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Collaborative TPL Assessment of Wave Energy Converters and Farms

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INTRODUCTION

The Technology Performance Level (TPL) assessment is a holistic methodology to assess a wave energy converter (WEC) technology's ability to achieve [continental grid] market competitiveness and acceptability via criteria-based consideration of key cost, performance, environmental, safety, and societal drivers.

The TPL assessment can be applied at all technology development stages and associated technology readiness levels (TRLs).

AIM

For lower TRL technologies, the TPL assessment is particularly effective because it highlights potential showstoppers at the earliest possible stage of WEC technology development, considering performance/potential before readiness. This can decrease cost, time, and risk during WEC development. As such, TPL assessments provide feedback to a developer, pointing out what aspects of their technology design show promise and where they can improve.

METHOD

The lion's share of the TPL assessment effort goes into the initial collation of accurate information about the WEC technology under development, backed by supporting documentation necessary for responding to the TPL questions with confidence.

The assessment consists of 88 questions in 7 capabilities with 4 sub-capabilities under Cost of Energy (see Results). Performance outside of specified ranges is noted as a "threshold breach".

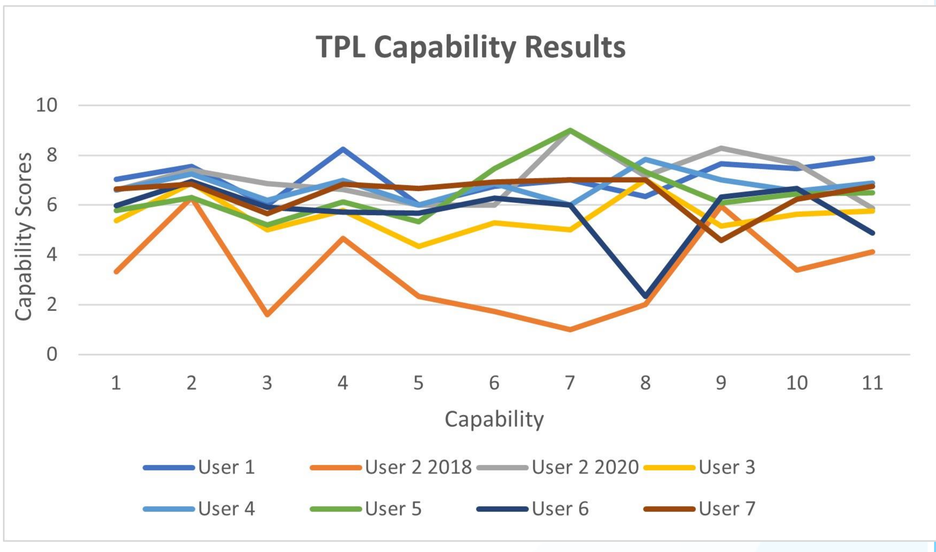
WEC technology is scored on the scale below:

TPL		Characteristics
9	high	Competitive with other energy sources without special support mechanism.
8		Competitive with other energy sources given sustainable support mechanism.
7		Competitive with other renewable energy sources given favorable support mechanism.
6	medium	Majority of key performance characteristics & cost drivers satisfy potential economical viability under distinctive and favorable market and operational conditions.
5		In order to achieve economical viability under distinctive and favorable market and operational conditions, some key technology implementation improvements are required.
4		In order to achieve economical viability under distinctive and favorable market and operational conditions, some key technology implementation and fundamental conceptual improvements are required.
3	low	Minority of key performance characteristics & cost drivers do not satisfy potential economic viability.
2		Some of key performance characteristics & cost drivers do not satisfy potential economic viability.
1		Majority of key performance characteristics & cost drivers do not satisfy, and present a barrier to, potential economic viability.

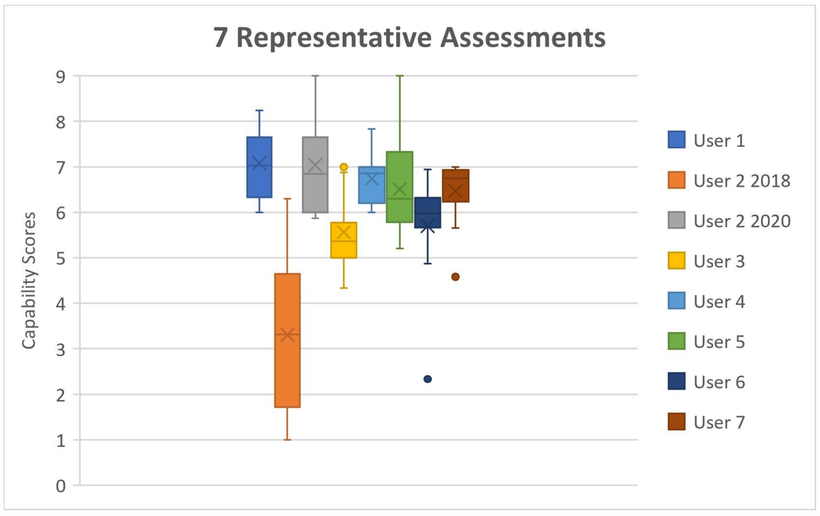
RESULTS

Capabilities Scored For Each Project

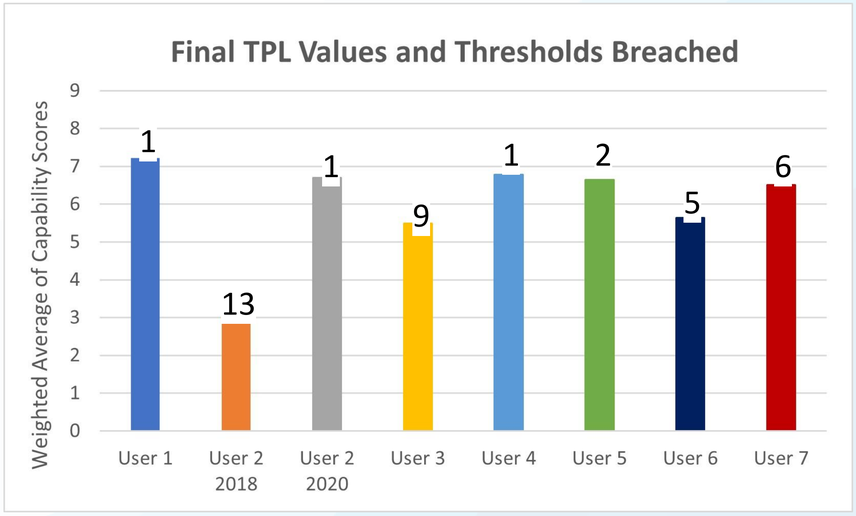
1. Cost of Energy
2. As low CAPEX as possible (sub-capability)
3. As low OPEX as possible (sub-capability)
4. Generate a large amount of electricity (sub-capability)
5. Have high availability (sub-capability)
6. Provide secure investment opportunity
7. Be reliable for grid operations
8. Be beneficial to society
9. Be acceptable for permitting/consenting
10. Safety
11. Be deployable globally



Seven developers shared details of their marine renewable energy technology, which the team evaluated. All were in TRL 1-3. User 2 submitted their design twice, orange vs gray, after working with design suggestions.



The seven user's data compiled in a box and whisker diagram shows the overall range and distribution of the TPL capability scores. The box represents the second and third quartiles, the minimum and maximum are found at the ends of the whiskers, the mean (X), and the median at the horizontal line. Note the two outliers for Users 6 and 7. Though the project data are compact and have high scores the outliers show low scores in "Beneficial to Society" and "Permitting and Certification (Consenting)." Note also the improvement for User 2.



The final TPL value is a weighted average of the capability scores. The number of thresholds breached is shown as the numeral over the bar. Thresholds are set as a measure of survivability, economic viability or sometimes just represent missing/unknown information. More important than the final score is the feedback provided to the user/developer at the end of the assessment.

To perform your own TPL assessment go to https://tpl.nrel.gov

CONCLUSIONS

- Feedback provided to the developer at the end of the assessment is the most important deliverable.
- Technology Performance Level assessments performed collaboratively with WEC developers can build awareness of a more wide ranging and holistic set of design criteria, leading to decreased production cost and increased performance.
- TPL Assessments can identify areas for technology improvement.
- In the case of User 2, improvement was possible and measurable.

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