

U.S. DEPARTMENT OF
ENERGY

Office of
**ENERGY EFFICIENCY &
RENEWABLE ENERGY**

water

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WATER POWER TECHNOLOGIES OFFICE

Innovating Distributed Embedded Energy Prize (InDEEP)

Introduction to Innovation Methods

May 10, 2023

Webinar Logistics

- Everyone is joined in listen-only mode
- Audio Issues?—Try connecting over the phone
- If that doesn't work, visit the [Zoom Help Center webpage](#)
- Q&A—Submit your questions using the chat box

Agenda

1. Introductions
2. Innovation Process
3. TRIZ – Techniques of Inventive Problem Solving
4. Innovation with TRIZ in Wave Energy
5. Q&A

Introductions

Innovating Distributed Embedded Energy Prize



- \$2.3M prize pool
- Three phases over two years
- Incentivize progress in early-stage research
- Help solve technical challenges that could be applied to wave energy

Contributing to Leaderboard Scoring

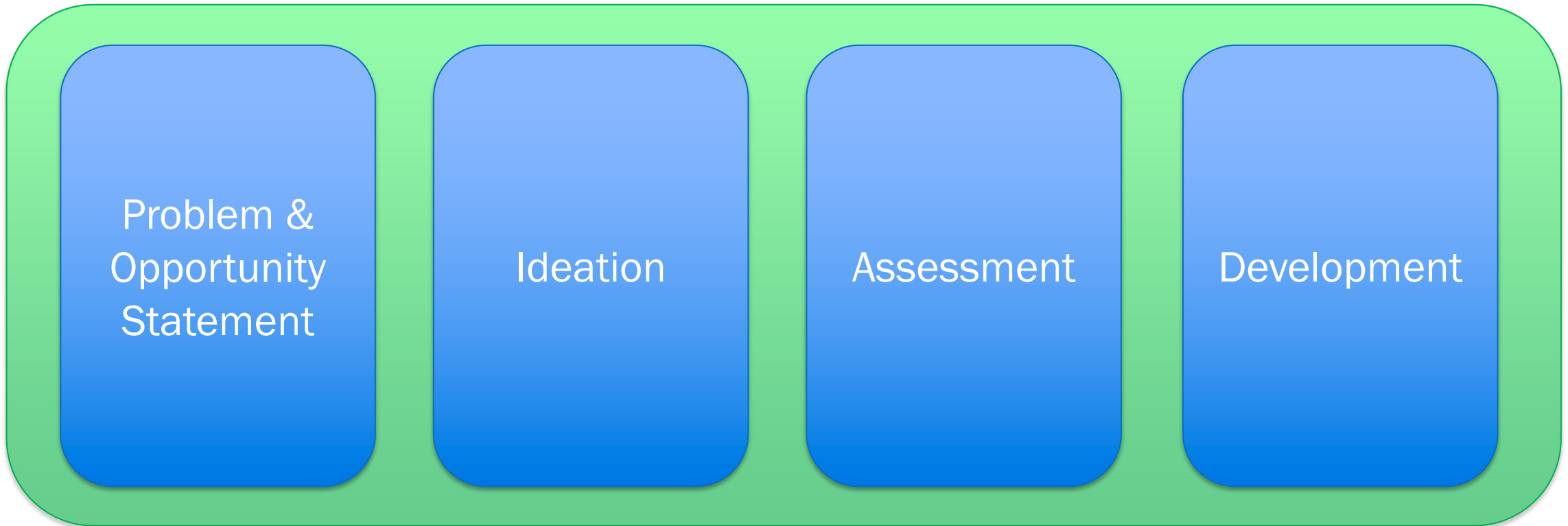
- For questions about the prize overall, view our recorded conversation on April 12
- Participation in this webinar contributes to your final leaderboard score
- **Make sure to complete the Leaderboard Eligibility Form to receive points for your participation**
- If you haven't done this yet, do so now:
<https://www.herox.com/indeep>



WPTO's desired outcome for InDEEP is an understanding of the landscape of innovators and potential DEEC-Tec solutions that could be applied to wave energy devices.

Innovation Process

Innovation Process



Innovation Process

- Problem & Opportunity Statement
 - Solution agnostic formulation
 - Functions/functional requirements
“What the system is to do”
 - Functional system
 - Functional hierarchy
 - Functional compatibility

Innovation Process

- Ideation
 - Idea generation process
 - Driven by functional requirements of the problem & opportunity statement
 - Application of different idea generation methods
 - Different application approaches of a given method
 - Generation of multiple concepts
 - Generation by multiple players/teams

Innovation Process

- Assessment
 - Formulation and application of assessment methods and tools for technology concepts and technology designs
 - Driven and expressed by Capabilities
“What the system is to be”
 - Identifying strengths & weaknesses
 - Prioritization
 - Merging
 - Down-selection
 - Improving

Innovation Process

- Development
 - Improving technology performance
 - Improving technology maturity
 - Iteration
 - Continuation and relation of
 - Problem & opportunity statement refinement
 - Idea generation methods and application
 - Assessment method, tools and application

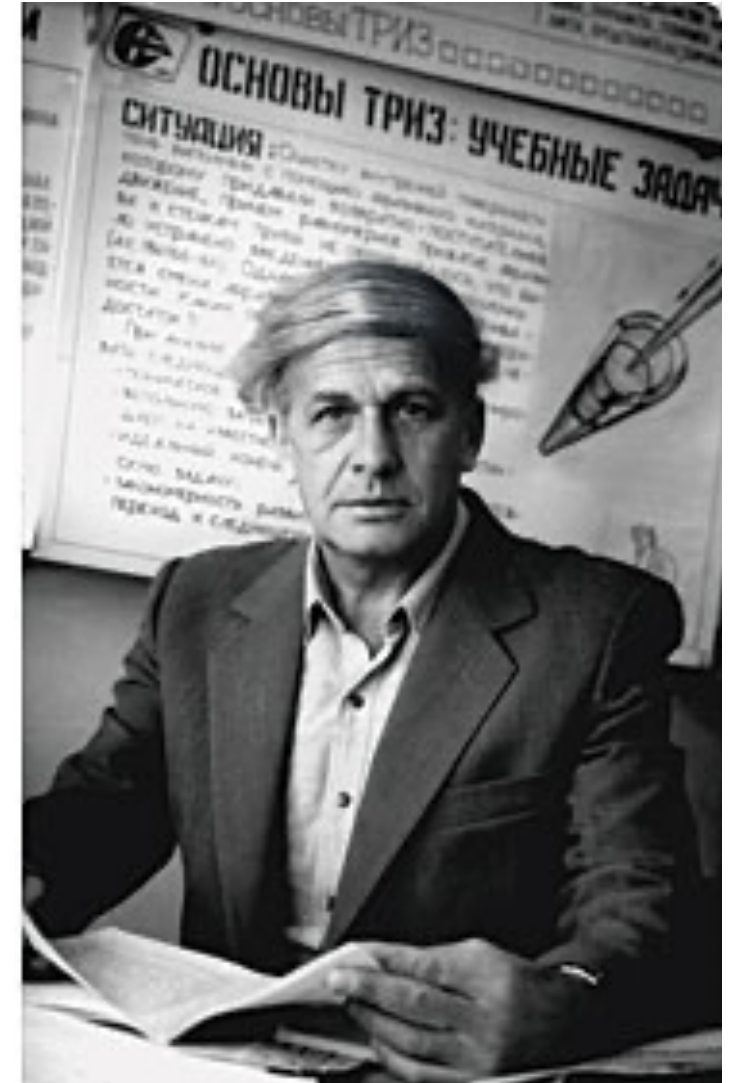
Innovation Impact Levels

32% Apparent (company knowledge) <i>Simple improvements using known knowledge</i>	Level One
45% Improvement (industry knowledge) <i>Adaptation of solutions used in similar systems / same industry</i>	Level Two
Approximately 18% Fundamental change (other industries) <i>Radical innovative new application from different industry</i>	Level Three
Less than 4% New application (new technology) <i>A new combination of technologies for new solutions e.g. materials</i>	Level Four
Less than 1% Breakthrough! (new science) <i>New Invention often based on (new) scientific effect</i>	Level Five

TRIZ – Techniques of Inventive Problem Solving

TRIZ – Background

- TRIZ/TIPS
 - “Teoriya Resheniya Izobreatatelskikh Zadatch”
Russian acronym, TRIZ
 - “Techniques of Inventive Problem Solving” TIPS
- Genrich Altshuller, a patent officer in the Soviet Navy, examined 40,000 patents between 1945 and 1985 in order to identify a methodology of inventive problem solving based on evidence, data and pattern recognition rather than isolated spontaneous or intuitive creativity.



TRIZ – Background

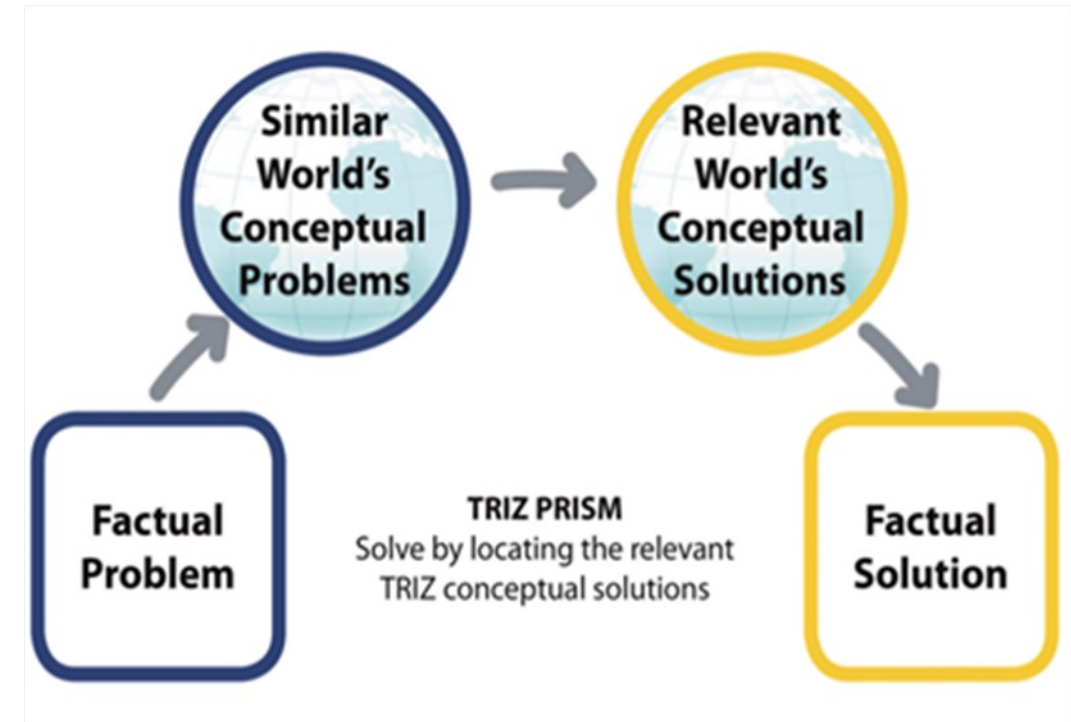
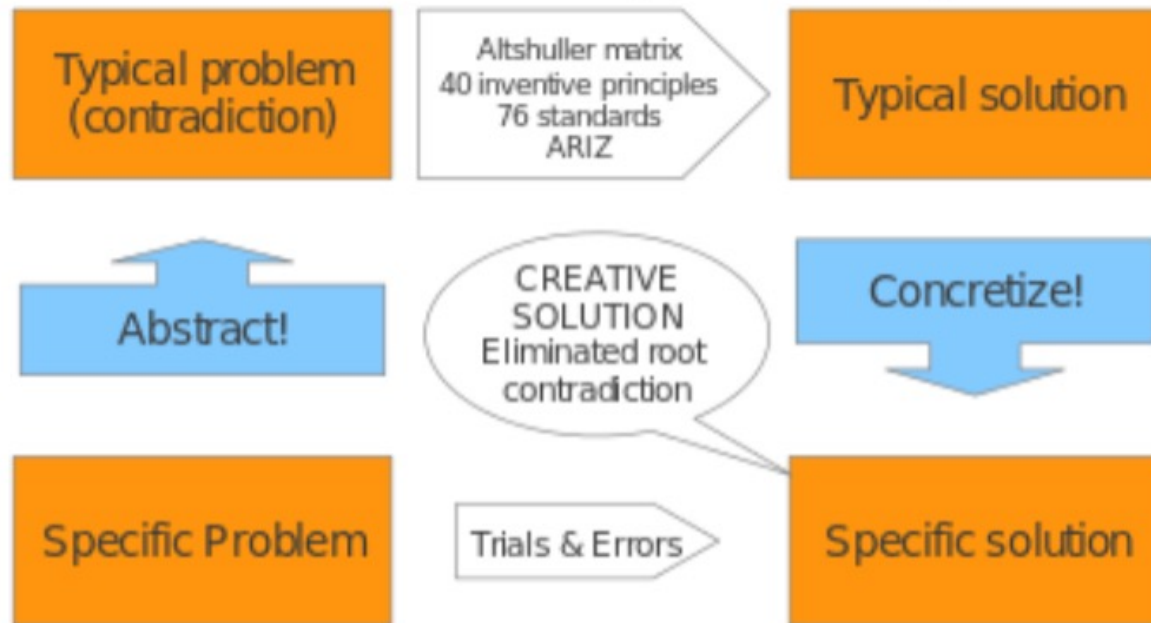
- Altshuller identified a finite set of reoccurring problem types and reoccurring inventive solution principles
- Followers of Altshuller have subsequently examined 3 million patents and have confirmed Altshuller's findings
- Following a strong TRIZ movement in the Soviet Union TRIZ emerged in the West in 1990 after the fall of the Soviet Union



Fundamentals of the methodology in 3 steps

- For a specific problem identify the associated typical problem in form of a root contradiction within 39 x 39 cases spanned up by 39 typical parameters
- Apply a finite number (<40) of identified and proven inventive problem-solving techniques that have shown to deliver impactful solutions for this typical problem
- Concretize the identified typical solution to find the sought specific solution

TRIZ – Methodology



Contradiction Matrix

	Worsening Feature → Improving Feature ↓	Weight of moving object	Weight of stationary object
		1	2
1	Weight of moving object		↓
2	Weight of stationary object		
3	Length of moving object		
4	Length of stationary object	→	35, 28, 40, 29

Consider Using Inventive Principles:

28 - Mechanics Substitution
29 - Pneumatics and Hydraulics
35 - Parameter Changes
40 - Composite Materials

Contradiction Matrix

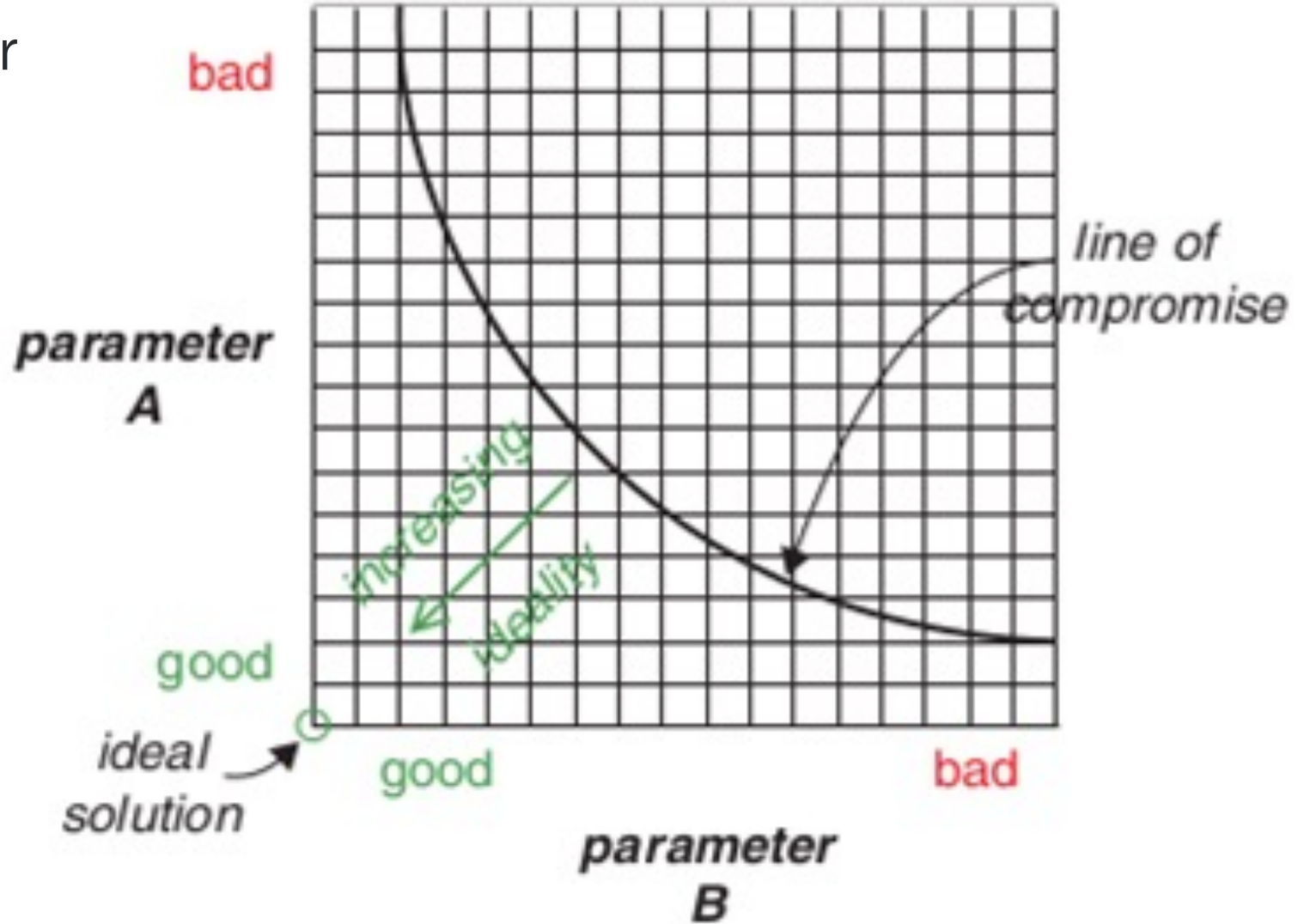
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40 Inventive Principles

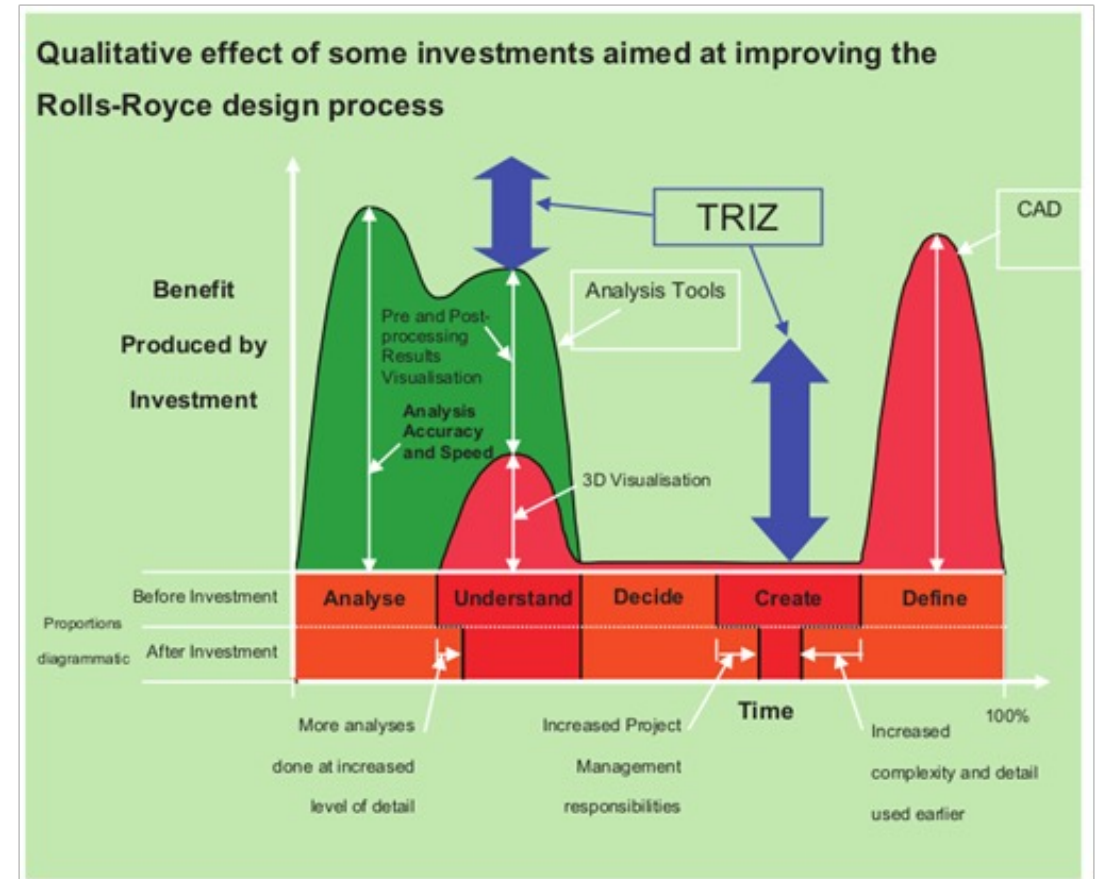
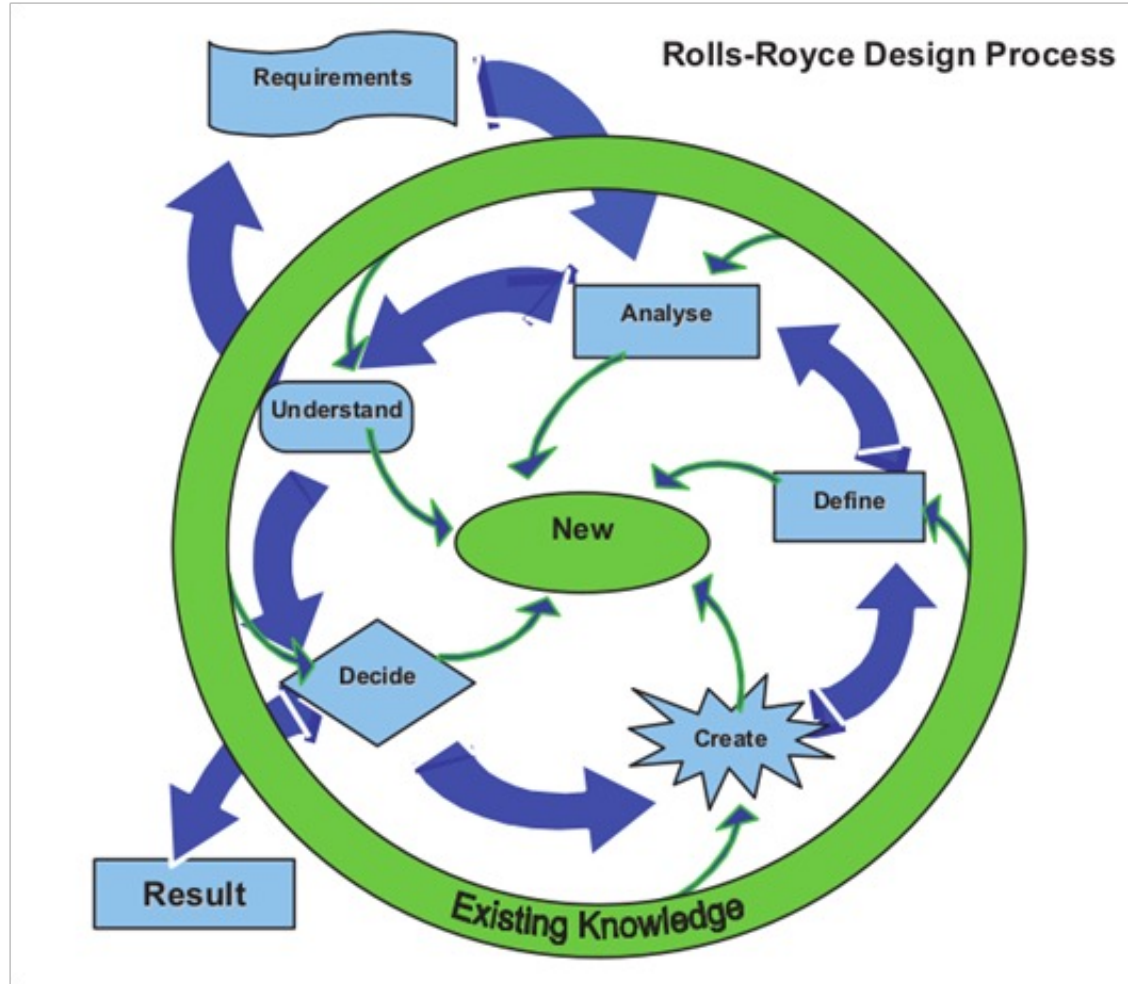
1. Segmentation	15. Dynamics	29. Pneumatics
2. Taking out	16. Partial or	and hydraulics
3. Local quality	excessive actions	30. Flexible shells and thin
4. Asymmetry	17. Another dimension	films
5. Merging	18. Mechanical vibration	31. Porous materials
6. Universability	19. Periodic action	32. Colours changes
7. Nested doll	20. Continuity of useful	33. Homogeneity
8. Anti-weight	action	34. Discarding
9. Preliminary	21. Skipping	and recovering
anti-action	22. Blessing in disguise	35. Parameter changes
10. Preliminary action	23. Feedback	36. Phase transitions
11. Beforehand	24. Intermediary	37. Thermal expansion
cushioning	25. Self-service	38. Strong oxidants
12. Equipotentiality	26. Copying	39. Inert atmosphere
13. The other	27. Cheap short-living	40. Composite material film
way around	28. Mechanics	
14. Spheroidality	substitution	

Dissolving Contradictions

- Beyond the pareto frontier
- Beyond optimization
- Beyond compromise
- Dissolving trade-offs



TRIZ – Benefits



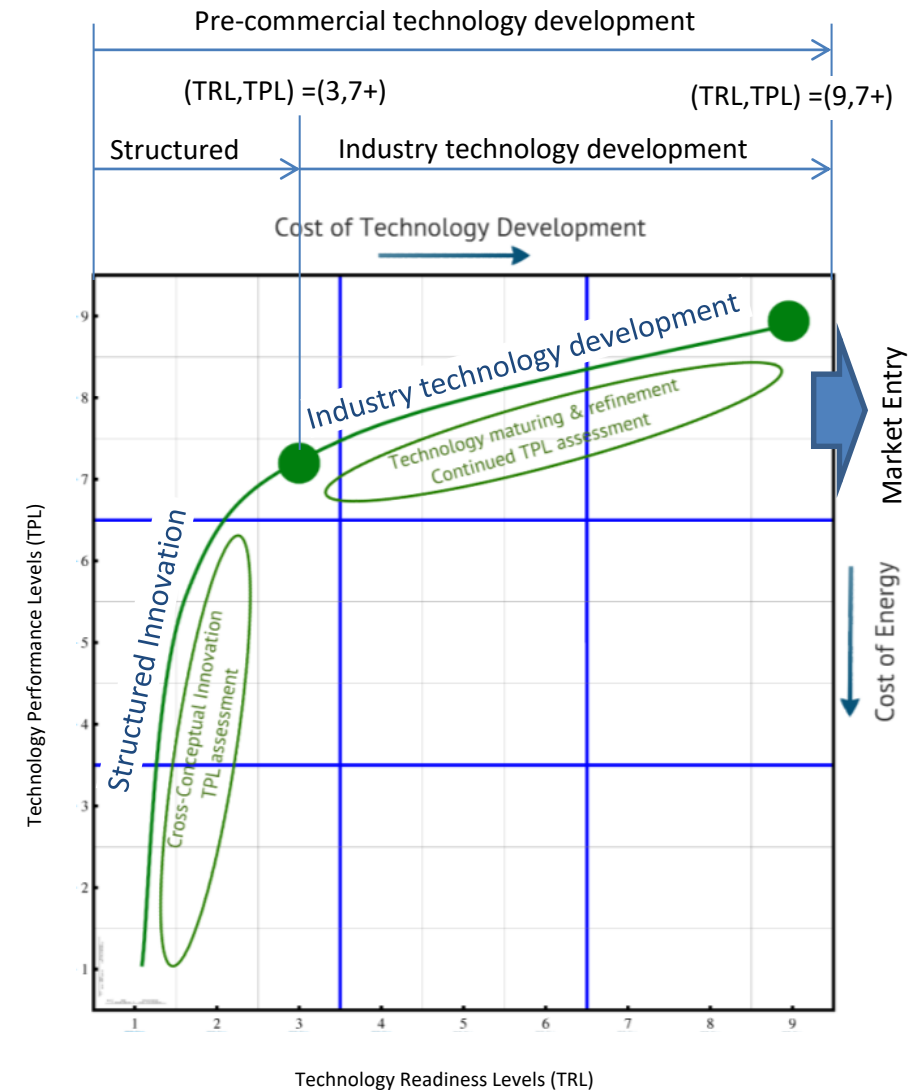
Reasons to use TRIZ

- TRIZ is systematic, auditable and repeatable
- TRIZ is based on proven successful patents
- TRIZ uses the world 's knowledge (systematic rather than random way)
- TRIZ closely targets and initiates the ideation process
- 40 inventive principles for solving contradictions
- 8 Trends of evolution of technology
- Ideality
- Thinking in Time and Scale
- 13 Standard creativity triggers

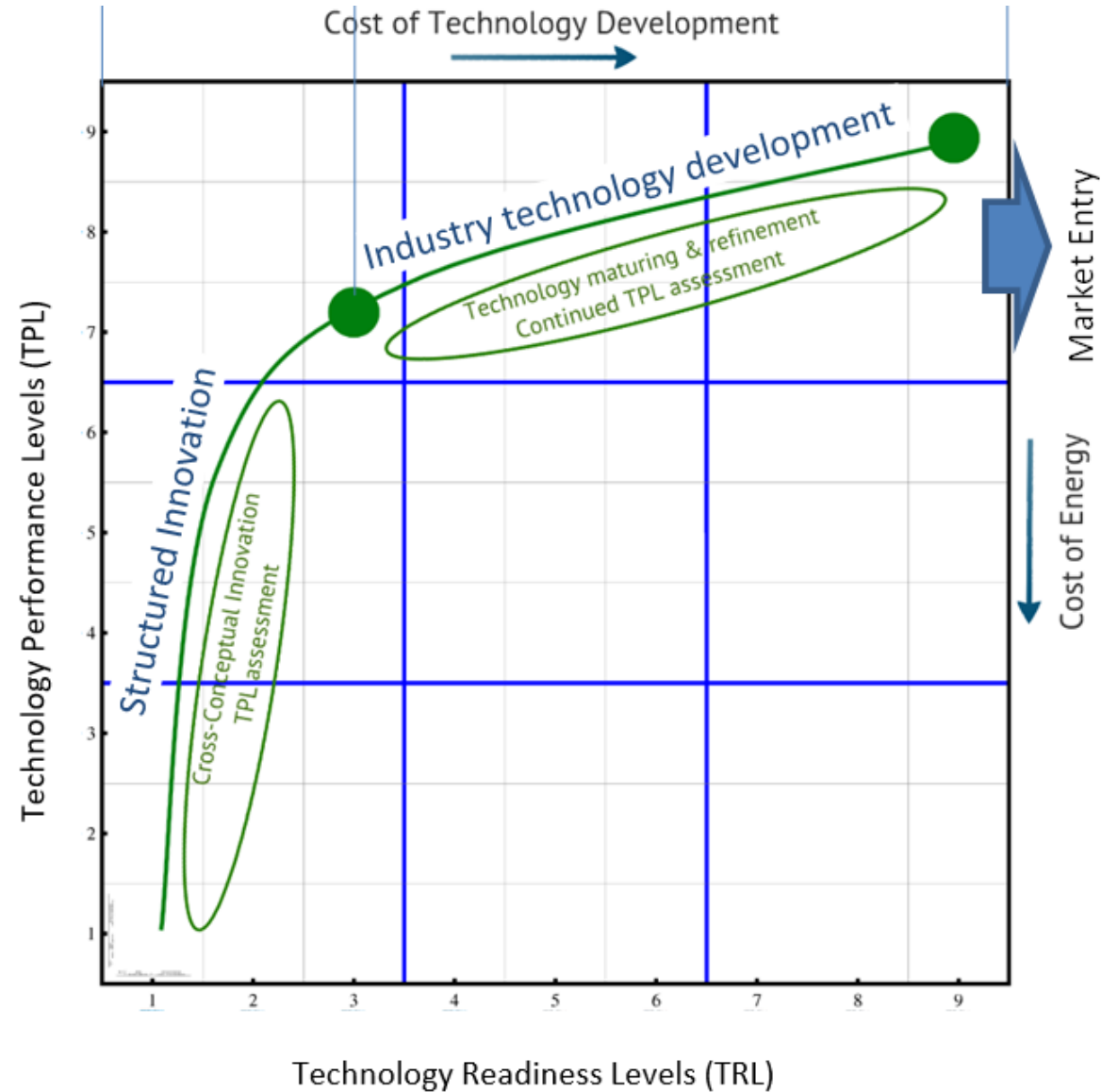
Innovation with TRIZ in Wave Energy

Technology Development Framework

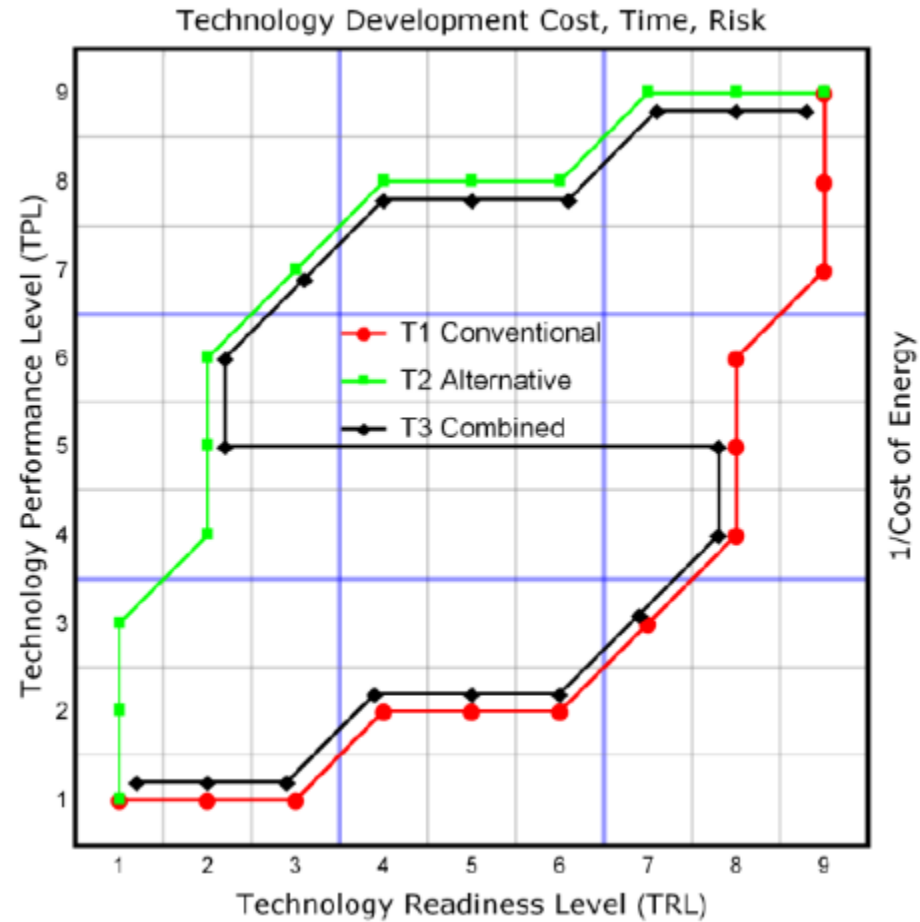
- Technology Readiness Levels (TRL)
- Technology Performance Levels (TPL)
- Technology Development Map
- TRL – TPL – Matrix



Technology Development Framework



Technology Development Cost, Time and Risk



Trajectory	T1 - Conventional	T2 - Alternative	T3 - Combined
Cost [\$ m]	155	65	114
Time [y]	22	13	23
Risk [\$ y m]	165	9	39

TRIZ has proven to work in wave energy

- New technology concepts so far are high quality
- Contradictions matrix ‘feels’ familiar to natural problem solvers
- Contradictions matrix sometimes leads to known solutions as well as new solutions
- Ideality concept & Ideality audit lead to auditable clarification of requirements & to new contradictions & to new ideas
- Resolution of limiting contradictions on one WEC archetype led to invention other WEC archetype – jumping archetype boundaries

- TRIZ is applicable at system levels
 - WEC farm
 - WEC unit
 - WEC sub/sub/sub/system
 - WEC component
 - WEC operation process
- InDEEP
 - DEEC
 - DEEC-Tec meta material
 - (DEEC-Tec meta material enabled WEC)

Technology Performance Levels (TPL)
come next!

Questions and Answers

Thank you!

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Wrap Up & Next Steps



Competitor Support Mechanisms

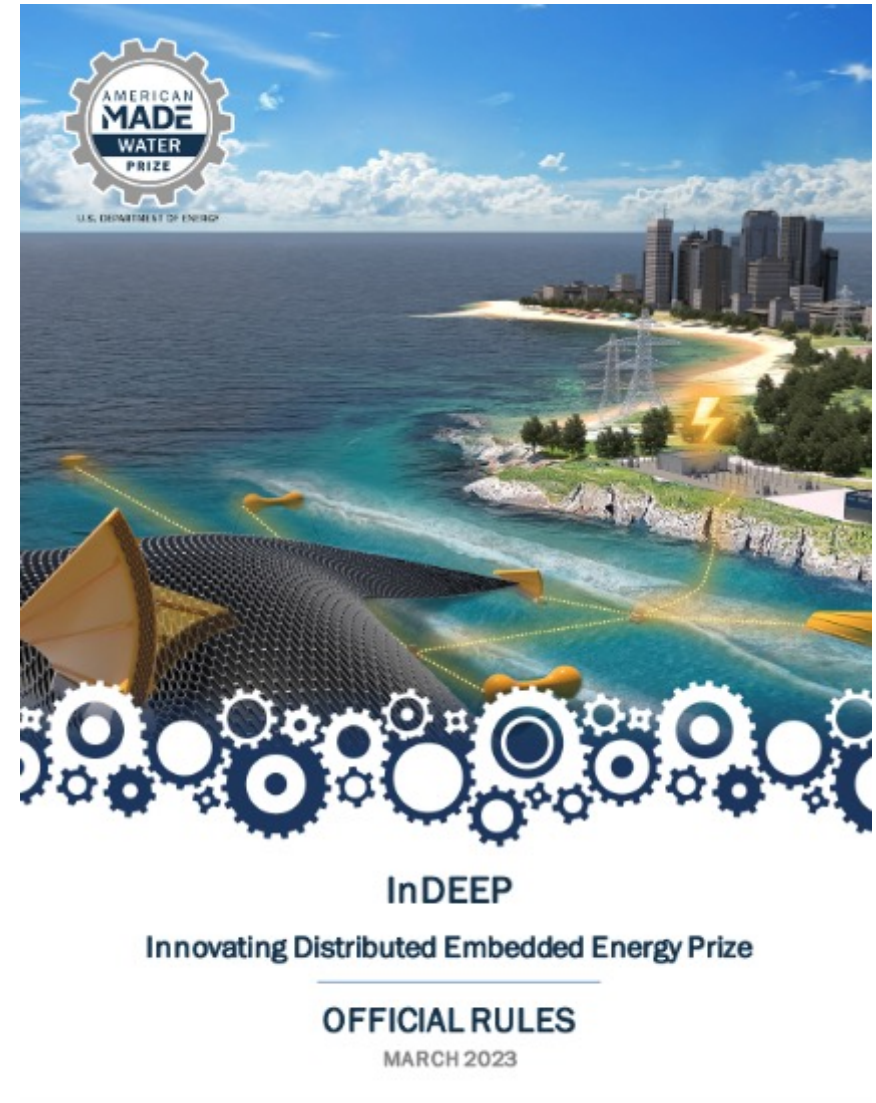
- Save the Dates!
Upcoming Training Sessions:
 - May 10: Innovation methods
 - July 5: TPL assessment
- Provide us feedback in the webinar poll to make sure upcoming sessions are useful
- Teaming Platform
- Submission Feedback
- Mentorship in Innovation Methods and TPL Assessment
- *Resources linked in Appendix C of the Rules Document*

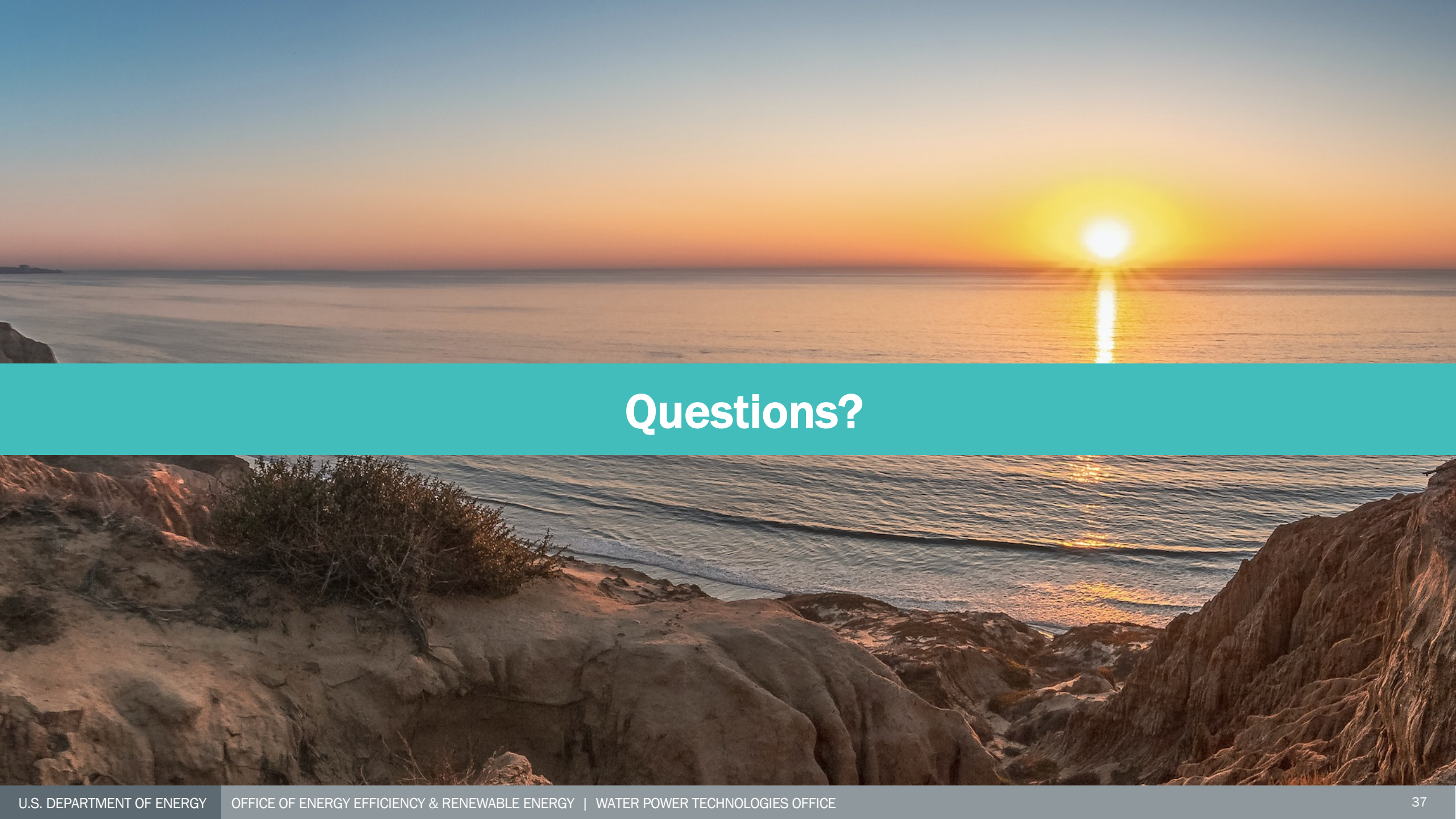


Read the Rules

For a more in-depth look at the prize overall where these topics will be applied, please read the rules document, available here:

<https://americanmadechallenges.org/challenges/indeep/docs/InDEEP-Prize-Rules.pdf>





Questions?