

## **Steam Generation using Renewables Energy – Integrated Green Energy Solution for EOR Operations**

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### **Abstract**

The application of generating steam in the aim of achieving Enhanced Oil Recovery (EOR) process is complex, reflected as a challenge, and crucial to produce heavy crude oil. The process requires a massive amount of thermal energy to acquire a ton of steam for daily EOR operations. Currently, steam is generated using conventional methods which requires utilizing natural gas as energy fuel, which leads to a release of significant amount of GHG emissions as a by-product of steam generation process, hence escalating environmental concerns.

Globally, Oil and Gas companies have set aspirations towards positive environmental culture and actively deploying renewable energy projects in line with their commitments in achieving energy mix demand and the net zero emissions by 2050. The objective behind this study is exploring deployment feasibility of different renewable energy technologies such as solar photovoltaic (PV), concentrated solar power, wind turbines along with thermal energy storage or electric heaters technologies while assessing their applicability to integrate with generating steam for EOR process.

The study also aims to identify the appropriate renewable energy technologies that are capable for meeting required heat demand to produce sufficient steam, while significantly reducing consumption of natural gas, and heavily minimize emissions of greenhouse gases (GHG).

Moreover, the study explores the renewable energy resources limitations due to intermittency related constraints and considers the possibility of utilizing various storage solutions both thermal storage and battery energy storage system (BESS). The study also explores possibility of hybrid arrangements of having renewable energy systems integrated with conventional steam generation systems. The renewable energy technologies for generating power and steam are compared technically, and economically to identify optimum fit for purpose steam generation technology.

The identified configurations of renewables energy system must sustain and maintain continuous steam generation profile for the intended EOR operation. Generally, it was found that 63 Sm<sup>3</sup>/ton of gas fuel savings per generated steam in (tons) is yielded with the concept of having renewable energy resource for generating steam.

This integrated approach of generating steam is a unique blend of selected technologies and appears as a novel solution in its essence, as currently there has not been a commercial case of renewable energy powering EOR operations globally. In addition, it is expected to open new horizons of expanding in supply chain, project delivery and job opportunities among EOR associated applications.