

SDG 9 industry, innovation and infrastructure:
The Manifa Oil Field Project – Engineering Resilience, Innovation and Sustainability

Introduction

The Kingdom of Saudi Arabia occupies most of the Arabian Peninsula. Although much of its vast territory consists of desert, the country's geography is marked by striking contrasts and remarkable diversity. Towering mountains, expansive plains, and rolling hills blend with dramatic coastlines along the Red Sea, the Arabian Gulf, and the Gulf of Aqaba. Within the deserts lie oases, the mountains hold springs, and the surrounding seas are home to coral reefs. Alongside modern metropolitan cities, the Kingdom also boasts fertile agricultural lands and extensive palm plantations.

This distinctive landscape has shaped Saudi Arabia's unique identity throughout history. The Red Sea and the Arabian Gulf together have long supported the nation's historical and economic ties with the wider world. Beneath their waters lies an abundance of marine life and thriving ecosystems. These provide sanctuary for thousands of migratory birds that return each year to its atolls, as well as vital breeding grounds for species such as Socotra cormorants, terns, ospreys, herons, and seagulls (Saudi Aramco 2015).

The challenge

Sea turtles, dolphins, coral reefs, and even rare migratory birds – that is the reality of the Manifa oil field, located off the northeastern coast of Saudi Arabia in the Arabian Gulf. First discovered in 1957, this vast reservoir stretches 45 km in length and 18 km in width, nestled within one of the region's most ecologically sensitive marine habitats (Saudi Aramco 2017).

Seagrass beds, coral reefs, pearl oysters, sea snakes, and endangered Hawksbill turtles called it home. Local fishing communities had relied on these waters for generations. Developing such an area posed enormous environmental and engineering challenges. Could oil be extracted without destroying the fragile ecosystem?



Oil Production in Manifa and Redevelopment of the Manifa Field

Oil production in Manifa began in 1964, supported by infrastructure capable of producing 125,000 barrels of oil per day. However, in 1984, production was suspended due to a drop in global demand for crude oil. The situation changed by 2005, as the demand for Arabian heavy crude rose significantly, prompting redevelopment (SaudiPedia 2023).

In 2006, Saudi Aramco launched a major initiative to boost production capacity, committing to invest USD 10 billion. This marked the beginning of a strategic effort to extract oil from the environmentally sensitive shallow waters in a sustainable way.

As the Saudi Aramco engineers say: ‘We began with an intensive planning phase. We’d need a revolutionary new approach. We’d need engineers, environmental protection officials, scientists, geologists, and marine specialists. We’d need to deploy innovative drilling techniques in the shallow waters. We’d need technology that didn’t exist yet. We’d need extensive engineering and ecological assessments, to make sure the marine ecosystem wouldn’t be affected. Finally, we’d need to learn from other similar projects, to avoid any potential pitfalls in construction.

‘The number of obstacles were [sic] daunting. But our engineering heritage had already enabled us to complete many extreme engineering projects, transforming our company into the world’s unprecedented production powerhouse. Here’s how we did it at Manifa Bay’ (Saudi Aramco 2025). The challenges faced by the Manifa Project were the following:

1. **Preservation of Marine Life:** The area is home to diverse marine species highly sensitive to human intervention. Safeguarding ecosystems was critical for success (Saudi Aramco 2017).
2. **Logistical Hurdles in Shallow Waters:** Operating in shallow offshore environments required unique logistics and safety measures.
3. **Innovation in Technology:** Novel technological approaches were needed to extract resources without harming habitats.

Sustainable Industrialisation and Environmental Innovation

Before construction began, Aramco collaborated with King Fahd University of Petroleum and Minerals (KFUPM) to evaluate the ecological sensitivities. This led to



repositioning infrastructure to minimise disruption to coral reefs, seagrass beds, and migratory paths (Saudi Aramco 2017).

Rather than resorting to standard offshore platforms, Saudi Aramco took a transformative approach – converting over 70% of the offshore field into an onshore-like facility by constructing 27 man-made islands. These islands, created from 45 million cubic metres of reclaimed sand, were interconnected by a 41-km causeway, integrating 13 bridges to preserve natural tidal flow and marine mobility. This massive infrastructure project was designed not just to extract oil but to do so in harmony with its environment – a key tenet of SDG 9.

By 2007, the company conceptualised the construction of 27 artificial islands connected by a causeway, designed to minimise the environmental impact (Offshore Magazine 2011). Temporary bridges were also installed to preserve the water circulation in Manifa Bay (SaudiPedia 2023).

Construction moved forward at a rapid pace, with the completion of the artificial islands and causeway, followed by the reclamation of more than 45 million cubic metres of sand from the seabed. The design phase for the Manifa Central Processing Facility was completed in 2009, just one year after the project officially began. By 2012, the construction and commissioning of the water injection systems were finalised, and Saudi Aramco's specially developed technology for the project was ready for deployment. Key environmental achievements included:

- Tidal circulation enhancement: Bridge gaps-maintained water flow, oxygenating ecosystems.
- Coral and seagrass restoration: Coral reefs expanded, and seagrass coverage increased significantly.
- Marine biodiversity preservation: Breeding grounds for turtles and migratory birds were safeguarded.
- Mangrove reforestation: Large-scale mangrove planting enhanced biodiversity and nursery habitats (Saudi Aramco 2024).

These measures aligned with the United Nations Sustainable Development Goals (SDGs) on sustainable industrialisation (UN 2015).

Technological Innovation and Knowledge Transfer



Manifa pushed the boundaries of petroleum engineering, requiring advanced drilling and reservoir management technologies. Saudi Aramco deployed directional drilling to reduce surface impact and built the Manifa Central Processing Facility, with a capacity of 900,000 barrels/day, integrated with major Saudi refineries (Saudipedia 2023). The project also set benchmarks in occupational safety, recording tens of millions of work hours without injury.

Economic and Community Impact

The Manifa project contributed to national development by:

- Creating thousands of jobs in engineering, construction, safety, and environmental monitoring.
- Supporting local fishing communities by protecting shrimp and fish breeding grounds (Saudi Aramco 2017).
- Enhancing Saudi Arabia's energy infrastructure and contributing to economic diversification.

Delivered ahead of schedule and under budget, Manifa demonstrated how responsible planning and innovation can deliver both economic and environmental value (Saudipedia 2023).

Manifa as a Global Blueprint

The Manifa oil field is more than an energy project; it is a blueprint for the future. It proves that engineering excellence, environmental stewardship, and economic growth can coexist. This holistic integration of industrial goals with environmental innovation directly aligns with the SDG's emphasis on inclusive and sustainable industrialisation. For future engineers, policymakers, and environmentalists, Manifa provides a powerful lesson: the path to sustainable development requires balancing economy and ecology.

Questions

1. What were the key environmental challenges faced during the redevelopment of the Manifa oil field, and how were they addressed?
2. In what ways did Saudi Aramco balance industrial development with ecological preservation in the Manifa project?



3. How did technological innovation contribute to the success of the Manifa project, particularly in terms of safety and efficiency?
4. What role did partnerships with academic institutions (like KFUPM) play in shaping the project's environmental strategy?

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