# **Supplementary Material**

The suitability of a saline aquifer for H2 storage will be a function of the values of the properties mentioned in the article. The considerations taken into account in assigning these values according to the characteristics of each site are described below.

**Primary Containment**

For a formation to be suitable from an HSE risk perspective, it must have a competent primary seal to contain the gas and an appropriate structural trapping mechanism. In this respect, a geological formation that has a shale seal with a thickness of more than 20 m, a depth of at least 500 m and an anticlinal structure would present a minimal risk of leakage in an initial assessment. This is because this type of lithology has low porosity and permeability. In addition, it should also be seismically stable within the regional geology. A basin with a compressive stress state and low seismicity would initially be a suitable situation for the UHS due to the geomechanical stability of these two states.

In the case of the reservoir, it is important from a safety point of view that the site is free of faults and deep wells. Lithology, permeability, porosity and thickness are other characteristics to be considered that affect both the safety and the capacity of the site. With regard to the hydrology of the reservoir, since it is an aquifer, the existence of a certain circulation associated with the open nature of the reservoir is in favour of safety, as it helps to relieve the stresses on the ground when gas is injected.

Table S1: Primary Containment: Suitability taken into account when assigning values to the various properties.

|  |  |  |  |
| --- | --- | --- | --- |
| **Attribute** | **Property** | **Description** |  |
| **Primary Seal** | ThicknessLithologyDemonstrated sealingDepth | >20 m Mudstones and shalesGood seal500 – 3700 m |  |
| **Regional geology** | Trapping MechanismStress stateTectonic | Good structural mechanism (anticline)compressivelow seismicity |  |
| **Reservoir** | LithologyPerm., PorosityThicknessFracture or primary porosityPores filled with…PressureHydrologyDeep wellsFault permeability | Homogeneous sandstone and carbonate>10% , >300 mD>10 m Primary porosityLow TDS WATER / BrinerUnderpressureSlow circulationWithout deep wellWithout fault / impermeable faults |  |

**Secondary Containment**

Hydrogen gas has a high diffusivity, so the presence of a secondary seal layer acting as a retardant formation will reduce the HSE risk. The characteristics to be considered for this secondary seal are the same as for the primary seal.

Table S2: Secondary Containment: Suitability taken into account when assigning values to the various properties.

|  |  |  |
| --- | --- | --- |
| **Attribute** | **Property** | **Description** |
| **Secondary seal** | ThicknessLithologyDemonstrated sealingTrap existenceDepth | >20 m Mudstones and shalesGood sealRegional seal500 – 1000 m |

**Attenuation potential**

Surface features that minimise HSE risks are associated with flat and windy topography, so that in the event of a leak, the gas concentration in the area can be diluted. Other risk mitigating aspects include the location of the site away from populated areas, such as an open field, and the absence of surface water that could act as a preferred pathway for gas transport. With regard to groundwater, if it is not drinking water, it can act as a safety factor by delaying the arrival of the gas in the atmosphere. Therefore, sites without drinking water aquifers between the storage formation and the surface, and aquifers with slow circulation, are preferred.

Table S3: Attenuation potential: Suitability taken into account when assigning values to the various properties.

|  |  |  |
| --- | --- | --- |
| **Attribute** | **Property** | **Description** |
| **Surface Characteristics** | TopographyWindClimateLand usePopulationSurface water | FlatWindyAridOpen range / FarmlandSparsely populated / SuburbanDry / Seasonal wetland |
| **Groundwater Hydrology** | Regional flowPressureGeochemistrySalinity | Slow flowUnderpressureAlkalineVery low TDS |
| **Existing Wells** | Deep/Shallow/Abandoned/Disposal wells | Without well |
| **Faults** | Tectonic faultsNormal faultsStrike-slip faultsFault permeability | No tectonic faultFew normal faultFew strike-slip faultsImpermeable faults |

# **Site Assessment**

**Guadalquivir**







**REUS**





