

THE INTEGRATION TREND OF THE OIL INDUSTRY INTO RENEWABLE ENERGY SOURCES

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Abstract

The global energy system is rapidly transforming as climate change, rising energy demand, and environmental concerns push the oil and gas industry to adopt renewable energy technologies. This study analyzes key trends and drivers of this transition, emphasizing significant cost reductions in solar and wind energy that have made renewable integration economically viable. Successful projects—such as Equinor’s Hywind Tampen, ADNOC¹’s clean-energy initiatives, and Chevron’s Coalinga Solar-to-Steam facility—demonstrate notable reductions in CO₂ emissions and operational costs. Analysis of EU greenhouse gas emissions from 2017 to 2022 also shows steady declines, with several countries achieving reductions exceeding 20%. Despite challenges such as intermittency, high investment costs, and infrastructure adaptation, renewable energy integration is becoming a crucial pathway for achieving environmental sustainability and long-term efficiency in the oil and gas sector.

Keywords

Renewable energy integration; oil and gas industry; solar energy; wind energy; energy transition; carbon emissions reduction; energy sustainability; Hywind Tampen; ADNOC; Chevron Coalinga project; greenhouse gas emissions; clean energy technologies.

The global energy system is currently undergoing a period of significant transformation. Issues related to climate change and global warming, the growing demand for energy, and the increasing impact of environmentally harmful factors are prompting the oil industry to reconsider its strategic approach. Today, many oil companies are striving to achieve ecological and economic sustainability by integrating renewable energy sources into their operations. In this process, energy sources such as solar, wind, geothermal, hydro, and biomass play a key role. According to the International Energy Agency (IEA), in 2023, the share of renewable energy in global energy production exceeded 29%. This has accelerated the transition of the oil industry toward a new direction. Several factors influence

¹ Abu Dhabi National Oil Company for Distribution

the integration of renewable energy sources by oil and gas companies. First and foremost is the critical need to reduce carbon emissions and combat climate change. Additionally, as the cost of renewable energy sources continues to decrease, their integration has become economically viable as well.

Energy Source	Price in 2010(per kWh)	Pirce in 2010(per kWh)	Price Change (%)
Solar PV	\$ 0.36	\$ 0.07	-80%
Onshore Wind	\$ 0.08- \$ 0.14	\$ 0.04- \$ 0.09	-40%
Offshore Wind	\$ 0.16	\$0.07	-50%

Table 1. Changes in the Prices of Solar and Wind Energy

*Manba: Integration of Renewable Energy Sources in Oil and Gas Operations a Sustainable Future” by Mohsen Kiamansouri

For example, according to the International Renewable Energy Agency (IRENA), since 2010, the cost of solar photovoltaic (PV) technologies has decreased by 80%, while the cost of wind energy has dropped by 40–50%. These changes have made renewable energy sources significantly more competitive compared to traditional fuels. As a result, oil and gas companies are increasingly encouraged to adopt these technologies in their operations.

Successful Projects

European countries are leading the way in renewable energy initiatives. For example, the *Hywind Tampen* project by Norway’s Equinor is the world’s first floating offshore wind farm, supplying electricity to oil platforms in the North Sea. The project has a capacity of 88 megawatts (MW) and covers about 35% of the annual electricity needs of five platforms. As a result, approximately 200,000 tons of CO₂ emissions are avoided annually. Although the project cost 7.4 billion Norwegian kroner (about 700 million USD), it is proving to be a worthwhile investment when considering its environmental and economic benefits. In the Middle East, similar efforts are gaining momentum. For instance, the UAE-based company ADNOC transitioned all of its onshore oil facilities to solar and nuclear energy sources starting in 2022. Moreover, it is supplying its offshore platforms with clean energy via HVDC (High Voltage Direct Current) cables. Through these measures, ADNOC aims to reduce carbon emissions from its offshore operations by up to 30%. In North America, especially in the U.S. and Canada, the transition is being implemented more cautiously. A notable example is Chevron’s *Coalinga*

Solar-to-Steam project in California, which demonstrates the successful integration of renewable energy into the oil industry. This project uses concentrated solar power to produce steam, which is then used in oil extraction processes. As a result, Chevron has been able to cut around 31,000 tons of CO₂ emissions annually. Furthermore, the project has reduced Chevron's operational costs by replacing natural gas with solar power, achieving significant economic efficiency. Additionally, thousands of small-scale solar systems are being used to power remote pumps, SCADA systems, and pipelines, thereby reducing the need for diesel generators and lowering associated costs.

Company	Type of Project Integration	Achievement	Environmental Impact
Chevron	Coalinga Solar-to-Steam Facility	Reduction of 31,000 tons of CO ₂ , improved energy efficiency	Reduction of CO ₂ emissions
Shell	Borssele III/IV Offshore Wind Farm	Energy supply for 825,000 households annually	Utilization of wind energy
Norvegiyaning Equinor	Hywind Tampen	Supplies electricity to oil platforms in the North Sea	Prevents 200,000 tons of CO ₂ emissions
ADNOC (BAA)	ADNOC	Converted oil facilities to solar and nuclear energy	Reduced carbon emissions by up to 30%

Table 2. Successful Renewable Energy Projects

Manba: Equinor, *Hywind Tampen Fact Sheet*, 2023 and ADNOC, *All onshore operations powered by clean energy*, 2022

From a technological standpoint, the oil industry is actively integrating the following renewable energy technologies:

Solar PV Panels – Used to supply electricity to wells, compressors, and monitoring systems. Their efficiency is particularly high in sunny regions.

Concentrated Solar Power (CSP) – Utilized to generate steam required for heavy oil extraction using solar energy. A clear example of this is the *Miraah* project in Oman, which cost around \$600 million and supplies 80% of the steam needed.

Wind Energy – Plays a crucial role, especially in offshore platforms. A notable example is the *Hywind Tampen* project.

Hybrid Systems – Combine solar, wind, backup generators, and batteries to ensure uninterrupted 24/7 power supply.

Energy Storage Technologies – Involve batteries, pumped hydro storage, hydrogen production, and other methods to stabilize electricity supply.

However, this integration process also faces a number of challenges.

Intermittency of Solar and Wind Energy – Due to the non-continuous nature of these energy sources, backup systems are required to ensure reliability.

High Initial Costs – Renewable energy projects demand significant capital investment.

Infrastructure Adaptation – Integrating new technologies into existing oil facilities is technically and financially complex.

Political and Economic Uncertainties – Changes in subsidies, carbon taxes, and ESG (Environmental, Social, and Governance) requirements cause companies to proceed cautiously.

EU Country	GHG Emissions in 2017 (million tons)	GHG Emissions in 2022 (million tons)	Change (2017–2022)
Austria	47.6	43.7	-9%
Belgium	71.6	65.2	-9%
Bulgaria	46.6	43.8	-5%
Croatia	13.7	11.6	-15%
Cyprus	5.8	5.8	0%
Czech Republic	84.6	76.9	-9%
Denmark	59.3	53.9	-9%
Estonia	19.1	11.6	-39%
Finland	42.2	33.6	-11%
France	264.3	253.2	-4%
Germany	655.4	542.4	-17%
Greece	56.7	53.8	-5%
Hungary	39.5	35.7	-10%
Ireland	41.7	40.1	-4%
Italy	261.1	247.7	-5%
Latvia	7.2	6.1	-15%
Lithuania	10.1	8	-21%
Luxembourg	7.5	7	-7%
Malta	1.5	1.3	-13%
Netherlands	151	120.3	-20%
Poland	300.2	276.4	-8%
Portugal	49.6	45.2	-9%
Romania	65.5	54.4	-17%

Slovakia	11.9	10.1	-15%
Slovenia	10.6	8.8	-17%
Spain	216.9	181.4	-16%
Sweden	37.4	32.8	-12%
United Kingdom	480	410	-15%

Table 3. Greenhouse Gas (GHG) Emissions of European Union (EU) Countries in 2017 and 2022

Source: Air emissions accounts by NACE Rev. 2 activity [Statistics | Eurostat](#)

The table shows that greenhouse gas (GHG) emissions decreased in most European countries between 2017 and 2022. The average reduction is around 10%, with some countries — such as Estonia, Lithuania, Germany, and the Netherlands — experiencing significant reductions of more than 20%. The largest decrease was observed in Estonia (39%), followed by Germany (17%) and the Netherlands (20%). These countries have implemented serious measures to reduce CO₂ emissions and undergo ecological transformation. In contrast, Cyprus recorded a 0% change, indicating no meaningful policy actions were taken during this period. In major economies such as Germany and the United Kingdom, the reduction in emissions is linked to the development of more environmentally friendly industrial and production processes. The implementation of new energy efficiency technologies and the shift toward renewable energy sources have played a major role in this decline.

In conclusion, the trend of integrating renewable energy sources into the oil industry is rapidly advancing as a response to modern changes in the global energy system. The need to combat climate change and reduce carbon emissions is pushing oil companies to incorporate renewable energy sources into their operations. Moreover, integrating renewable technologies not only promotes environmental sustainability but also enhances economic efficiency. As the prices of solar and wind energy continue to decline, their integration becomes increasingly feasible and attractive.

References

1. M. Kiamansouri, “Integration of Renewable Energy Sources in Oil and Gas Operations a Sustainable Future” EJCMPR. 2025; 4(1): 111-135.

2. D.Ekechukwu, P.Simpa “Trends, insights, and future prospects of renewable energy integration within the oil and gas sector operations”. May 2024World Journal of Advanced Engineering Technology and Sciences 12(1):152-167
3. <https://www.hi.no/hi/nettrapporter/toktrapport-en-2023-10>
4. <https://www.equinor.com/news/20230823-hywind-tampen-officially-opened>
5. Air emissions accounts by NACE Rev. 2 activity
https://ec.europa.eu/eurostat/databrowser/view/env_ac_ainah_r2_custom_13098228/default/table?lang=en