



# TÜV SÜD at a glance

By choosing TÜV SÜD, a dedicated team of global experts is committed to help you manage risks and access global markets through a comprehensive portfolio of technical solutions.

- Our logo is universally respected as an independent and impartial symbol of safety, security and sustainability.
- TÜV SÜD certification marks and certificates represent third-party endorsement by a globally renowned organisation, while our personnel certificates provide our customers with greater market opportunities.





### Role of Third Parties in the Growing Hydrogen Economy



As hydrogen projects leave the demonstration status, quality
 requirements on components and systems are strongly rising

Role of **third parties**: **Independent assessment** of a component/system/plant quality and **check for compliance** with certain requirements

- Third party assessments reduce risks and are triggered by all market players
- Demand strongly growing, but no "business as usual" as several boundary conditions are missing

Typical services: Certifications and technology readiness level assessments



### Certification Levels for Component and System Manufacturers





07/04/2023

## **Certification Levels for Component** and System Manufacturers







**Hydrogen Tech** World Conference 2023

H2-Ready? Component and Plant Quality Assessment by Third Parties

07/04/2023



### Example: Certification of an electrolyzer acc. to ISO 22734



H2-Ready? Component and Plant Quality Assessment by Third Parties

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### And what about the Technology Readiness of a System?

**Maturity Leve** 

Technology Readiness Level (TRL)	Milestone achieved for the element	Work achievement (documented)	Additional requirements in EN 16603-11:2019 [L01]
TRL 1: Basic principles ob- served and reported	Potential applications are identi- fied following basic observations but element concept not yet for- mulated.	Expression of the basic principles in- tended for use. Identification of potential applications.	A TRL shall not be called TRL 1 unless the condi- tions specified in 4.2.1 of [L01] are met
TRL 2: Technology concept and/or application formulated	Formulation of potential applica- tions and preliminary element concept. No proof of concept yet.	Formulation of potential applications. Preliminary conceptual design of the element, providing understanding of how the basic principles would be used.	A TRL shall not be called TRL 2 unless the condi- tions specified in 4.3.1 of [L01] are met.
TRL 8: Actual system com- pleted and accepted for flight ("flight qualified")	Flight model is qualified and inte- grated in the final system ready for flight.	Flight model is built and integrated into the final system. Flight acceptance of the final system.	A TRL shall not be called TRL 8 unless: 1. the conditions speci- fied in 4.9.1 of [L01] are met 2. a system, integrating the element, has passed through a successful Ac- ceptance Review (AR). NOTE 1 This successful AR at system level can be from another program NOTE 2 Whatever is the hi- erarchy level of the element in the product tree, TRL 8 for that element can only be achieved upon successful completion of the AR at system level.
TRL 9: Actual system "flight proven" through successful mission operations	Technology is mature. The ele- ment is successfully in service for the assigned mission in the actual operational environment.	Commissioning in early operation phase. In-orbit operation report.	A TRL shall not be called TRL 9 unless: 1. the conditions speci- fied in 4.10.1 of [L01] are met, 2. a system, integrating the element, has passed through a successful Commissioning Result Review (CRR).

- Certification proves, that the requirements of a specific standard/guideline/... are fulfilled by the component/system/project = State-of-the-Art
- But: Hydrogen technology isn't mature and the state-of-the-art has white spaces
- The **Technology Readiness Level** (TRL) of a system:
  - > quantifies the **maturity** of the technological **development status**
  - > Scale from 1 ("idea") to 9 (mature technology with proven operational experience)
  - > Covers a **broader scope** then certification
- A **TRL assessment** of a system gives:
  - the system's manufacturer a good evaluation on the current development status and
  - helps an operator/investor in estimating the risk of buying and operating the system
- Growing demand for a TRL assessment by third party driven mostly by insurance companies/investors



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### How does a TRL Assessment look like?

**Normative Basis** 

	DEV. 54.602.11		INTERNATIONAL ISO
	DIA 14 10003-11	DIN	STANDARD 16290
25 49.140	B	NACE OF 16270 2016-09	First edition 1933-11-01
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eutsche Fassu ace engineering - efinition of the Te 50 16350-2013, n	nerren (150-16230:2015, moantzierr); ng EN 16603-11:2019 - chnology Readiness Levels (TRLs) and their crit roddind):	eria of assessment	Space systems — Definition of the Technology Readiness Levels (TRLs) and their criteria of assessment
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- EN 16603-11 and ISO 16290
- Definition of a mature technology:
  - Existence of reproducable processes for design, manufacture, test and operation
  - Performance requirements from operation environment are met

### Concretization for specific application

Rating category	Definition
	<ul> <li>Functional and operational performance criteria have been defined</li> </ul>
	<ul> <li>Manufacturing site running, manufacturing processes are established and in operation</li> </ul>
	<ul> <li>FAT and SAT procedures are defined</li> </ul>
	<ul> <li>Operation in the field is running</li> </ul>
2	<ul> <li>Definition of performance requirements and of the relevant environment completed</li> </ul>
	<ul> <li>Production of manufacturing equipment is ready to start or running</li> </ul>
	<ul> <li>Tests of critical functions on (sub-)element level have been successfully performed</li> </ul>
	<ul> <li>Supplier qualification completed</li> </ul>
	<ul> <li>Pilot or test project has been successfully completed (test plan, test results)</li> </ul>
3	<ul> <li>Critical functions are identified and analyzed, test plan for verification available</li> </ul>
	<ul> <li>Design specification for (sub-)element defined</li> </ul>
	<ul> <li>Pilot manufacturing plant running</li> </ul>
	<ul> <li>Design of manufacturing equipment started</li> </ul>
	<ul> <li>Supplier gualification process defined</li> </ul>
	<ul> <li>Pilot or test project started</li> </ul>
	<ul> <li>Preliminary performance requirements (including functional performance requirements)</li> </ul>
	<ul> <li>Basic design of element</li> </ul>
4	<ul> <li>(Sub-)element proof-of-concept completed (analytical, laboratory level)</li> </ul>
	<ul> <li>Basic manufacturing line in operation</li> </ul>
5	<ul> <li>Basic R&amp;D completed (preliminary design)</li> </ul>
	<ul> <li>Feasibility demonstrated (product and production)</li> </ul>
	<ul> <li>Project plan for further development of product and build-up of manufacturing available</li> </ul>

 Derivation of necessary documentation to show maturity of design, manufacturing, testing and operation experience by manufacturer

#### TRL Determination by Third Party

Торіс	Conter	nt developed by TÜV Si	D	
Technology qualification basis	Description of the system, the technology, performance and specific requirements			
Technology assessment	<ul> <li>Technology composition analysis</li> <li>Technology categorization</li> <li>Identification of main challenges and uncertainties</li> </ul>			
Threat assessment	HAZOP     Reliability     Availability     Maturity of the manufacturing process     Production roadmap     Assessment and classification of the midterm production			
Production				
TRL assessment	• TRL (	determination acc. to TÜ	V SÜD grading	
Gas turbine type:		Turbine Model		
Sub-system		TRL for 30% H <sub>2</sub>	TRL for 100% H <sub>2</sub>	
Inlet		9	9	
Compressor Combustion: Piping System Burner		9*	9*	
		6	6	
		6	4	
Combustion Chamber		6	3	
Turbine		9*	9*	
Instrumentation & Control Concept		9*	9*	
Operation Concept		9*	9*	
Maintenance Concept		9*	9*	
Maintenance Concept				



Document review, Workshops, onsite assessments,

### How does a TRL Assessment look like?



### **Hydrogen Tech** Conference 2023

#### H2-Ready? Component and Plant Quality Assessment by Third Parties

TRL Determination by Third Party

Content developed by TÜV SÜD

Technology composition analysis

· Maturity of the manufacturing process

TRL for 30% H<sub>2</sub>

9

9\*

6

6

Assessment and classification of the midterm

TRL determination acc. to TÜV SÜD grading

Turbine Model

TRL for 100% H<sub>2</sub>

9

9\*

6

4

3

9\*

9\*

9\*

9\*

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and specific requirements

Technology categorization

Production roadmap

HAZOP

Reliability

Availability

production

Description of the system, the technology, performance

Identification of main challenges and uncertainties

Topic

Technology qualification basis

Technology assessment

Threat assessment

Production

TRL assessment

Sub-system

Compressor

Inlet

Gas turbine type:

Combustion: Piping System



### As market professionalizes, quality requirements on hydrogen components and projects are rising

- Growing demand for quality assessment by independent third parties for risk reduction
- Certifications and TRL assessments help manufacturers to show outstanding component and plant quality and help operators, investors and insurers for risk estimation
- But assessment not business-as-usual, as hydrogen technology isn't mature and relevant boundary conditions are still missing



Summary





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Add value. Inspire trust.

TÜV