# **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** | Thickness  Lithology  Demonstrated sealing  Depth | >20 m  Mudstones and shales  Good seal  500 – 3700 m |  |
| **Regional geology** | Trapping Mechanism  Stress state  Tectonic | Good structural mechanism (anticline)  compressive  low seismicity |  |
| **Reservoir** | Lithology  Perm., Porosity  Thickness  Fracture or primary porosity  Pores filled with…  Pressure  Hydrology  Deep wells  Fault permeability | Homogeneous sandstone and carbonate  >10% , >300 mD  >10 m  Primary porosity  Low TDS WATER / Briner  Underpressure  Slow circulation  Without deep well  Without 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** | Thickness  Lithology  Demonstrated sealing  Trap existence  Depth | >20 m  Mudstones and shales  Good seal  Regional seal  500 – 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** | Topography  Wind  Climate  Land use  Population  Surface water | Flat  Windy  Arid  Open range / Farmland  Sparsely populated / Suburban  Dry / Seasonal wetland |
| **Groundwater Hydrology** | Regional flow  Pressure  Geochemistry  Salinity | Slow flow  Underpressure  Alkaline  Very low TDS |
| **Existing Wells** | Deep/Shallow/Abandoned/Disposal wells | Without well |
| **Faults** | Tectonic faults  Normal faults  Strike-slip faults  Fault permeability | No tectonic fault  Few normal fault  Few strike-slip faults  Impermeable faults |

# **Site Assessment**

**Guadalquivir**







**REUS**





