**Highlights**

* Proposes a novel decision-making framework for offshore Carbon Capture, Utilization, and Storage (CCUS) projects.
* Incorporates the *interval-valued Fermatean fuzzy environment* to handle high uncertainty in project evaluation.
* Integrates economic, environmental, and technical factors into a unified assessment model.
* Demonstrates applicability through a case study on offshore CCUS deployment.
* Offers valuable insights for policymakers and investors in the energy transition sector.