PROCURING INNOVATIVE CLIMATE CHANGE SERVICES

Policy Brief Technology Readiness Levels to identify the maturity of Climate Services

The PROTECT Project

PROTECT supports urgent action for **climate adaptation, mitigation, and resilience**. It enables public authorities to use state-of-the-art public procurement approaches in order to identify solutions – **Climate Services (CS) based on Earth Observation** – that best fit the specific and systemic needs of the public demand. The focus is on five application domains, namely: Energy & Utilities, Sustainable Urban Communities, Agriculture, Forestry and other Land use, Marine and Coastal Environments and Civil Security and Protection. PROTECT will source and assess existing and high-potential CS solutions and technologies that use Earth Observation data. It will engage with an extensive and varied community of procurers, facilitate the definition and aggregation of their needs and functional requirements for climate services, explaining, fostering and supporting a 'buying with impact' approach. PROTECT will **prepare the operational ground for one or more joint, cross border or coordinated pre-commercial procurement (PCP) processes**. At policy level, it will provide decision-makers for procurement, climate and policy, at EU, national, regional and local levels, with practical recommendations and guidelines to boost the use of innovation procurement for climate action.

Summary

- The stages of technology development can be illustrated by and agreed upon the concept of **'Technology Readiness Levels' (TRL).**
- There are 9 Technology Readiness Levels, ranging from 1 (fundamental research) to 9 (early deployment of near-commercial technologies).
- Each of these stages **relate to specific activities covered by Pre-Commercial Procurement (PCP) or by Public Procurement of Innovative solutions (PPI)**.
- The TRL framework is relevant for the assessment of the maturity of Climate Services (CS).
- **CS technologies at TRL 6 can be demonstrated in a relevant environment**, while at TRL 7 the system prototype is demonstrated in an operational environment.
- At TRL 8 a CS system is **complete and qualified**.
- At TRL 9 the actual CS system is **proven in operational environment**.

Recommendations on the TRL assessment

- Public organisations across Europe can **make strategic use of public procurement instruments** towards innovative and sustainable solutions including Climate Services.
- A state-of-the-art analysis and a sound market consultation can provide information to assess the maturity of available solutions.
- Essentially, **solutions at a lower TRL** (e.g., TRL 3-5) that may require further development, **could be tackled through a PCP**.
- **Solutions at higher TRL** (e.g., TRL 7-9), on the other hand, **can be procured through a PPI** approach using any of the different types of contracting procedures as established in the EU Public Procurement directives.
- A common understanding and good assessment of the TRL concept is essential to define the procurement strategy.

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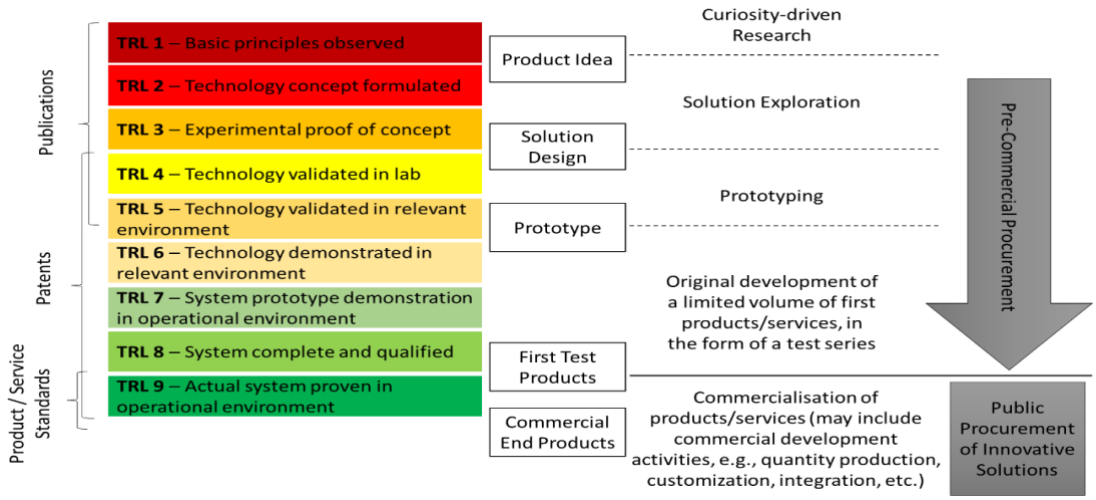
Fig 1: TRL in relation to the innovation cycle and the procurement approach



Introduction

The different typical stages of technology development are explained and broken down using the concept of **'Technology Readiness Levels'** (TRLs, see Fig. 1). There are 9 TRLs, ranging from 1 (fundamental research) to 9 (early deployment of near-commercial technologies).

Each of these stages relates to specific activities covered by Pre-Commercial Procurement (PCP) or by Public Procurement of Innovative solutions (PPI).

The assessment of the TRL of a solution provides the grounds for a choice of procurement approach and procedure. Agreeing upon the definition of the levels of a TRL framework to understand the readiness of solution is also the basis for the evaluation and testing scheme.

Mapping Procurement with TRLs

While PCP focuses on the R&D phase prior to commercialization, PPI, which does not cover R&D, concentrates on the commercialization/ diffusion of solutions. In other words, **PCP only covers the procurement of R&D services**, in a way that is clearly separated from any potential subsequent purchase of commercial volumes of end-products.

The boundaries of what R&D may cover under PCPs (which clarifies also how PCP maps to TRLs) are set by the following two legal frameworks: **the 2014 EU State aid framework for research, development and innovation** (R&D&I) and the **WTO Government Procurement Agreement (GPA).**

PCP procures R&D covering solution exploration and design, prototyping, original development and validation/testing of a limited volume of first products or services in the form of a test series.

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According to Article XV (1)(e) of WTO GPA 1994 and Article XIII(1)(f) of the revised WTO GPA 2014, which **defines original development as the boundary of where R&D stops**, original development of a first product or service may include limited production or supply in order to incorporate the results of field testing and to demonstrate that the product or service is suitable for production or supply in quantity to acceptable quality standards, but does not include quantity production or supply to establish commercial viability or to recover R&D costs.

This fits with the 2014 EU State aid framework for research, development and innovation (R&D&I), which states that **in order for PCP to exclude State aid, the object of a PCP contract must fall within one or several categories of research and development** defined in this framework and must be of limited duration, it may include the development of prototypes or limited volumes of first products or services in the form of a test series but the purchase of commercial volumes of products or services must not be an object of the same contract. The **R&D categories** defined in the R&D&I State aid framework that may thus be covered by PCP are listed below.

R&D Categories

'**fundamental research'** means experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any direct commercial application or use in view;

'**industrial research'** means the planned research or critical investigation aimed at the acquisition of new knowledge and skills for developing new products, processes or services or for bringing about a significant improvement in existing products, processes or services. It comprises the creation of components parts of complex systems, and may include the construction of prototypes in a laboratory environment or in an environment with simulated interfaces to existing systems as well as of pilot lines, when necessary for the industrial research and notably for generic technology validation;

'**experimental development'** means acquiring, combining, shaping and using existing scientific, technological, business and other relevant knowledge and skills with the aim of developing new or improved products, processes or services. This may also include, for example, activities aiming at the conceptual definition, planning and documentation of new products, processes or services. Experimental development may comprise prototyping, demonstrating, piloting, testing and validation of new or improved products, processes or services in environments representative of real life operating conditions where the primary objective is to make further technical improvements on products, processes or services that are not substantially set. This may include the development of a commercially usable prototype or pilot which is necessarily the final commercial product and which is too expensive to produce for it to be used only for demonstration and validation purposes. Experimental development does not include routine or periodic changes made to existing products, production lines, manufacturing processes, services and other operations in progress, even if those changes may represent improvements. The latter are considered innovation / commercial development activities.

Types of Innovation

On the other hand, PPIs do not procure R&D but innovative commercial end-products/ services. **A PPI is started when products/ services are near-to-the market or already on the market in small quantities**. In order to deliver those innovative solutions with the required quality/price level to the procurer for the PPI, vendors may still need to do 'innovation' activities e.g. to customise existing solutions to specific client needs and/or scale up their production chain from R&D to commercial production volumes. According to the 2014 EU State aid framework for research, development and innovation (R&D&I), 'innovation' activities include:

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'organisational innovation'
the implementation of a new organisational method in an undertaking's business practices, workplace organisation or external relations, excluding changes that are based on organisational methods already in use in the undertaking, changes in management strategy, mergers and acquisitions, ceasing to use a process, simple capital replacement or extension, changes resulting purely from changes in factor prices, customisation, localisation, regular, seasonal and other cyclical changes and trading of new or significantly improved products;

'**process innovation**': the implementation of a new or significantly improved production or delivery method (including significant changes in techniques, equipment or software), excluding minor changes or improvements, increases in production or service capabilities through the addition of manufacturing or logistical systems which are very similar to those already in use, ceasing to use a process, simple capital replacement or extension, changes resulting purely from changes in factor prices, customisation, localisation, regular, seasonal and other cyclical changes and trading of new or significantly improved products.

Policy implications

Innovation policy is essential for advancing the transition to a green economy, sustainable development and environmental stewardship. By promoting the innovation of Climate Services can have an impact on climate change mitigation and adaptation. To understand the potential of existing off-the-shelf services and identify technology gaps where R&D is needed a maturity requires the assessment on standard TRL framework.

Relation between PCP and TRLs

As explained under footnote 40 of the 2014 EU R&D&I State aid framework, the different R&D categories[1] can also be considered to correspond to Technology Readiness Levels 1 (fundamental research), 2-4 (industrial research – the type of by activities targeted by phase 1 of a PCP) and 5-8 (experimental development – the type of activities targeted by phase 2 and 3 of a PCP)[2]. As PCP is driven by a specific procurement need (with a concrete use case in mind), fundamental research is not the aim of a PCP. Procurers launching a PCP have a concrete use case/application for the innovative solutions in mind so they will launch a PCP call for tender that does not request providers to undertake "fundamental" research but "applied" R&D: industrial research and experimental development including field testing (so PCP call for tenders will call for R&D activities ranging in between TRLs 2-8). However, it is possible that during a PCP some vendors realise that they could achieve better applied R&D results if they further elaborate some fundamental research aspects related to their solution approach. If they decide to do this, it is up to them to do that within the budget and timeline of the ongoing PCP.

In cases where the final end-products of a PCP do not need to be produced in large quantities and the procurer requests to obtain the limited set of end-products that results from phase 3 testing at the end of the PCP, then in fact TRL 9 does not exist and TRL 8 covered by the PCP equals the final commercial deployment of the end-products. In some cases, even TRL 6-7 may not exist and then TRL 9 meets TRL 6. This happens for example when the prototype consists of the final end-product and there is no

[1] Due to the multiplicity of TRL classification systems and their generic description, it is not possible to provide a concrete and generally applicable mapping of TRLs. See point 31 in: Revision of the Frascati Manual: Chapter 8. Government Sector R&D (oecd.org)

[2] According to this framework, when classifying different activities according to the relevant category, the Commission will refer to its own practice as well as to the specific examples and explanations provided in "The Measurement of Scientific and Technological Activities, Proposed Standard Practice for Surveys on Research and Experimental Development", Frascati Manual, OECD, 2002.

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need of any mass production / large scale testing nor integration with other components. The whole R&D trajectory of a typical product would normally be less complex and lengthy as the TRL scale may suggest.

Whereas mapping this TRL scale and sequence of steps may not apply to every procurement process or to all sectors[3], it provides a guidance scheme to understand the progress in terms of 'technology maturity' that the solutions of vendors are making as the R&D progresses during the PCP. For example, a procurer may use TRL levels to compare the level of maturity of solutions at different milestone points in a PCP (e.g. at the end of phase 1/2/3). Another example is the TRL table below that refers to software development.

TRL	Definition
1	Preliminary algorithmic stage. Publication of research results.
2	Individual algorithms or functions are prototyped.
3	Prototype of the main functionalities of the integrated system.
4	Alpha version. Preliminary release of non-mature software version; distributed to a community at an early stage of the software development life-cycle; that implements the main functionality of the software and by which preliminary verification and validation activities are archived.
5	Beta version. Preliminary release of non-mature software version; distributed to a community at an early stage of the software life-cycle, that implements the complete functionality of the software and by which preliminary verification and validation activities are archived.
6	Ready for use in an operational or production context, including user support, as a building block or a tool.
7	Demonstrator. Building block and tailored generic software product qualified for a particular purpose.
8	System qualified and ready to be applied in an operational environment.
9	Has been applied in the execution of an operational environment

Relation between PPI and TRLs

PPIs do not procure R&D but commercial volumes of innovative commercial end-solutions that correspond to TRL level 9 (system proven in operational environment). To ensure that the solutions that are offered by potential bidders for the PPI meet this requirement, it is wise that the procurer requires vendors to demonstrate proof of compliance via conformance testing, certification, labelling before awarding the PPI contract.

A mistake often made is that procurers sign PPI procurement contracts for deploying commercial volumes of end-solutions at a point in time when TRL level 9 has not been reached yet. They discover only during contract implementation that they have locked themselves into a contract with a suboptimal vendor, who is in reality not able to deliver the solution (the vendor had in reality not finished R&D yet before signing the PPI contract and the technological risk of R&D failure is carried into the PPI contract). Or they are stuck with a vendor who needs significant extra time and budget to deliver the solution with the required performance / price levels. In some sectors (e.g. e-health) this leads to 70% of contracts not reaching the initial objectives, with colossal budget and time overruns or even total contract failures as a result. Preventing risk of failure for large scale PPI contracts is one of the main reasons for using separate procurements/contracts for R&D (PCP) and deployment (PPI).

Conclusion

The role of innovation policy is vital in driving the development and deployment of Climate Services (CS). Effective innovation policies fostering the strategic use of innovation procurement have the potential to drive economic growth, protect the environment, and improve social welfare, creating a pathway towards a more sustainable and inclusive future. In this context, a common understanding of the TRL framework is essential to define the starting and ending TRL of solutions to be procured.

[3] The TRL scales were originally developed by the defense/space sector where complex systems of several subcomponents exist, and the security/safety requirements are so high that the quality of a first prototype is never ready/reliable enough to use as final end-product.

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