

HOW CAN SOLAR ENERGY SUPPORT MORE EFFICIENT ENHANCED OIL RECOVERY?

Framework Step:

STEP 4 – Support and contribute to innovation leading to new products and services

4. B *What can extractives industries do?*

- Leverage extractives sector operations to increase use of renewable energy, as appropriate. This could be done for example by either linking production to renewable energy (e.g. making use of solar and wind power to reduce the contribution of fossil fuels and green-house gases to mineral and oil & gas production, while reducing high electricity costs associated with the use of decentralised diesel generators) or by developing green supply chains (e.g. mining rare earths and supporting local manufacturing of magnets for wind turbines to provide clean energy or mining lithium to manufacture electric batteries for incorporation into green products).

Tags: *In addition to the Framework step(s) that they fall under, examples will also be tagged by crosscutting issues. Please select all applicable tags.*

- local employment
- local supplier participation and development, including SMEs
- marginalised groups (women, indigenous people)
- skills development and upgrading
- access to credit
- shared infrastructure (transport, water, power)
- technology transfer
- innovation
- economic diversification
- Other: _____

Problem Statement:

Petroleum Development Oman uses natural gas in Enhanced Oil Recovery (EOR) to heat water into steam, which is then pumped into oil wells in order to increase the viscosity of heavy oil and increase production. However, this relies on substantial quantities of natural gas – EOR accounts for more than 20% of the country's natural gas use, an amount that will grow as EOR is increasingly relied upon to keep oil production up. At the same time, there is also increased domestic demand for natural gas for power generation, desalination and industrial applications to support the diversification of the economy.

Parties Involved:

- Oman Ministry of Oil and Gas
- Petroleum Development Oman (PDO) (Government of Oman (60%), the Shell Group (34%), Total (4%) and Partex (2%))
- GlassPoint (a solar energy company)

Common ground:

PDO wanted to find a more economical means of Enhanced Oil Recovery (EOR) that would free up natural gas to be used in other sectors of the economy, such as power generation and industrial applications, in line with the priorities set out by the government of Oman.

Actions taken:

PDO partnered with GlassPoint, a California-based company, to develop a thermal solar-based EOR solution. Thermal solar projects harness the sun's heat, using it to transform water into steam that can be used in EOR to increase oil production. GlassPoint's approach consists of parabolic troughs that concentrate sunlight to heat up metal tubs containing water, converting it to steam. The troughs are situated in large glasshouse structures, to protect them from the elements. The steam is then injected into mature oil fields to heat heavy oil and allow its extraction. The glasshouse structures protect the thermal solar systems from the elements, allowing them to be lighter and simpler in construction, and consequently cheaper. Because sand and dust building up on the outside of the structures has a negative impact on solar intensity, an automatic cleaning system washes the buildings overnight with water, while they are non-operational. Most of the water is captured and reused. This is especially important considering Oman's arid environment.

PDO and GlassPoint's pilot project in Amal entered operation in December 2012. Generating 7 megawatts of thermal energy (MWth), which is converted into 50 tons of emissions-free steam per day, the project came in on time and on budget, and has exceeded performance targets. Production at the Amal field has increased to nearly record levels.

Based on the success of the pilot project, construction began in 2015 on the Miraah project. The PDO funded Miraah has a cost of 600 million USD and is 100 times larger than the pilot project, rated at 1,021 MWth, one the largest solar plant on the planet. Spread out over a total of 36 glasshouses, the buildings are being constructed sequentially in clusters of four over a three square kilometre area. The project enters steam production in 2017, with progressively more steam units coming online. According to GlassPoint, the vast majority of the materials for the project are being sourced locally, and construction is being handled by local firms. Omani engineers are thus also getting experience in constructing solar powered EOR plants, and with solar projects more broadly.

Obstacles:

- Thermal solar-based EOR is an emerging technology, and while the pilot project was successful, it may be challenging to increase the scale 100 fold.
- The innovative nature of the technology may also create challenges for local construction firms and material suppliers, who need to develop proficiency with new techniques.

Enabling factors:

- The State General Reserve Fund (SGRF), Oman's largest sovereign wealth fund administered by the Ministry of Finance, is a major shareholder in GlassPoint. In 2014, SGRF led a US\$53 million investment in GlassPoint along with Royal Dutch Shell and other investors to accelerate the deployment of solar EOR in Oman and throughout the region.
- The pilot project feeds its steam directly into the existing EOR steam infrastructure at the Amal West oil field. The ability to integrate the project directly into the existing conventional system saved time and money. The Miraah project is also being directly integrated into the existing system.

Lessons Learned:

- This is an example of a cost-effective application of solar technology that frees natural gas for alternative use, such as power generation and industrial applications, and reduces emissions from the production of heavy oil.
- It accomplishes multiple goals: extracting oil in a more energy efficient manner, allowing natural gas to support the diversification of the economy, and developing local expertise in a new technology that has broad regional and global applications across the oil sector.
- The business case for the technology is partially due to Oman's geography – a high degree of solar radiation year-round means that substantial amounts of steam can be generated.

