

Technology readiness levels. What does it mean? What does it need to prove?

Scott Wise · August 29, 2026

Every federal funding announcement states an entry and an exit TRL. This range is not a scoring factor, but it is a control gate to even qualify for scoring. Any technology that is ranked too low or too high in its stated maturity relative to the limits cited in the announcement will be rejected. The most applied standard is that of the DOE. I am using its language to identify the differences between levels 1 through 7. At the right of each is what criteria actually frame each level. Levels 8 and 9 exist, but federal R&D programs rarely fund there.

	DOE DEFINITION	WHAT FRAMES THE LEVEL
1	Basic principles observed and reported	Published research identifying the underlying principle. Paper studies and observation of the physical world. No application yet.
2	Technology concept and/or application formulated	A practical use has been named. Analytic work only. DOE's own wording: 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	Lab work has verified the concept on separate elements. Components validated individually, with no attempt to integrate them into a system.
4	Component and/or system validation in a laboratory environment	The pieces work together. Low fidelity compared with the eventual system — ad hoc hardware, bench conditions, small-scale tests.
5	Laboratory scale, similar system validation in a relevant environment	Same components, but the system configuration now matches the final application in almost all respects and is tested against realistic conditions. This is the entry gate on most federal R&D announcements.
6	Engineering or pilot-scale, similar prototypical system validation in a relevant environment	Step up from laboratory to engineering scale. Scaling factors determined. The prototype performs every function the operational system will require.
7	Full-scale, similar prototypical system demonstrated in a relevant environment	Full-scale prototype in the field. Final design virtually complete, with results analysed against the eventual operating environment. This is the exit gate on most federal R&D announcements.

The definitions provided above are published in the DOE funding announcements. Other agencies use scales that differ in wording and scope. Never assume government continuity: refer to the definitions relevant to your agency application.

Confusing TRLs

4 to 5 is not about scale

Both are laboratory. The difference is in recognition of the environment. TRL 4 is bench conditions; TRL 5 is conditions representative of where the technology will actually operate. The reviewer applies the same rules, but filters to the relevant operating environment the award would require.

The solicitation defines "relevant environment," not the applicant. If an announcement specifies "sub-1-millidarcy rock at reservoir temperature," then lab work at conventional conditions, however rigorous, will be classified as TRL 4 evidence, not qualification for TRL 5.

This is why the same technology can carry two very different numbers at the same moment. A product with a decade of commercial results in one operating environment will be ruled as TRL 3 in a different use case, because none of the graded technology validation was performed fitting the required usage the announcement names. Nothing about the technology changed; only its intended use.

Where applicants get it wrong

- **Claiming a TRL by analogy.** "Similar systems are at TRL 7" is not your TRL. The maturity ranking attaches only to your technology supported by your evidence.
- **Treating lab testing as environment.** Well-instrumented bench work is still bench work. Actual performance in the required environment is what moves 4 to 5.
- **Scoring the project instead of the technology.** DOE states plainly that the TRLs listed are for the proposed technologies, not for the overall field site or facility.
- **Entering too low.** Below the stated entry TRL, the application will not be received as qualified for scoring.
- **Entering too high.** A technology already at the exit TRL invites the obvious question. Why does it need federal research money at all?

How to establish the number honestly

Write down the operating environment the announcement names. If you are in the oil and gas business, you know that conventional and unconventional wells are not the same. Performance at altitude is not the same thing as an atmospheric test chamber. Check carefully what is important: permeability, temperature, pressure, salinity, duty cycle, whatever the project requires. Then list what you have tested and under which of those conditions. Where the two lists diverge is your real TRL, and the gap between it and the stated entry gate is your work plan.

The practical point

TRL is the first gate, and it is a gate you can measure yourself before you spend anything. The band is published in the announcement. Your evidence is in your own files. The comparison takes an afternoon.

If the two do not line up, that is worth knowing in week one rather than week eleven.

Weighing an announcement? Let's establish where the technology actually sits →

Reference summary. Use the NOFO specification as the only guide. TRL definitions vary between agencies and occasionally even between departments or programs within the same agency.

Other helpful resources: [the federal acronym glossary](#), [the engagement checklist](#), and [current open opportunities](#).