

TECHNOLOGY READINESS LEVEL

Technology Readiness Levels (TRL) are a type of measurement system used to assess the maturity level of a particular technology. Each technology project is evaluated against the parameters for each technology level and is then assigned a TRL rating based on the projects progress. There are nine technology readiness levels. TRL 1 is the lowest and TRL 9 is the highest.

Technology Readiness Levels in the European Commission (EC)

Technology Readiness Level	Description
TRL 1.	Basic principles observed: Lowest level of technology readiness. Scientific research begins to be translated into applied research and development (R&D). Examples might include paper studies of a technology's basic properties.
TRL 2.	Technology concept formulated: Once basic physical principles are observed, then at the next level of maturation, practical applications of those characteristics can be invented or identified. At this level, the application is still speculative- there is not experimental proof or detailed analysis to support the conjecture. Examples are limited to analytic studies.
TRL 3.	Experimental proof of concept: At this step in the maturation process, active research and development (R&D) is initiated. This must include both analytical studies to set the technology into an appropriate context and laboratory-based studies to physically validate that the analytical predictions are correct. These studies and experiments should constitute proof-of-concept validation of the applications/concepts formulated at TRL 2.
TRL 4.	Technology validated in lab: At this level the design, development and lab testing of technological components are performed. Following successful proof-of-concept work, basic technological elements must be integrated to establish that the pieces will work together. The validation must be devised to support the concept that was formulated earlier, and should also be consistent with the requirements of potential system applications. It is "low-fidelity" validation compared to the eventual system.
TRL 5.	Technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies): The basic technological components are integrated with reasonably realistic supporting elements so they can be tested in a simulated environment. Examples include "high-fidelity" laboratory integration of components.
TRL 6.	Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies): 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. Examples include testing a prototype in a high-fidelity laboratory environment or in a simulated operational

environment.

- TRL 7. **System prototype demonstration in operational environment:** TRL 7 is a significant step beyond TRL 6, requiring an actual system prototype demonstration in a real relevant environment. The prototype should be near or at the scale of the planned operational system and the demonstration must take place in real environment. The goal of this stage is to remove engineering and manufacturing risk.
- TRL 8. **System complete and qualified:** Technology has been proven to work in its final form under the expected conditions. Examples include developmental test and evaluation of the system in its intended system to determine if it meets design specifications. In almost all cases, this level is the end of true system development.
- TRL 9. **Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies):** Actual application of the technology in its final form and under target conditions, such as those encountered in operational test and evaluation. At this point, the technology is ready for commercial deployment.