at 15 U.S.C. § 3719).

ALL DECISIONS BY DOE ARE FINAL AND BINDING IN ALL MATTERS RELATED TO THE SMART VP PRIZE CHALLENGE.