

General guide for Technology Readiness Level “TRL” & Investment Readiness Level “IRL” considerations

TRL & IRL EVOLUTION schedules and capabilities		TRL / IRL Implementation		Scientific evidence level
		factor %	risk %	
EU Community S&T - RTD maturity progress	TRL 1-3 = IDEA = basic principles, technology concept formulated	0-1%	100%	THESIS: theoretical assumptions
	TRL 4 = technology validated in laboratory	<3%	>97 %	
	TRL 5-6 = PILOT technology validated and demonstrated in relevant environment IRL5-6 = validate revenue model & market fit high technical risk/full commercial risk	<25%	>90%	
	Low RMI operational area		RTD risk break-even point	
EU Community S&T - RTD maturity progress	TRL 7= PROTOTYPE demo in operational environment IRL 7 = prototype viable product	60-75%	40-70%	Prototype demonstrated
	TRL8 = FIELD DEMO system complete and qualified IRL 8 = validate value delivery	75-90%	15-25%	Industrial validated
	TRL 9 = actual system proven in operational environment, full scale industrial replication model ready for market competitive commercial deployment. IRL 9 = identify and validate metrics The TRL9/IRL9 is the first full industrial/market/commercial replication model. Demonstrate conversion of science into practice: competitive manufacturing, industrial training, user/market uptake and exploitation in practice.	95-99%	1-5%	Market validated for commercial replication
Industrialized and market competitive commercialized innovation		97-99%	1-5%	Commercial replicated

- ✓ **The TRL** (also known as Technology Readiness Assessment “TRA”) is based on the EU Commission Decision C(2014)4995) and US official methods since 1980’s (NASA, DoD, ESA, ISO 16290:2013 standard).
- ✓ **The IRL** is based on the OECD (The Organisation for Economic Co-operation and Development) and other large financial institutions methods www.oecd.org. IRL is an evidence based demonstration to investors, that there’s a repeatable and scalable business model.





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Technology readiness levels are levels on a scale that can be used for estimating the maturity of a given technology. There are nine levels, which each represent a state in the development of technology, from the first thoughts to the final technology.

TRL 1: Basic principles observed

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

TRL 2: Technology concept formulated

- ✓ Enhanced knowledge on 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.
- ✓ Prototyping approach and preliminary technical specifications for laboratory test are defined.

TRL 3: Experimental proof of concept

- ✓ First laboratory scale prototype (proof of concept) or numerical model realized.
- ✓ Laboratory tests of the technological element, but not the whole integrated system.
- ✓ Identification of key parameters characterising the technology.
- ✓ Verification of the proof of concept through simulation tools and cross-validation with literature data (if applicable).





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TRL 4: Technology validated in lab

- ✓ Small-scale prototype integrated with complementing subsystems at laboratory level.
- ✓ Validation of the new technology through enhanced numerical analysis (if applicable).
- ✓ Measurable Key Performance Indicators.
- ✓ Prototype shows stable performance (either TRL4 or TRL5, depending on the technology)

TRL 5: Technology validated in relevant environment

- ✓ Large scale prototype integrated with components of supporting elements and auxiliaries.
- ✓ Robustness is proven in relevant working environment.
- ✓ Prototype shows stable performance.
- ✓ The process is reliable, and performances live up to expectations.
- ✓ Other parameters concerning scale-up, environmental, regulatory, and socio-economic issues are defined and qualitatively assessed.

TRL 6: Technology pilot demonstrated in relevant environment

- ✓ Demonstration of the technology is fine-tuned to a variety of operating conditions in relevant environment.
- ✓ The process is reliable, and the performances live up to the expectations.
- ✓ Demonstration of interoperability with other connected technologies.
- ✓ Manufacturing approach is defined.
- ✓ Environmental, regulatory, and socio-economic issues are addressed.





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TRL 7: System prototype demonstration in operational environment

- ✓ Full scale pre-commercial system is demonstrated in operational environment.
- ✓ Compliancy with relevant environment conditions, authorisation issues, local/national standards is guaranteed.
- ✓ Integration of upstream and downstream technologies are verified and validated.
- ✓ Manufacturing approach is defined.

TRL 8: System complete and qualified

- ✓ Technology has been experimented in deployment conditions (i.e. real world) and proven its functioning in its final form.
- ✓ Manufacturing process is stable enough for 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: System proven in operational environment

- ✓ Technology proven fully operational and ready to be commercialised.
- ✓ Full production chain is in place and all materials are available.
- ✓ System optimised for full rate production.

Adapted from “DG RTD – TRL Project Technology Readiness Level: Guidance Principles. Directorate-General for Research and Innovation (European Commission) Unit G.3. EUR 27988 EN (page 6-7 common trends for all technologies). November 2017.

