Leveraging Opportunities for Technology Development and Application

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Technology Development Objective:

To develop and deploy new or improved technologies capable of utilizing untapped resources, or better utilizing existing resources.

Small Business Innovation Research / Small Business Technology Transfer (SBIR / STTR)

Both the SBIR and STTR programs at DOE have three distinct phases.

- Phase I
  - Explores the feasibility of innovative concepts with awards up to $100,000 for about 9 months.
  - Only Phase I award winners may compete for Phase II funding.
- Phase II
  - Focuses on the principal R&D effort
  - Awards up to $750,000, over a two-year period.
- Phase III
  - Non-Federal funding is used by the small business to pursue commercial applications of the R&D.
  - Federal agencies may award non-SBIR/STTR-funded, follow-on grants or contracts for products or processes that meet the mission needs of those agencies, or for further R&D.

Small Business Innovation Research / Small Business Technology Transfer

- Grant applications submitted by small businesses MUST respond to a specific Technical Topic and Subtopic during included in the open solicitation.

- **The Water Power Program intends to take full advantage of this mechanism to help fill the technology pipeline with innovative solutions to MHK and Conventional Hydropower challenges.**

Question 1:

How can we best integrate the SBIR/STTR Program, and structure Technical Topic descriptions, to address industry R&D needs?

Technology Readiness Levels

- Technology Readiness Levels (TRLs) have evolved as a measure to:
  - assess the maturity of evolving technologies
  - determine what is needed to mature a technology or a system for an "operational" application

- TRL designations are uniquely applicable and especially valuable to DOE decision makers in its support of the evolving MHK industry and associated technologies.
  - No standardized technology descriptions currently exist within the emerging MHK industry

- DOE has taken the following position:
  - Gather the best available information, and make recommendations.
  - Developers are best qualified to define the necessary and specific RDD&D needs
  - Considering the cost-shared nature of DOE-sponsored projects, development timelines had to be accelerated
  - DOE seeks to be the catalyst.

Technology Readiness Levels

- The *MHK Technology Readiness Advancement Initiative* (Funding Opportunity Announcement Nr. DE-FOA-0000293) provides the opportunity to support MHK technology development and evolution, spurring innovation along the entire technology development pathway.

Question 2:

How can we best utilize TRLs to advance technologies associated with conventional hydropower?

Question 3:

What other mechanisms should be considered in order to advance the operational readiness of advanced technology solutions?

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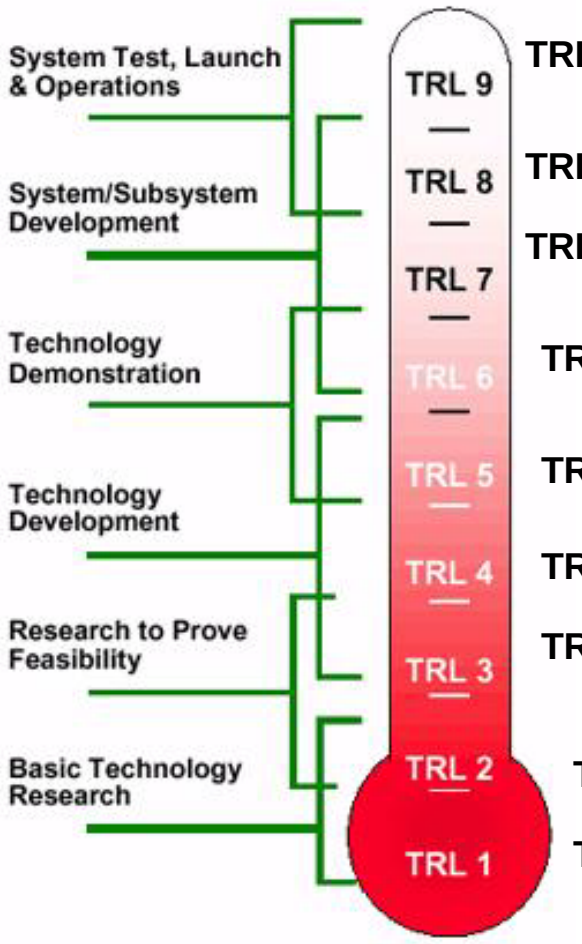
BACKUP SLIDES

NASA Graphic Depicting TRLs

NASA

DOD



TRL 9: **Actual System "proven" through successful system or mission operations.**

TRL 8: **Actual system completed and qualified through T&E**

TRL 7: **System prototype demonstration in the planned operational environment**

TRL 6: **System model/prototype demonstration in a relevant environment**

TRL 5: **Component or breadboard validation in relevant environment**

TRL 4: **Component or breadboard validation in laboratory environment**

TRL 3: **Analytical and experimental critical functional and/or characteristic proof-of-concept**

TRL 2: **Technology concept and/or application formulated**

TRL 1: **Basic principles observed and reported**

Further Considerations for MHK TRLs

NASA and DOD

- Focus is on developing "Mission Critical" Systems for space and weapons systems application.
- System RD&D is typically fully funded by the sponsoring activity
  - Cost overruns and delays are borne by the sponsor
- Development Cycle is a balance between technology evolution and overall platform development
  - Large platforms, System of Systems approach

Water Power Technologies

- Focus is on developing technologies with immediate commercial application
- Technology development costs are born by the private sector, or at best, is a cost-shared venture
- Development Cycle is time-critical
  - Developers seek to develop and deploy viable systems within a highly competitive environment.

MHK TD: TRL Designations

DOE TRL		TRL Description	
1	Discovery / Concept Definition / Early Stage Development	Basic principles observed and reported.	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development.
2		Technology concept and/or application formulated	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions.
3		Analytical and experimental critical function and/or characteristic proof of concept.	Active research and development is initiated. This includes engineering and laboratory studies to physically validate analytical predictions of separate elements of the technology.
4	Proof of Concept	Component and/or system validation in laboratory environment	Basic technological components are integrated at sub-scale to validate design predictions and system level functionality.
5	System Integration and Laboratory Demonstration	Fabrication and integration at a scale relevant to full scale	Fidelity of representative system technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment.
6		Representative model or prototype system is tested in a relevant environment.	Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness.
7	Open Water System Testing, Demonstration and Operation	Prototype components are fabricated/integrated to establish functionality	Prototype near, or at, planned operational system. Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment
8		Prototype system is tested/qualified in an ocean environment	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development.
9	Commercial- scale Production / Application	Actual system proven through successful mission operations (fielded and in use).	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation.

- **DOE TRL 1-3: Discovery / Concept Definition / Early Stage Development, Design and Engineering**

  - *DOE TRL 1-2: These are the lowest levels of technology readiness. Scientific research begins to be translated into applied research and development where basic principles are observed and reported. Technology concept and application are formulated and investigated through analytic studies and in-depth investigations of principal design considerations. This stage is characterized by paper studies, concept exploration, and planning.*

  - *DOE TRL 3: In this stage, active research is initiated, including engineering studies and laboratory studies to physically validate analytical predictions of separate elements of the technology.*

- **DOE TRL 4: Proof of Concept**
  - *Basic technological components are integrated at sub-scale to validate design predictions and system level functionality. Fully operational sub-scale model(s) are tested in a laboratory environment.*

- ***DOE TRL 5/6: System Integration, and Technology Laboratory Demonstration***
  - *DOE TRL 5: Basic technological components are fabricated at a scale relevant to full scale and integrated to establish and verify subsystem and system level functionality and preparation for testing in a simulated environment.*
  - *DOE TRL 6: Representative model or prototype system at a scale relevant to full scale, which is beyond that of TRL 5, is tested in a relevant environment. This stage represents a major step up in a technology's demonstrated readiness and risk mitigation and is the stage leading to open ocean testing.*

- **DOE TRL 7/8: Open Water System Testing, Demonstration, and Operation**
  - *DOE TRL 7: Prototype scale components and subsystems are fabricated and integrated to establish and verify subsystem and system level functionality and preparation for testing in an open ocean operational environment to verify expected operation and fine tune the design prior to deployment in an operational demonstration project.*
  - *DOE TRL 8: The prototype in its final form (at or near full scale) is to be tested, and qualified in an open ocean environment under extreme operating conditions to demonstrate readiness for commercial deployment in a demonstration project.*
- **DOE TRL 9: Commercial Scale Production / Application**
  - *Actual commercial application of the technology in its final form.*