
 Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile			CONTRACT TERIN/2021/265	UNIT WP1-LA1
	SITE CASACCIA (RM)	50-PK-01		
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Ref. T.EN: 203998C-001-SP-4100-500001

Hydrogen Demo Valley Pre-Feasibility Study

Duty Specification for Solid Oxide Fuel Cell Package

50-PK-01



REV.	DATE	DESCRIPTION	PREPARED	VERIFIED	APPROVED
2	07/04/2022	FINAL ISSUE	S.BALDASSERONI	A. LECCESE	P.F. PEPPOLONI
1	23/03/2022	FINAL ISSUE	S.BALDASSERONI	A. LECCESE	P.F. PEPPOLONI
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1. INTRODUCTION

ENEA, the Italian National Agency for New Technologies, Energy and Sustainable Economic Development, has planned the realization of a Hydrogen Demo Valley (HdV) inside the research facility located at "La Casaccia", in the municipality of Rome (Italy). Such infrastructure will act as an incubator of technologies and services related to the entire hydrogen value chain, and is expected to be completed in May 2024.

T.EN Italy Solutions SpA has been awarded the preparation of a pre-feasibility study aimed at defining the scope and the execution model for the subsequent design phase and construction activity.

2. PROCESS DESCRIPTION

This duty specification concerns the supply of a Cogenerative Solid Oxide Fuel Cell Packaged unit for the production of electricity and thermal energy. ENEA is evaluating the possibility (Option 1) to use the SOFC as heat source to produce hot water ($T = 75 \div 90^{\circ}\text{C}$; heat duty is 50,2 kW, flow rate = 2,4 l/s) circulating through an external water-fired absorption chiller (NOT to be included in this scope of supply); Supplier is requested to confirm this arrangement.

Alternatively (Option 2), the SOFC electrical output shall be limited to 10 kWe.

Fuel gas will be one of the following:

- Odorized natural gas (NG) from the SNAM network,
- Hydrogen (suitable for fuel cell applications for road vehicles),
- H2-NG blends with a quantity of hydrogen in the range $0 \div 20\%$ (vol.).

Supplier shall indicate the fuel gas operating envelope and corresponding fuel cell performances.



The Fuel Cell Package is planned to work approximately > 8000 hours / year (baseload).

3. FUEL CELL SPECIFICATION

Main characteristics:

a) Thermal and Electrical output:

- Option 1: Thermal output (requested) $50 \div 55$ kW
- Option 2: Electrical output (requested) 10 kWe

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- | | |
|--------------------------|--------------------|
| b) Electrical efficiency | Supplier to advise |
| c) Overall efficiency | Supplier to advise |
| d) Service Factor | > 8000 hrs / year |

4. FUEL GAS SPECIFICATION

- | | |
|---|--|
| a) Inlet pressure (op./des.) | 12/24 barg (NG), 20/24 barg (H2) , 5÷11/12 bar (H2-NG) |
| b) Inlet temperature (op./des.) | 15/60°C (NG), 40/60°C (H2), 15÷40/60°C (H2-NG) |
| c) Hydrogen purity | as per SAE J2719 standard |
| d) Natural gas composition (see table below). | Natural gas composition is compliant with Italian Decree of 18 May 2018 and subsequent amendments and additions. |

Component	Average (mol. %)
CH ₄ – Methane	90.224
C ₂ H ₆ – Ethane	6.065
C ₃ H ₈ – Propane	1.050
C ₄ H ₁₀ – i-Butane	0.111
C ₄ H ₁₀ – n-Butane	0.154
C ₅ H ₁₂ – i-Pentane	0.035
C ₅ H ₁₂ – n-Pentane	0.027
Hexane +	0.018
CO ₂ – Carbon Dioxide	1,021
N ₂ – Nitrogen	1.263
He – Helium	0.034
H ₂ – Hydrogen	0.000
O ₂ – Oxygen	0.000
Co – Carbon Monoxide	0.000

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Component	Average (mol. %)
H ₂ S - Hydrogen Sulfide	≤ 5 mg/Sm ³
S as Mercaptans (*)	≤ 5 mg/Sm ³
Total Sulfur (*)	≤ 20 mg/Sm ³

(*) Excluding odorizing sulfur.

e) Natural gas properties (see table below)

Property	Average
M.W.	17.779
S.G.	0.614
HHV (25/0 °C)	11.551 (kWh/Nm ³)
W.I. (25/0 °C)	14.747 (kWh/Nm ³)
LHV (25/0 °C)	10.434 (kWh/Nm ³)

5. UTILITIES SPECIFICATION



Electric power

- | | |
|-------------------|--------------------|
| a) Medium voltage | 8,4 kV |
| b) Low voltage | 400 V, 50 Hz, 3 Ph |
| | 230 V, 50 Hz, 1 Ph |
| c) UPS | will follow |

Potable Water

- | | |
|-------------|-----------------|
| a) Source | Tap water |
| b) Pressure | 2,5 barg (TBC) |
| c) Quality | see table below |

pH	—	6,80
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Conductivity a 20°C	μS/cm2	262
Kubel oxidation number (as O ₂)	mg/l	<1,0
Arsenic – As	μg/l	6,4
Disinfectant (residue)	mg/l	0,08
Iron – Fe	μg/l	21,2
Nitrites (as NO ₂)	mg/l	< 0,1
Sulfates	mg/l	24,7
Ammonium (as NH ₄ ⁺)	mg/l	< 0,1
Total hardness	F°	9,2
Dry residue at 180°C	mg/l	292,6

Nitrogen

will be supplied by ENEA

Instrument air

will be supplied by ENEA



6. SITE AND CLIMATIC DATA (MONTHLY AVERAGE)

- Ambient temperature (min/max) 4°C / 29°C
- Max humidity (at min/max temp.) 77% / 65%
- Wind speed (max) 16 km/h
- Rain (max) 132 mm
- Altitude above sea level 150 m

7. SCOPE OF SUPPLY

The package shall include (but not necessarily be limited to) the following main parts:

- One or more Solid Oxide Fuel Cell Stacks

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- Fuel gas pretreatment (if necessary)
- Inverter (Power conditioning) and inverter cooling system
- Heat recovery circuit
- Emergency Cooling System (if necessary) which dissipates heat and ensures the cooling of the Fuel Cell even in the event of a sudden drop in heat demand from the user
- Water Treatment System (if necessary)
- A unit control cabinet, equipped with a PLC (SIL-3) for the local control and supervision of electrical and thermal parameters. The control system shall be equipped with local/remote switch suitable for remoted start/stop and load modulation and communicating facilities for interfacing with the SCADA in the main control room with open industry standard protocols (such as OPC, modbus, DNP3, etc).
- The supply must however include everything necessary for a safe and correct operation of the unit.
- All the equipment constituting the fuel cell package shall be placed in one or more containers.
- Each container shall be suitable for outdoor installation with a required degree of protection IP 55.
- Provisions for F&G detection and fire-fighting and inside the container.
- Compliance with PED, ATEX and Italian legislation.

8. REQUESTED INFORMATION

Supplier shall submit a technical and commercial proposal to include:

- Process Flow Diagram and Heat & Material Balance
- Electric and thermal output and efficiency vs. load rangeability
- Utilities and chemicals consumptions (in operation and stand by)
- Exhaust gas net of recirculation (temperature, flow rate and composition)
- Dynamic behaviour
- Effluents and emissions
- List of signals to be sent from the PLC to monitor the operation
- Dimensions and weight

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- Reference List
- Expected lifetime, degradation vs. operation mode
- Maintenance requirements with expected Opex
- Schedule for design, construction and delivery of the unit
- Budgetary offer for purchase, lease or right to use.
- Typical performance guarantees.
- Commissioning times and costs.
- Battery limits summary.