TRL - Technology Readiness Level

The following TRL definition is applicable for different technology areas.
It is based on the TRL scale used by Horizon2020.

TRL 1: Basic principles observed

- Identification of the new concept.
- Identification of the integration of the concept.
- Identification of expected barriers.
- Identification of applications.
- Identification of materials and technologies based on theoretical fundamentals/literature data.
- Preliminary evaluation of potential benefits of the concept over the existing ones

TRL 2: Technology concept formulated

- Enhanced knowledge of technologies, materials and interfaces is acquired.
- New concept is investigated and refined.
- First evaluation about the feasibility is performed.
- Initial numerical knowledge.
- Qualitative description of interactions between technologies.
- Definition of the prototyping approach and preliminary technical specifications for laboratory test.

TRL 3: Experimental proof of concept

- First laboratory scale prototype (proof-of-concept) or numerical model realized.
- Testing at laboratory level of the innovative technological element (being material, sub-component, software tool, …), but not the whole integrated system.
- Key parameters characterizing the technology (or the fuel) are identified.
- Verification of the proof of concept through simulation tools and cross-validation with literature data (if applicable).

TRL 4: Technology validated in lab

- (Reduced scale) prototype developed and integrated with complementing subsystems at laboratory level.
- Validation of the new technology through enhanced numerical analysis (if applicable).
- Key Performance Indicators are measurable.
- The prototype shows repeatable/stable performance (either TRL4 or TRL5, depending on the technology)

TRL 5: Technology validated in relevant environment

- Integration of components with supporting elements and auxiliaries in the (large scale) prototype.
- Robustness is proven in the (simulated) relevant working environment.
- The prototype shows repeatable/stable performance (either TRL4 or TRL5, depending on the technology).
- The process is reliable and the performances match the expectations (either TRL5 or TRL6, depending on the technology).
- Other relevant parameters concerning scale-up, environmental, regulatory and socio-economic issues are defined and qualitatively assessed.

TRL 6: Technology pilot demonstrated in relevant environment

- Demonstration in relevant environment of the technology fine-tuned to a variety of operating conditions.
- The process is reliable and the performances match the expectations (either TRL5 or TRL6, depending on the technology).
- Interoperability with other connected technologies is demonstrated.
- Manufacturing approach is defined (either TRL6 or TRL7, depending on the technology).
- Environmental, regulatory and socio-economic issues are addressed.

TRL 7: System prototype demonstration in operational environment

- (Full scale) pre-commercial system is demonstrated in operational environment.
- Compliancy with relevant environment conditions, authorization issues, local/national standards is guaranteed, at least for the demo site.
- The integration of upstream and downstream technologies has been verified and validated.
- Manufacturing approach is defined (either TRL6 or TRL7, depending on the technology).

TRL 8: System complete and qualified

- Technology experimented in deployment conditions (i.e. real world) and has proven its functioning in its final form.
- Manufacturing process is stable enough for entering a low-rate production.
- Training and maintenance documentation are completed.
- Integration at system level is completed and mature.
- Full compliance with obligations, certifications and standards of the addressed markets

TRL 9: Actual system proven in operational environment

- Technology proven fully operational and ready for commercialization
- Full production chain is in place and all materials are available
- System optimized for full rate production

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Adapted from "*DG RTD – TRL Project Technology Readiness Level: Guidance Principles for Renewable Energy Technologies Final Report*". Directorate-General for Research and Innovation (European Commission). Authors: Antonio De Rose, Marina Buna, Carlo Strazza, Nicolo Olivieri, Tine Stevens, Leen Peeters, Daniel Tawil-Jamault, Table 14, page 41-42. November 2017.

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