وزارة الطاقة والمعادن
Ministry of Energy and Minerals

National Young Professionals Committee

Spark by NYP

Magazine 2nd Edition

THEME

Editorial Message

Dear Readers,

Welcome to the second edition of Spark by NYP Magazine!

We are excited to present you a diverse range of articles related to climate change and energy transition to capture your interest and attention.
As young professionals ourselves, we understand the challenges and opportunities that come with navigating through a transition. That's why we have curated content that reflects the varied experiences and perspectives of our readers. From personal experiences of young professionals and pearls of wisdom from a successful industry leader, we hope to provide you with insights and inspiration that can help you on getting knowledge and navigating your career journey.
In this edition, you will find articles on topics related to hydrogen energy, net-zero emission target to articles related to work-life balance and the importance of neurodiversity to companies. We believe that these topics are essential in order to understand the big picture of the current situation and thrive in today's rapidly evolving professional landscape. We have also included a section on skill-building, which features tips from young professionals experience in the field.
We would like to extend a special thank you to all our contributors, whose hard work and dedication made this edition possible. We hope that their stories and perspectives will resonate with you and inspire you to continue pursuing your goals and aspirations.
We would also like to hear from you, our readers. We welcome your feedback and suggestions for future editions. Our goal is to create a platform that reflects the needs and interests of young professionals in Oman, and we value your input in making that a reality.
Thank you for joining us for this second edition of Spark by NYP Magazine. We hope you enjoy reading it as much as we enjoyed putting it together.

Amjad Al Shukri
Exploration Geoscientist
Edition Leader

NYP
Spark
A Magazine Issued By NYP Of The Ministry Of Energy And Minerals

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National Young Professionals (NYP)

In October 2018, young professionals from across the different subdivisions of Oman's energy industry came together with a mission to connect, develop, and grow the future generation of industry leaders. The National Young Professionals (NYP) Committee was established under the auspices of the Ministry of Energy and Minerals and is supervised by the Ministry Undersecretary and managed by its Board Committee.

The NYP provides a platform for knowledge sharing and networking with peers of local, regional, and global emerging leaders. It helps members stay up-to-date with the latest trends and topics in the energy sector worldwide. Through its activities, the NYP seeks to create synergy between all stakeholders, promote best practices and excellence in task delivery, accelerate experience gaining, and master essential soft skills. The Committee is linked with the World Petroleum Council (WPC) as a global organization and the YP Committee and representatives from around the globe, providing opportunities to develop regional and global collaborations.

The mission of the NYP is to contribute to the energy future by bringing together the passion and talents of energy industry students, young professionals, and emerging leaders. The NYP seeks collaborative and innovative solutions to key technical, social, environmental, and management energy challenges for future generations. It aims to create a collaborative platform for young people to be heard, bridge the generation gap through mentorship networks, promote a realistic image of the petroleum industry challenges and opportunities and champions new ideas within the energy industry.

NYP will continue delivering value-based events. In this regard we are pleased to issue the second edition of the Spark by NYP Magazine that is designed in particular for the energy industry young professionals. All the industry young professionals are invited to participate in the future editions and present their capabilities to their industry fellows and leaders towards sustaining the prosperity of the energy industry of Oman and the world.

His Excellency. Mohsin Al Hadhrami
Undersecretary for Ministry of Energy and Minerals

As the energy industry navigates through a critical transition, numerous challenges have emerged. It is crucial for the industry to involve and engage the youth, as they constitute a significant proportion of the workforce and represent the future leaders. The active participation of young professionals in the energy transition journey is essential for achieving the industry's goals. Their knowledge, skills, and talents are invaluable resources for the industry's success and prosperity. Therefore, investing in the youth by enhancing their knowledge and skills will ensure a smooth transition to a more sustainable energy supply.

Moreover, young professionals in the energy industry hold a responsibility to continuously learn, upgrade their skills, and seize every possible opportunity to keep pace with the accelerated advancements in industry technology. By doing so, they can stay competitive and contribute to the industry's growth and development.

We are excited to introduce this magazine, designed specifically for young professionals in the energy industry. This publication aims to showcase their knowledge and capabilities in resolving various challenges faced by the industry. Through this magazine, we hope to provide a platform for the youth to share their expertise, collaborate with industry peers, and develop innovative solutions to drive the industry forward.

We believe that this magazine will play an essential role in promoting the youth's engagement and involvement in the energy transition journey, ensuring a sustainable and prosperous future for the industry.

Pearls of Wisdom

Eng. Yousuf Al Ojaili
President of BP Oman

What is it like to be in charge of a company that is investing in one of the largest and complicated oil and gas project in the Sultanate and around the world?
I moved to bp in 2015 at the time of low oil prices. It was a challenging decision, but I am glad that I made the decision. It was a big change. I had to know how the system works, how and where people work, and I am still learning till this day.

Adapting new processes and workflows has been vital to success in the last oil prices downturn and industry changes. How did bp navigate the transition?
I believe bp was one of the first companies in the world to address energy transition. As we pivot to become an integrated energy company and reinvent the way we work; there was pressure to focus on cost-control, to increase cash-flow and to reduce the company's debt. In addition to that, bp started in renewable and hydrogen space and we are seeing the result of that.

Many people, many funds, endowments, are getting out of fossil fuel industry, how worrying is that for the future of many Oil and Gas companies?
The changes are happening, and we will continue as the other companies to provide the world with the affordable and secure energy. Oil and gas will still account for around 35% to 40% of the world energy demand in 2050 but at the same time the focus is to balance this energy. First, to de-carbonize the energy and keep it more environmentally friendly. Second, transitioning to renewables which bp estimates will account for 50-60% of the total energy demand by 2050.

What roles did mentorship play in your professional development? Any tips on how young professionals can find and reach out to mentors?
When I started my career, mentorship was not well-structured. That said, I benefited from it and took the opportunity to seek individual mentorship from the people I knew in the company. However nowadays, mentorship is very well structured.
My advice for the youth is to seek mentorship opportunities and to make it a two-way mentorship. I have had a young employee who was my mentor in areas as geology and digital and I have kept mentoring people inside and outside the company.

Apart from technical knowledge, what skill's' has contributed immensely to your success as a CEO?
I believe I am an approachable person. I try to know people by name as much as possible and I like two-way communication.

How would you define diversity? And what role do you think it plays in the energy industry?
My personal definition of diversity is multi-nationals with a very strong nationalization target. In addition to have good balance in both gender and age. Moreover, I believe in the importance of having Omanis work in other bp international operations to gain experience and ultimately benefit Oman.

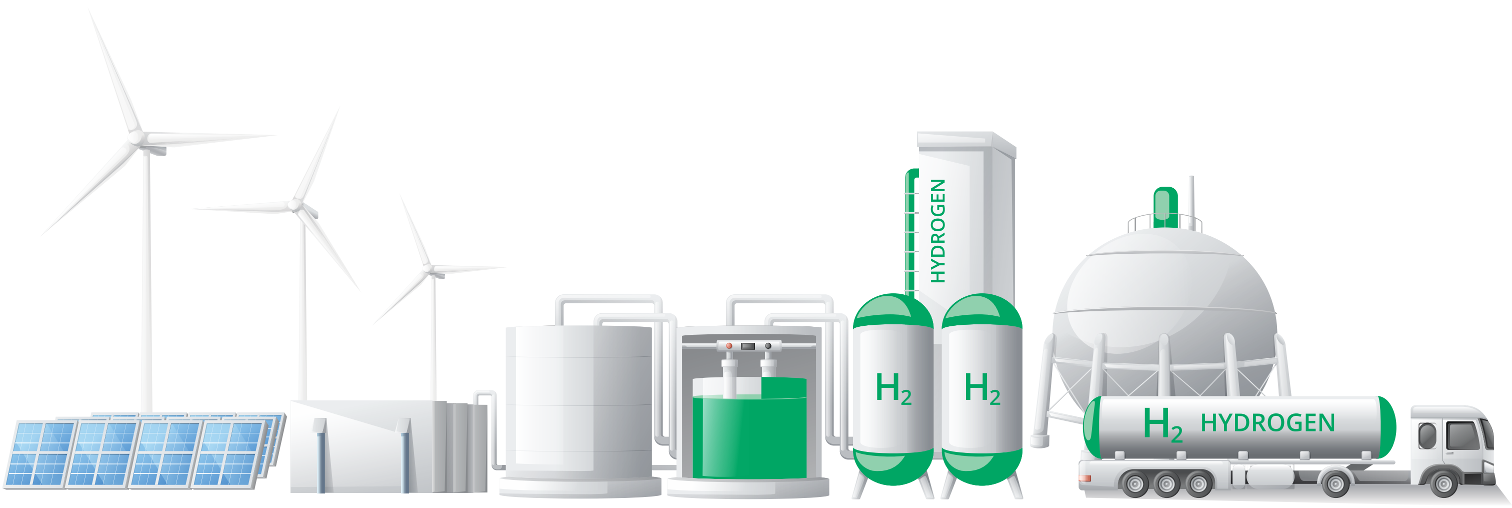
What is your advice to young professionals in the industry?
Try to learn as much as possible horizontally throughout your career. Learning does not have to be only vertical as there is a lot to learn in the energy industry. My other piece of advice will be to strengthen your communication skills as it will be key as you progress.

The Analysis Study on Production, Transportation, and Storage of Green Hydrogen Utilizing Ammonia

Project Summary

Recently, Hydrogen energy has become a hot topic for research in power generation due to the progressing energy transition towards clean energy. The aim of the study was to study the future of the hydrogen energy in terms of production, storing and transportation. Several studies have documented to compare between the different items and confirm the importance of the hydrogen energy. Based on the production comparison, solar panels (energy) has been selected among other options to provide the required energy for the electrolysis to be used in hydrogen production.

Operating cost and the amount of CO2 emissions were the key factors behind the selection of solar energy as a primary source of electricity. Producing hydrogen with clean and renewable energy is a main contributor to support Oman in achieving zero goal emissions by 2050. Ammonia being a very well researched field with many applications, its known how to handle, store, care and transport in a safe manner. Making it a very reliable option to act as hydrogen storage. However, it is necessary to choose a good catalyst as it is to store hydrogen. The study and the experiment results concluded that (Ru) could be the most beneficial catalyst because it has the highest conversion percentage, the highest rate, and the lowest energy to reach catalyst activity. In recent time, (Ru) is extremely expensive compared to other catalysts. Due to the new innovations, nanotechnology can be used to increase the efficiency and decrease the amount of catalyst as well as decreasing energy consuming. Four of hydrogen storage solutions were addressed and studied in this study. The analysis of the geological storage, compressed hydrogen, liquified hydrogen and materials-based storage revealed that salt domes is the best choice to store hydrogen. There isn't a single hydrogen transportation method that works best in all transport scenarios. It depends on the distance, quantity, final use and presence of existing infrastructure. Therefore, in real-world settings, it is necessary to consider a carrier's operational value offer in addition to comparing its expenses to other carriers.



Impact on climate change

Green hydrogen emits no greenhouse gases but can provide high-temperature heat to drive sizable industrial activities. Green hydrogen is created using renewable power, as opposed to other varieties of hydrogen, which are produced using coal and traditional natural gas.. More severe environmental, health, and safety regulations must be put in place for green hydrogen production, storage, transit, and consumption in order to address these problems.

Repeatability across Oman

In Oman, local green ammonia production and storage to reduce renewable power curtailment is explored. Also, the impacts of institutional incentives on green ammonia production and storage are evaluated.

Cost savings

Based on the estimated costs of renewable energy in various regions of the world in 2035, the low costs of solar energy projected in parts of the world such as the Middle East mean that the cost differential between producing green hydrogen in the UK through electrolysis and importing green hydrogen in the form of ammonia is significant. In the future, it will be more cost-effective to import green hydrogen in the form of ammonia and crack it in the UK compared to produce it in the UK. The end-to-end cost of importing hydrogen as ammonia from the Middle East would be £100/MWh compared to £120-150/MWh of UK-based hydrogen generation.

About the team

Green Flame is a professional research team that consists of experienced graduates in petroleum and natural gas engineering and earth science with a passion for green hydrogen energy. They aiming to find new and suitable ways to develop sustainable, alternative solutions to hydrogen production and storage. The team has many participations and awards related to hydrogen energy. Such as, top 10 best scientific papers in Oman Green Hydrogen Summit 2022 conference and 3rd place in ADIPEC SPE virtual university program.

Green Flame is a professional research team that consists of experienced graduates in petroleum and natural gas engineering and earth science with a passion for green hydrogen energy. The team has many participations and awards related to hydrogen energy.

Green Flame

Team members:

Al-Rayan Al Mahdouri
Maryam Al Ghafri
Al-Mohanad Al Mahrouqi
Laith Al Dughaishi
Safa Al Hanai
Shurooq Al Hinai
Supervisor – Dr. Intisar Al Busaidi

Nanofluid Enhanced Parabolic Solar Collector

Humaid Al Fakhri
Mohammed Al Harrasi
Anas Al Yahmadi
Salah Al Ghammari
Supervisor – Dr. Afzal Husain

Figure 1: parapolice trough collector

Impact on climate change

The venture is affected emphatically is the environment, as the utilization of renewable energy-founded gadgets and frameworks will decrease the outflows of CO2 and dawdle the phenomenon of global warming. The diminished reliance on non-renewable energy sources will help in accomplishing and looking after manageability. There are multiple benefits that result from enhancing the performance or the efficiency of the parabolic trough collector, especially in Oman since it receives high solar irradiation. Such benefits, the increase of using this type of collector and reducing the use of non-renewable energy as well as there will be an environmental benefit, while the use of PTC will preserve the environment from pollution and global warming phenomena which affects positively the local community. In addition, the implementation of these enhancements will reflect positively on the designer since it will help him to understand the advanced level of solar collecting technology and then apply it.

Repeatability across Oman

Oman has one of the world's largest solar densities. Solar energy has the ability to provide enough power to satisfy all of Oman's national demand for electricity. Solar energy so far has been used mainly for water heating and in the oil industry. Most of the renewable energy is coming from the sun. Solar power can be used for heating, electricity generation, heating water and many commercial and industry applications.

Project Summary

The Parabolic Trough Collector is considered as linear solar collector because it concentrates the sunlight in the focal line of the solar collector system and the output temperature of the working fluid can reach up to 500℃. The Parabolic Trough Collector is mainly used to produce electricity by transferring the solar energy to thermal energy for generating steam to be used in power plants. Our project aims to design a small parabolic trough collector with an enhanced receiver tube working with a nanofluid.

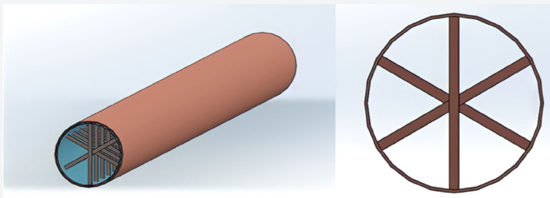


Figure 2: Selected Receiver Tube

Results

The experiment was conducted at SQU using the available and the proper instrument through the time from 12:30 PM to 3:30 PM, and using water as working fluid. It is observed that the enhanced tube (without glass cover due to unavailability) has better heat transfer performance than the plane tube. The enhanced tube has an efficiency of 23.43% compared to the plane tube which has an efficiency of 19.12% when the flow rate is 18 L/h, respectively. The temperature difference of the enhanced tube is 8.2 degree Celsius compared to the plane tube which has a temperature difference of 6 degrees Celsius when the flow rate is 18 L/h. We simulate the system using Ansys, assuming the overall efficiency of 66% which is average overall efficiency of the parabolic trough collector we found that temperature difference reaches 3+96 degrees.

Achievement

Our project won first place in the Mechanics and Robotics category in the engineering gathering 12 at Sultan Qaboos University. The Engineering gathering is the largest student engineering event in Amman. The exhibition includes engineering projects from Omani and non-Omani educational institutions in several fields, renewable energy, oil and gas, urban development, and others.

Graphene-Based Polymeric Solar Cells in Alternative Energy Application

Aisha Al Wahaibi
Nusiba Al kharusi
Muzn Al Abri
Al-Hasnaa Al Adwani
Supervisor: Dr. Farooq Al Jahwari

As our dependence on renewable energy becomes more apparent, the need for efficient solar cells becomes more crucial, especially when they are one of the easiest and cheapest ways to generate clean energy. The basic principle of a graphene-based polymeric solar cell is essentially not that different from current inorganic/silicon solar cells being produced today, with the exception that some of the materials currently in use are replaced with graphene derivatives. As with any device or material, there are parameters that can be improved to increase the operational efficiency.

Problem contact

As a result of low efficiency of the current solar PV (Photovoltaics) panel which is only about 15 to 20% (under Standard Conditions), graphene-based polymeric solar cells will be the consumer favorite for anyone seeking for high efficiency solar panel. Graphene based polymeric solar cells have a higher efficiency due to:

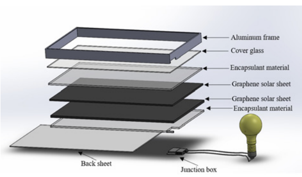
1. High solar energy absorbance properties.
2. produced with excellent flexibility.
3. higher thermal conductivity, which increases the generation power.

Project aim

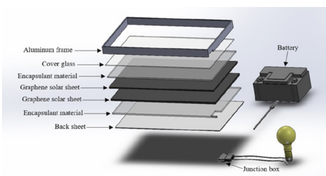
The project aims to develop solar cells made of the locally produced polyethylene integrated with locally graphene in a nano-composite. The successful completion of this project will add a value to the locally produced polyethylene and graphene which will contribute in enhancing Oman's economy and opening new job opportunities. This will also contribute to the zero-carbon print target of Oman's Vision 2040.

3D models

The 3D models for graphene-based polymeric solar sell is show below:



Graphene-Based Polymeric Solar Cells section view



3D model of Graphene-Based Polymeric Solar Cell

Impact to Oman

Oman is a major producer of raw thermoplastic polymers in the GCC. The two main thermoplastic polymers, which are produced now, are polypropylene (PP) and polyethylene (PE) with different grades of each. Most of these grades of PP and PE are exported overseas as raw materials and then probably imported as finished products.

Considering the pressing demand on reducing carbon print at Oman and adding In-Country Value (ICV) products to enhance Oman's economy and the technological development at Oman.

Interest in the field

The project is under research and study as it is new technology. Lab facilities in the engineering and physics departments are required essentially to develop the material, examine its properties and microstructure, and study the efficiency of the final prototype. Overall, through the collaborative support of material science engineering candidates and SQU, the intended results of the project are going to be achieved.

Awards

- Won at the 6th edition of Upgrade program. The Ministry of Higher Education, Research and Innovation is in charge of planning the program. It brings together recent graduates from various institutions and showcases the best capstone initiatives. By transforming them into emerging businesses in the information and communication technology and industry domains, it seeks to have a socioeconomic impact.
- Achieved the first place across all universities and colleges in Oman in 3rd solar decathlon competition sponsored by bp Oman which focused in improving the efficiency for solar photovoltaic systems.


NYP
Committee

First Year Experience Tips

Fahmi Al Shidhani
Production Engineer
Occidental Oman

The first year of work was an exciting and challenging time for me. It marks the transition from academic life to the professional world, and there are a lot of new things to learn and adjust. On my first day, I got up excited and put on my coverall for the first time. The feeling it gave me was so memorable, I can never forget it. In my first year of work, I was hungry to learn everything to maximize my knowledge & strength as much as possible to avoid being lost in an empty land.

I spent a lot of time learning new skills, building relationships, and discovering my strengths and weaknesses. I also worked on getting to know my job and the company policies and procedures, as well as the company's culture.

My advice to the YP's is to use the time in learning. Don't be shy or hesitant to ask, "If you never ask you will be lost". Work smart to develop your skills, face challenges, be better than you were yesterday. You shouldn't compare yourself to anyone. Instead, focus on getting better at what you do. Like the quote says: "The only person you should try to be better than, is the person you were yesterday." If you do this, you will become better every day. Finally, read more, get wiser and stronger and get out of your comfort zone. The most important thing, Enjoy the journey!

Saif Al Mahrouqi
Geophysicist
Ministry of Energy & Minerals
Concession Department

Entering to work life and starting of a career was a turning point from study life to a responsible life. So for every start you will encounter new challenges due to responsibility, doing many tasks, dealing with people of different ages and intellectual levels beside balancing and managing your time.

In the beginning of the career journey, you will face difficulties to complete the works and duties assigned to you, especially if your educational background is different from your field of work. In my case, I studied geophysics relating to Oil and Gas sector however, I ended up working in the Minerals sector. You will experience and notice in the work environment that your colleagues submit their task relatively quickly and you still don't even understand that task! But only few months after the beginning, you will find yourself with skills and experience that helps you to complete the works hence, becoming active, productive member in your team, and be able to develop the mechanisms of work to accomplish your job tasks even ahead of your colleagues.

Finally, there is nothing difficult in life, but there are challenges that you have to face, which then you will realise that you are capable of doing anything.

Hani Al Lawati
Applied Geoscientist
Yellow Horizon Trading SPC

Transitioning from university life to the real world is a tough phase as you try filling voids with productive work. When searching for opportunity I found a 3-month online course on LinkedIn offered by Petroleum Engineer's Association focusing on petroleum, economic geology, geophysics, and petroleum engineering concepts that are essential for work in the hydrocarbons industry. I took a few entrance exams, applied for jobs, got to the interview stage but no further success. Despite disappointment, I realized hard work, perseverance, and determination are the fuel for prosperity.

My first job, working in sales and procurement, was unrelated to my major. A new environment, dealing with insulation foam and Steel/GI panels, I had multiple duties; attending customers, working with staff, must know about the items I buy and sell. It was challenging, exhausting yet fruitful, as I got disciplined to work under pressure and solve matters.

It took me over a year find work in the mining field, operating on a fresh stream sediment sampling project at Minerals Development Oman's concession areas. Initially it was tiring and difficult making all kinds of decisions on field, but later I noticed a change in my level of knowledge and skill when describing rock type, identifying minerals, and finishing work quickly without sacrificing quality as I worked daily in the field.

Ultimately, there are no easy routes to success; you have to sacrifice your time and overcome obstacles to achieve the benefits tomorrow. This can only happen through positive attitude, resilience to face failure, persistence, and a fresh mind open to new changes and ideas.

NYP Highlights

Petro-Olympics I 2019

The Petro-Olympics I was a competition-based event launched in 2019, designed for young professionals in the oil and gas industry. The event challenged participants' technical and business knowledge of the industry.

FLF 2019

In June 2019, fourteen young professionals representing various companies attended the World Petroleum Council 6th Future Leaders Forum in Saint Petersburg. The winners of Petro-Olympics I from Petroleum Development Oman also participated.

OPES 2022

The OPES 2022 Young Professional Forum provided participants with valuable insights into the current challenges facing the energy industry. The event focused on innovative ideas and initiatives that can make professionals more competitive, connected, and better leaders in a world of agile and disruptive changes.

Energy-Olympics II 2022

Following the success of the first Petro-Olympics, the second edition was reintroduced as the Energy-Olympics II in 2022. This interactive competition-based event challenged technical industry professionals on their knowledge of industry operations and changing technologies. Eight upstream oil and gas young professional teams from different companies participated, and the winning team from Oxy joined the Future Leaders Forum in Kazakhstan.

ENERGY OLYMPICS II

FLF 2022

In September 2022, eleven young professionals representing various companies attended the World Petroleum Council 7th Future Leaders Forum in Almaty, Kazakhstan. NYP representatives from Oman participated as moderators and speakers for various panel sessions with global industry experts. The winners of Energy-Olympics II from Occidental Oman also joined the forum.

World Petroleum Council Forum 2022

The NYP Committee have successfully participated for the second time (first was in 2019) in the World Petroleum Council (WPC) 7th Youth Forum, in Almaty Kazakhstan from 29 Sep to 3 October. After long screening process by the Program Committee, seven Omani YPs assigned as moderates and speakers for different sessions. As well as the Energy-Olympics II winners from Oxy Oman were also sponsored by their company to attend the event making it eleven YPs Omani delegates.

Conversion of CO2 to Methanol in Oman

Nowadays, it is commonly acknowledged that greenhouse gas (GHG) emissions are one of the most difficult environmental problems facing humanity right now and that carbon dioxide is the main source of GHGs. Since the start of the industrial era, GHG emissions have drastically increased. In 2018, the average CO2 concentration was 407 ppm [1], which is nearly 40% greater than in the mid-1800s [2]. The greatest source of CO2 emissions among human activities that release GHG is the burning of fuels for electricity and heat, accounting for more than 42% of the estimated CO2 emissions, with 43% and 26% of these emissions going toward industrial and residential demands, respectively. In addition, direct CO2 emissions from automobile transportation (23%) and industrial plants (19%) are the other two major sources of anthropogenic CO2 emissions in addition to energy generation. Moreover, by 2050, it is anticipated that the world's energy demand would double. Therefore, even though renewable energy's market share is growing over time, the usage of fossil fuels will continue to exceed it in the energy industry.

Fossil fuel is a non-renewable energy source that is responsible for global warming by releasing carbon dioxide, the principal greenhouse gas. This project is aimed at outlining a feasible method for separating carbon dioxide from the natural gas stream and using an efficient method, to produce goods that are cost-effective.

By 2050, Oman's ambitious national strategy seeks to achieve net-zero carbon emissions. The net-zero emission ensures that the number of greenhouse gases added to the atmosphere and those removed from it are equivalent. According to that, Oman has signed Paris Cop21 agreement which strives to achieve a balance between removals and anthropogenic emissions by sources by sinks of greenhouse gases in the second half of this century.

Capturing of CO2 could be done using different methods such as absorption, adsorption, membrane, and Cryogenic distillation. The absorption method is classified as chemical absorption including amine, carbonate buffer, and ammonia. Another classification of absorption is physical absorption, which includes Selexol and Rectisol, Membrane methods, and Cryogenic method.

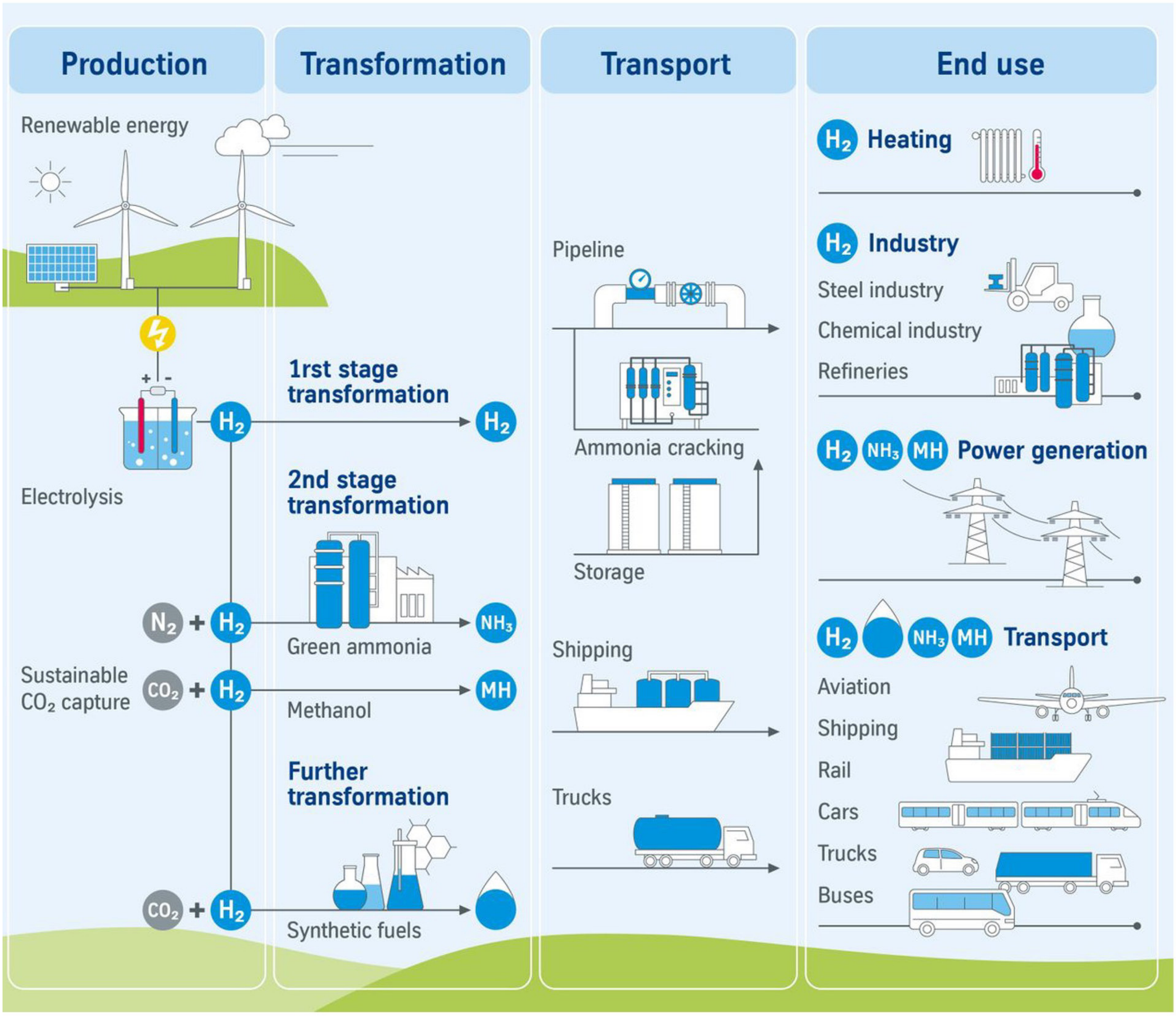


Figure 1: Green methanol production

CO_2 capture can be converted into many value-added products such as methanol (CH_3OH), urea (H_2N-$CONH_2$), synthetic natural gas (SNG), methane (CH_4), polymers, and hypooxalous acid ($H_2C_2O_2$).
Methanol (CH_3OH) is one of the most promising fuels nowadays which is manufactured using converting industrial CO_2 due to its liquid condition at surrounding temperatures and the variety of uses it has in the chemical and energy industries. Dimethoxy ethane, acetic acid, Methyl tert-butyl ether, and formaldehyde products are used in windshield washer fluid, plywood, solvents, adhesives, foams, and other products are made from methanol, one of the most crucial building blocks of the chemical industry. Methanol, which has high octane rating that enables a larger compression ratio and more effective combustions, also replace oil derivatives, and be used directly as a fuel for heat engines and fuel cells, as stated by Nobel Prize George A. Olah. Therefore, the world worldwide methanol market grew and surpass 48 billion euros in 2021, recording a Compound Annual Growth Rate of 12.4% from 2016 to 2021. It is anticipated that the worldwide methanol market would grow much more in the future.[5] The general idea of green methanol production is shown in Figure 1.
The 3E performance metrics (engineering, economic and environmental) were used to assess the alternative generation of methanol from industrial CO_2. To evaluate the many facets of the CO_2 collection unit and the CO_2 conversion unit, they were separated into several measures. [5]
In engineering performance, the mass balance metrics evaluate the overall mass of CO_2 and H_2 transformed, as well as the mass requirement of specific inputs and outputs. [5]

The energy balance metrics analysis the potential for energy integration as well as the utility demand, including the need for heat and electricity. Systematic process- to-process heat recovery is carried out on the systems to achieve high energy efficiency and reduce utility costs. Data evaluation, pinch analysis, and an improved heat exchanger network are used. [5]
In economic performance, the process economics are determined by both capital expenditures and operating cost. Capital expenditures are based on calculations for the adjustment factors for the expenses of various pieces of equipment and utilities. The equipment expenses often include two separate contributions: the purchased equipment cost, which solely takes into account the equipment purchase cost, and the installed equipment cost, which considers both purchase and installation costs. For operative cost concerns on the electricity price, MEA costs, catalysts costs, and H_2. [5]
In environmental performance, although around 95% of hydrogen is now produced from fossil fuels, hydrogen production must switch to renewable energy sources. For this environmental 19 assessment, wind-based water electrolysis was chosen as the method with the least negative effects on climate change. Finally, this analysis takes into account the infrastructure of the CO_2 capture and conversion operations as well as the process of producing hydrogen. In view of the environmental constraints upon the mercuric chloride reagent used in this test, it is likely that the test method will be changed by IMPCA to the equivalent of the BS 507 test. Utilizing methanol at least as blends would result in huge savings at the user level and can effectively decrease the capital investment in addition to satisfying environmental constraints for oil refineries in producing premium-grade gasoline. [5]
Methanol is one of the environmental pollutants. It decomposes easily in water and soil with high concentrations that lead to pollution of fresh and saltwater making the aquatic life in the vicinity of the discharge. Methanol has a short life since it biodegrades significantly more quickly than hydrocarbons. Safety is one of the most important reasons why methanol is a good choice for researchers to be utilized in the engine. The auto- ignition temperature of methanol is high, which radiates less heat, can be extinguished by water, and burns with smoke. [5]

Ahmed Al Awaidi
Chemical and Process Engineer

Al-Khalil Al Sarhani
Chemical and Process Engineer

The Analysis Study on Production, Transportation, and Storage of Green Hydrogen Utilizing Ammonia

Recently, Hydrogen energy has become a hot topic for research in power generation due to the progressing energy transition towards clean energy. Hydrogen is the most basic element on the planet, and it is an energy transporter rather than an energy generator. Hydrogen can store and supply useable energy, but it does not occur naturally and must be synthesized from other chemicals. The aim of the study was to study the future of hydrogen energy in terms of production, storage, and transportation. Producing hydrogen with clean and renewable energy is the main contributor to support Oman in achieving zero goal emissions by 2050.
Hydrogen can be produced in low-carbon ways using a variety of domestic resources, including fossil fuels like natural gas and coal combined with carbon capture and storage; water splitting using nuclear energy and renewable energy sources like wind, solar, geothermal, and hydroelectric power; and biomass through biological processes.

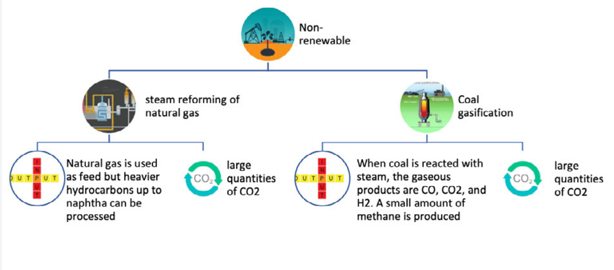


Figure 1 Hydrogen Production from Non-Renewable Energy

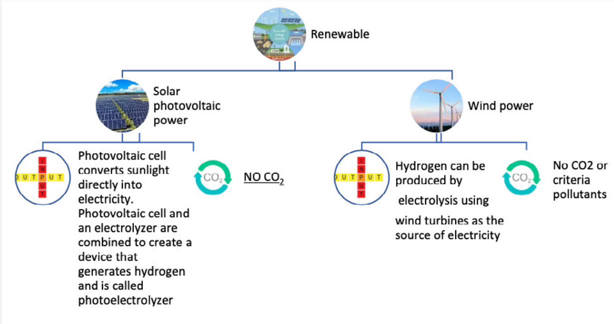


Figure 2 Hydrogen Production from Renewable Energy

Based on the below comparison, solar panels (energy) have been selected among other options to provide the required energy for the electrolysis to be used in hydrogen production.
An alternative to compressed and liquified hydrogen storage is materials-based storage. This technique uses materials that can absorb or react with hydrogen to bind it. Methanol is an excellent hydrogen carrier and can therefore be used as a hydrogen store for fuel cells. Methanol is easily turned into hydrogen through a catalytic process, using a fuel reformer. Ammonia is another material that offers a path to turning hydrogen into a liquid fuel more easily than using liquefaction. Ammonia's energy density by volume is nearly double that of liquefied hydrogen, making it far easier to store and transport. Making it a very reliable option to act as hydrogen storage.
It is necessary to choose a good catalyst as it is to store hydrogen. When speaking from a commercial and environmental point of view, conversion percent of ammonia decomposition and H2 production is the most important parameters. Due to the different conditions used in the various studies, it is often not easy to compare the performance of the different catalyst systems.
Several mechanisms have been suggested for the decomposition of ammonia, many of which were based on measurements at conditions far away from the ones relevant for ammonia decomposition to generate pure hydrogen. Two possible rate-limiting steps are discussed, cleavage of the first N– H bond to result in the formation of adsorbed NH2 and H, or the recombination of adsorbed nitrogen atoms to result in desorption of N2.

Table 1: The amount of H2 and CO2 from non-renewable processes

Process	Reactions	H_2 from H_2O (%)	CO_2/H_2 (Nm^3/Nm^3)	CO_2 and CO emission at per kg of H_2 production at 75% System efficiency	
				CO_2 (kg)	CO (kg)
Steam reforming	$C_nH_m+nH_2O \rightarrow nCO+(n+m/2)\ H_2$				
+CO conversion	$nCO+nH_2O \rightarrow nCO_2+nH_2$				
From					
Methane	$CH_4+2H_2O \rightarrow CO_2+4H_2$	50.0	0.25	7.33	-
Ethane	$C_2H_6+4H_2O \rightarrow 2CO_2+7H_2$	57.1	0.29	8.38	-
Pentane	$C_5H_{12}+10H_2O \rightarrow 5CO_2+16H_2$	62.5	0.31	9.17	-
Naptha	$C_{10}H_{22}+20H_2O \rightarrow 10CO_2+31H_2$	64.51	0.32	9.46	-
Partial oxidation of 6ydrocarbon (heavier than naptha	$2C_nH_m+H_2O+23/2O_2 \rightarrow nCO+nCO_2+(m+1)H_2$				
From	$2C_8H_{18}+H_2O+23/2O_2 \rightarrow 8CO+8CO_2+19H_2$	5.3	0.42	12.35	7.85
Coal gasification	$CH_{0.8}+0.6H_2O+0.7O_2 \rightarrow CO_2+H_2$	70	1.00	29.33	-

Table 2: The amount of H2 and CO2 from renewable processes

Process	Reactions	H_2 from H_2O (%)	CO_2/H_2 (Nm^3/Nm^3)	CO_2 and CO emission at per kg of H_2 production at 75% System efficiency	
				CO_2 (kg)	CO (kg)
Electrolysis (PV, Wind, Hydro)	$2H_2O \rightarrow 2H_2+O_2$	100	0	0	

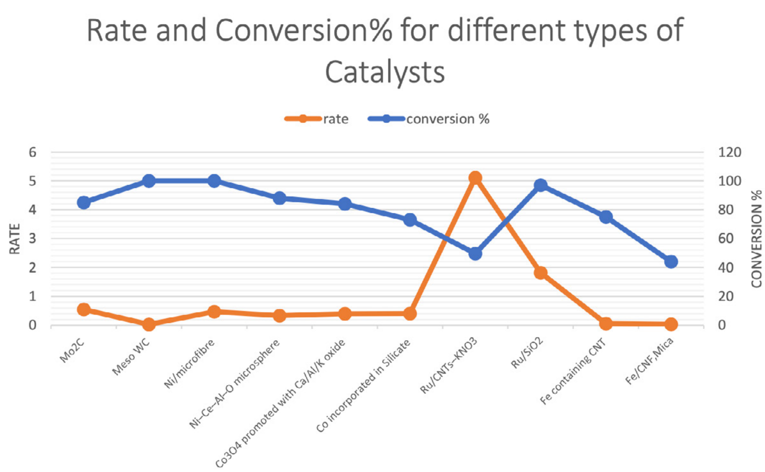


Figure 3: Rate and Conversion % for different types of catalysts

From the figure above, (Ru) has the highest conversion percentage, and (Fe) has the lowest. Furthermore, (Ru) has the highest rate, and (Fe) has the lowest. From the results, (Ru) can be chosen to be the best catalyst with the highest efficiency.
As a general result, in line with experimental findings Ni- and Co-based catalysts had higher average activity than Fe-based catalysts. However, (Ru) could be the most beneficial catalyst because it has the highest conversion percentage, the highest rate, and the lowest energy to reach catalyst activity. In recent times, (Ru) is extremely expensive compared to other catalysts. Due to the new innovations, nanotechnology was a hot target that can be used to increase efficiency and decrease the amount of catalyst as well as decrease energy consumption.

The success of the green economy will depend on delivering hydrogen at the lowest possible cost from worldwide production sites to end consumers. The most promising hydrogen transportation methods include gaseous hydrogen pipelines, ammonia-based hydrogen transportation, liquefied hydrogen (LH2), and hydrogen stored in liquid organic hydrogen carriers (LOHC).

There is no single carrier that can be said to be the best, the cost of hydrogen delivery depends on several factors: the amount of hydrogen transported, the transport distance, the transport means used, and the state in which hydrogen is transported.
Overall, it has been noted that hydrogen is an essential element while the process of production, storage, and transportation is expensive. Each step is accompanied by vast challenges, thus becoming impossible in real-life situations since most companies want to maximize profits. Moreover, in order to do so, operational values must outweigh the use value.

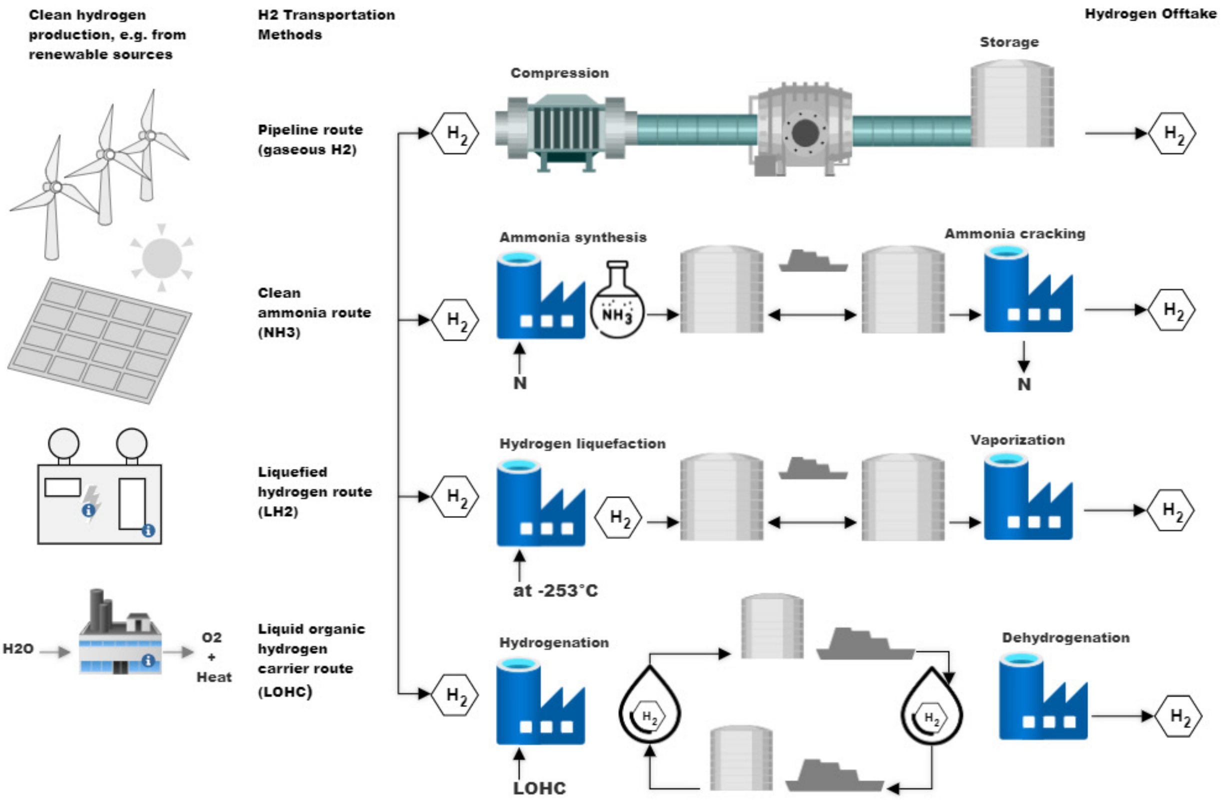


Figure 4: The most common routes for hydrogen transportation

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Green Chemistry and Sustainable Industrial Technology

Many industrial processes, such as oil and gas extraction, refineries, chemical plants, coal extraction and preparation, and landfill management, use gas flaring to burn the unwanted or excess gases and liquids released during normal or unplanned over-pressuring operations. However, gas-flaring emissions contribute significantly to global warming and are contrary to sustainable development goals (SDG) and COP26 targets. Nevertheless, flared gas can be converted into hydrogen, which is a clean alternative to natural gas or methane as a power source. Once hydrogen is burned, it produces no carbon emissions, but rather water and energy.

Hydrogen can be produced from a variety of sources using different catalysts and applying various conditions. In this project, decane was selected as the main feedstock, given that in an ideal world, natural gas consists of methane and other gases containing carbon-carbon (C-C) and carbon-hydrogen (C-H) bonds. Specifically, decane has 10 carbon and 22 hydrogen atoms. Meanwhile, two catalysts were selected: Ni/Starbon, synthesised in the lab from a renewable substance, and Ruthenium on carbon (Ru 5wt.%/C), which is a commercially available catalyst. The reactions took place at two temperatures, 180°C and 370°C. The effects of the catalysts and temperature on the decane-cracking process were studied in 33 experiments under different conditions.

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Hydrogen Production from Hydrocarbons

The burning of natural gas in conjunction with oil extraction is known as gas flaring. Associated gas flaring is an example of ineffective energy use that is characteristic of most oil-producing nations, representing a practice that dates back over 160 years. It is motivated by various factors, including market and economic restraints, a lack of facilities, insufficient regulation, and the absence of political will. However, flaring is a massive waste of precious natural resources, which should otherwise be used for profit, for example, in the generation or conservation of electricity. Globally, over 142 billion cubic meter of gas is flared each year.

Figure 1 illustrates the global totals for natural gas flaring between 2014 and 2021. Meanwhile, the average amount of electrical energy produced from 1 m3 of natural gas is approximately 2.87 KWh. Thus, the amount of energy wasted worldwide as a result of gas flaring amounts to over 3.9 billion KWh.

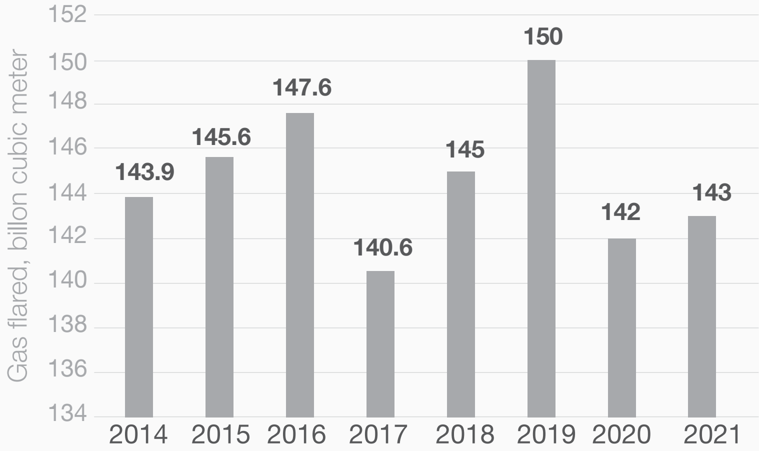

Figure 1. Volume of natural gas flared worldwide from 2014 to 2021

Data from 2020 indicates that since 2012, Russia, Iraq, Iran, the United States, Algeria, Venezuela, China and Nigeria had been the top eight gas-flaring countries for nine consecutive years. Specifically, as a result of gas flaring, 350 million tons of carbon dioxide were emitted worldwide in 2018. This practice contributes to climate change, as well as inflicting other harmful effects on humans (such as respiratory problems) and the environment.

It is extremely difficult for oil companies to capture, store, transport, and distribute associated gas, and the cost of ending routine flaring could reach $100 billion. Associated gas collection and transportation through a gas pipeline are traditional approaches to the use of flare gas. Operators must typically capture a large quantity of associated gas from multiple flare sites, ideally located close together. This gas must then be transported for use. However, there are several alternative ways of addressing the problem of routine gas flaring. As the worldwide focus on reducing emissions increases, accessing energy sources such as hydrogen becomes an increasingly desirable approach. Investment is therefore being made in the necessary infrastructure to convert hydrogen into a practical, emission-free resource.

Energy and environmental systems need to be improved through sustainable development, including the integration of a circular economy and cleaner production to meet the emerging needs of humanity. Once gas flaring is avoided, ambitious GHG reduction goals will be achieved, thereby enabling a significant role for gas flaring. Besides being economically viable, it also contributes to achieving a circular economy by recovering the carbon dioxide and other impurities released through gas flaring processes. Moreover, it introduces flexibility into the network.

Figure 2. Logos for Sustainable Development Goals No.7 and 13

Climate change has been the subject of many international conferences over the decades. The G7 Summit in Cornwall and COP26 in Glasgow in 2021 provide recent examples. Leaders from around the world are meeting to discuss what action needs to be taken to tackle the climate change. Two of the key themes of COP 26 were the expansion of GHG emission reduction targets and the reduction of methane emissions. Following discussions at COP26, the automotive industry is moving toward hydrogen power instead of biofuels or the petroleum sources.

As part of Sustainable Development Goal No. 7, aimed at guaranteeing access to affordable, clean, reliable, sustainable, and modern energy for all, there is a need to reduce or eliminate wasteful and destructive practices, such as associated gas flaring. Around 60% of global greenhouse gas emissions are produced through energy supply.

Many organisations have committed to reducing global gas flaring by participating in the World Bank Global Gas Flaring Reduction (GGFR) initiative and setting a company flaring intensity target. In order to reduce flaring intensity, petroleum companies could recover associated gas by deploying every possible solution from reservoir re-injection and exportation to local market distribution, liquefaction for export, and power plant feeding. The latter solutions, along with gas valorisation, represent the core pillar of petroleum producers' commitment to improving access to modern energy services in the geographical regions where they operate.

One of the goals of SDG No. 7a is to enhance international cooperation in facilitating access to clean energy research and technologies, including renewable energy, energy efficiency, and advanced and cleaner fossil fuel technologies, as well as promoting investment in energy infrastructure and clean energy technologies by 2030. Moreover, SDG No. 13 is to take urgent action to combat climate change and its impact. For example, in order to prevent the worst effects of climate change and limit warming to 1.5oC, greenhouse gas emissions must peak immediately and be reduced to zero by 2050.

Hydrogen is a chemical element that can be found in molecular form in water and methane. It cannot be extracted like oil or natural gas but needs to be released by applying energy. However, hydrogen production benefits from the fact that a variety of feedstock and energy sources can be used. Hydrogen also provides a low-carbon energy source because it produces no carbon dioxide when burned: only water and energy. It is possible to produce hydrogen from methane via the steam methane reforming process and water gas shifting reaction, which converts the carbon monoxide produced through steam methane reform into carbon dioxide and more hydrogen. This reaction occurs at high temperatures and pressure. However, in an ideal world, the flared gas would not only contain methane, but a combination of other hydrocarbons such as alkanes, alkenes, and branch hydrocarbons. Decane was selected as the feedstock for all the Experiments conducted in this study since it contains 10 carbon and 22 hydrogen atoms. Once cracked, these will display different behaviour that must be stabilized. Two catalysts were tested: Ni/Starbon, synthesised in a lab using a DCM microwave, and a commercial Ru 5wt%/carbon catalyst. Ni/Starbon was selected because nickel is well known as the most suitable metal for steam reforming hydrocarbons, due to its low cost compared with other metals, together with its heat resistance. Starbon was selected to support the nickel particles. Moreover, it is made from renewable, biodegradable, and non-toxic resources.

Based on the results of 33 experiments, the advantages and disadvantages of each catalyst were analysed and discussed in this study. The advantages of the Ni/Starbon catalyst are that hydrogen was produced at 370oC and under atmospheric pressure, which is very far removed from the industrial conditions of hydrogen production using different catalysts and with a lower H2/COx ratio. This will meet SDG/COP26 targets, save a vast amount of energy, and reduce emissions into the environment, thereby reducing the effects on climate change. Moreover, the cost of the catalyst is relatively low, and it is easy to produce from renewable substances. However, the disadvantages of the Ni/Starbon catalyst are that hydrogen is only produced in the first cycle, recovery is not easy, the reactivation method is unknown, and at high temperatures, the catalyst decomposes to other pollutants, especially ethane and CO2. In contrast, the advantage of Ru/C is that it is more capable of cracking decane to produce smaller hydrocarbons, although it also has the disadvantage that no hydrogen was produced in any of the Experiments in this study. It is also relatively expensive, and Ru is a critical element.

Fog water collection in the Dhofar Region of the Sultanate of Oman

The Dhofar Region, in the south of Oman, is located about 650 miles (1,040 km) from Muscat (Fig. 1) (''A most refined reserve," 2009). This paper explains the fog collection technique used in the Dhofar Region during monsoon season, and how this technique reduces the dependence on groundwater by creating a clean additional water source.

Figure 1: Location map of the Dhofar Region in the southern part of Oman (Fanack, 2016).

Fog water collection techniques

The fog water collection technique is a simple and sustainable way to ensure fresh water for multi-uses such as afforestation, farming, and as a drinking water source for human and animal consumption (Klemm, 2012). Normally, precipitation is the main water source that supplies an aquifer. However, there are some areas in world located in upland regions, where the collection of fog droplets by vegetation not only supports the vegetation but also contributes to aquifers. These regions are called cloud forests, because the fog source is from clouds moving over these regions (Schemenauer, 1994b). In the Dhofar Region, the main water source is the groundwater system. However, as fresh groundwater is extracted due to high demand for irrigation and other uses, salinity contamination occurs as salt water naturally flows in from the coastal plain. For this reason, people increasingly extract water directly from mountain drainages, but this fresh water source is not enough to cover the high and growing demand for water to different sectors. The Dhofar Region, especially coastal areas like Salalah (the administrative capital of Dhofar), is affected by an annual monsoon season each summer between June and September. This phenomenon is caused by moist air from the Indian Ocean (Fig. 2). This presents an excellent opportunity to supply water using the non-conventional alternative technique of fog water collection and thereby reduce dependence on conventional water sources like the groundwater.

On average, fog occurs during 20-25% of the days annually, and it mostly happens during the monsoon season. This presents an ideal condition for fog water collection in Dhofar (Fig. 3). The first study of fog water collection techniques at Jabal Dhofar was published by Fallon (1978). He used wire netting to intercept water and increase precipitation. Stanley Price, et al. (1988) started new investigations of fog collection and demonstrated that up to 50 L/d could be collected by a 1m2 screen of aluminum wire mesh. Barros and Whitcombe (1989) did additional experiments during the 1989 monsoon season. Their study concentrated on the possible applications and benefits of fog water collection techniques. They concluded that the Dhofar coastal mountain region had potential to produce 30 to 40 L/d, over a two-month period, at 900 to 1000m elevation, using 1m2 standard collectors (Barros and Whitcombe, 1989). Later, Abdul-Wahab et al. (2009) also worked in Jabal Dhofar during monsoon season to develop residential-type fog collectors to directly meet the needs of mountain residents, and thereby decrease the extraction of groundwater. The collected fog water was directed into storage tanks for later use by people, animals, and agriculture.

Figure. 2: Map with locations marked that have potential for successful fog collecting to produce fresh water in arid or seasonally arid regions.

Barros and Whitcombe (1989) also carried out experiments to determine the ability of trees to collect fog water for later use. In 2009 Abdul-Wahab et al. did similar experiments to measure the potentiality of specific trees to condense fog depending on leaf shapes, size, and cross-sectional area of the tree canopy. The study concentrated on three types of trees including fig, lemon, and tamarind. Fog collection from the fig tree over a 47-day period during the monsoons was 140.5 L/m2, or an average of 2.7 L/m2/d. Fog collection from the lemon tree was 243.0 L/m2, or an average of 4.4 L/m2/d. The tamarind tree produced 218.9 L/m2, or an average of 4.3 L/m2/d over the same period (Abdul-Wahab et al. 2009).

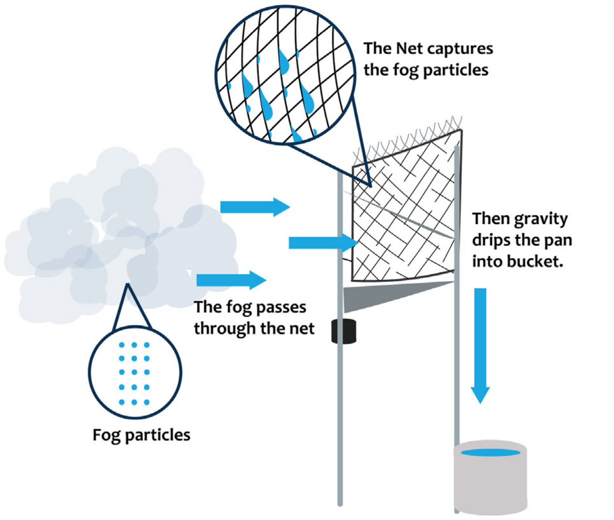

Figure 3: Shows the fog collection Basics, and how the droplet of the fog moves through the mesh due to wind power.

Methods of the fog water collection

There two types of fog collectors which have been used during the last 20-30 years. The first one is called a standard fog collector (SFC). This is a 1m2 collector used to evaluate potential fog collection sites. The second type is called a large fog collector (LFC) and is 4×10m in size. Both collectors use 2 layers of 35% raschel mesh shade cloth. The water is collected as fog droplets condense on the mesh surface and then drip into a gutter pipe which drains into a storage tank (Fig. 4) («Fog Collection Basics,» 2014).

Expanded applications made in the Dhofar Region

In 2019, the Shabiba media channel released a video that documents some of Oman's government efforts to harvest fog water on a large scale during the monsoon season in Dhofar. A project was implemented to collect this water from an area covering 931,260 square meters. Project sites were selected based on the amount of fog available, wind speed and direction, elevation, and soil fertility in these locations. The project was designed so that prevailing winds pushed fog through an array of nets. The condensed moisture dripped from the nets into collecting pipes where it then flowed into special storage tanks for use after the monsoon season. As a result, the project collected a total of 350,000 gallons (1,324,894 Liters) of water. This project successfully demonstrated a working model for the sustainable management of natural resources. If scaled up, there is potential for this project to preserve the environment from desertification, reduce the loss of vegetation that covers the Dhofar Mountains, provide fresh water to communities across the Salalah Plain and irrigate local crops.

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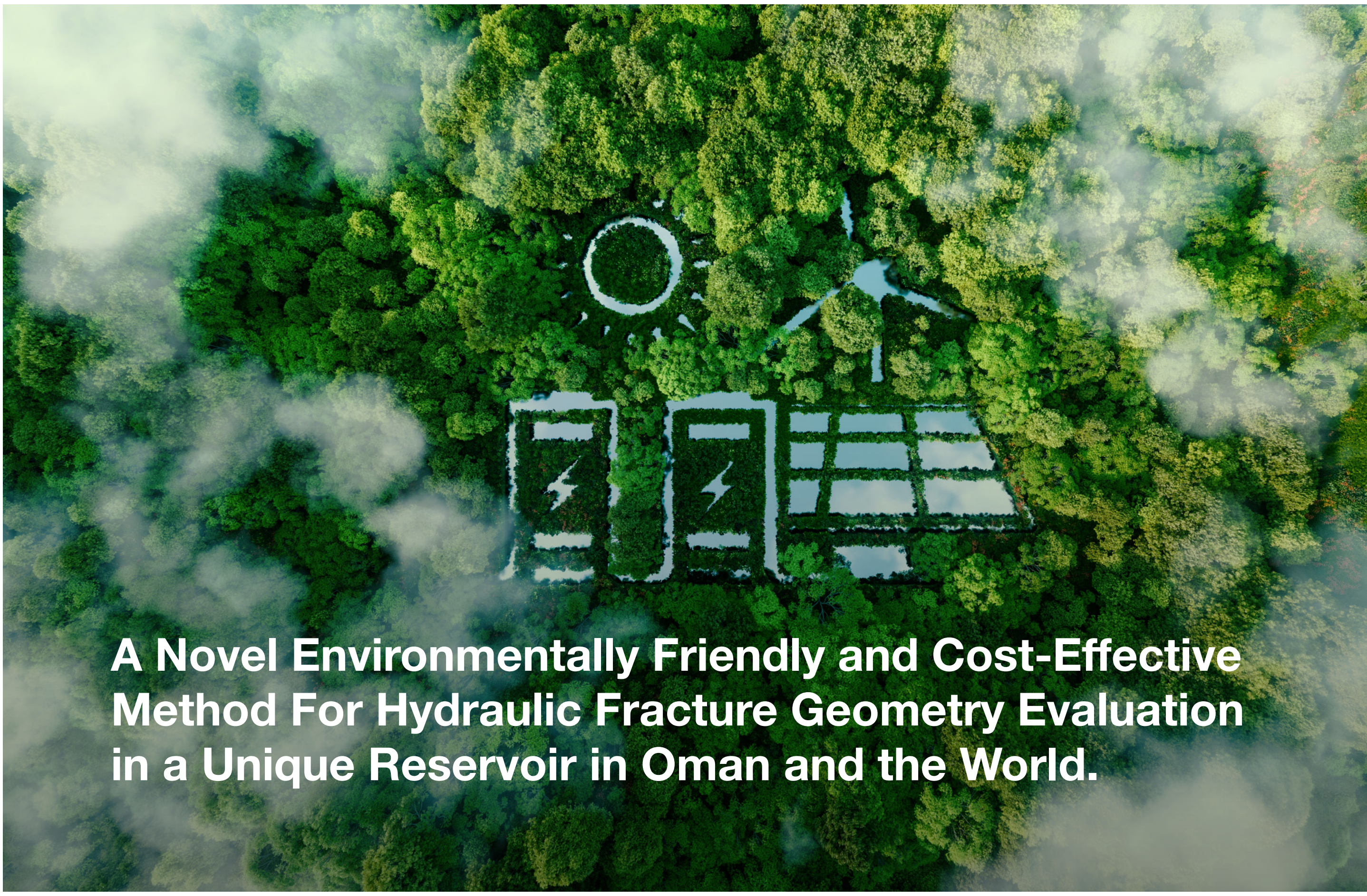

A Novel Environmentally Friendly and Cost-Effective Method For Hydraulic Fracture Geometry Evaluation in a Unique Reservoir in Oman and the World.

One of the most common methods for increasing hydrocarbon production in low-permeability formations is the creation of hydraulic fractures in the reservoir rocks. Hydraulic fracturing (HF) is a process that involves injecting wells at a high pressure with water, proppants, radioactive tracers and large quantities of chemical additives to fracture the formation and produce new cracks and pathways to help extracting natural oil and gas.
Some resources that are extracted through fracking are called “tight oil” or “tight gas,” because these pockets of fossil fuels are tightly trapped in hard rock formations. The Athel reservoir in the Sultanate of Oman is a Pre-Cambrian, tight, layered, homogeneous, silicilyte oil bearing rock with high micro porosity and low permeability. Due to layering, vertical permeability is almost zero, which leads to the need of multistage hydraulic fracturing to maximize frac coverage for field development.
The objective of multistage hydraulic fracturing is to increase the surface area of the reservoir in contact to the wellbore. Proppants help keep high conductivity in the newly created fractures. After hydraulic fracturing, an extended fracture network is created to enlarge the contact area between the wellbore and rock matrix, which could significantly enhance the production rate. Placing multiple hydraulic fractures in a horizontal well is a highly effective method to increase per well production. However, multiple, closely spaced fractures could introduce strong interactions among the fractures, often referred to as the stress shadow effect. The effect could lead to fracture width reduction, greater risk of screen-out, and possible change of fracture direction. The model for multistage hydraulic fracturing in unconventional reservoirs should take such stress shadow effect into consideration to properly design the stage length and perforation spacing to achieve optimal performance.
Hydraulic fracture height and azimuth are important parameters for evaluating hydraulic fracturing job efficiency and important input for subsequent fracturing job modeling and design. Fracture models consider several parameters such as rock mechanical properties, lithology, stress magnitude and directions. The confident understanding of fracture geometry is critical for successful job planning and execution. There are several techniques available to evaluate fracture geometry such as micro-seismic monitoring, spectral noise log and radioactive (R/A) tracers. All listed methods except micro-seismic hydraulic fracture monitoring (HFM) provide only fracture height. Time-lapse acoustics-based method can provide both height and azimuth.

Risk of Radioactive (RA) Tracers

The height of the induced fracture is an important parameter in the treatment process. Proper assessment of the created fracture height is critical for determining if the created fracture is contained within the desired interval or extends into adjacent layers or water zones.
One of the methods to evaluate the height of the fracture is by adding different radioactive isotopes to the frac fluid and/or proppant while conducting hydraulic fracturing treatments. These isotopes emit gamma-ray radiation which is logged to determine the location of the fluid and/or proppant as well as an estimate of the proppant concentration. After analyzing the data, Engineers can redesign future jobs based on the post job radioactive tracer results. Those results can help Engineers to avoid problems in future stimulation treatments like breaking into a water zone or high-water saturation intervals that may communicate with the rest of the fractured gas zones.

The concentration of the radioactive tracers is selected depending upon the estimated time between tracing and logging. Logistics, environmental impact, and legal limits can affect the final recommendation of the concentration of the radioactive tracer.
The use of the radioactive tracer technology can provide important information that will help the overall well optimization of well completions and production enhancement outcome. However, radioactive tracer usage.

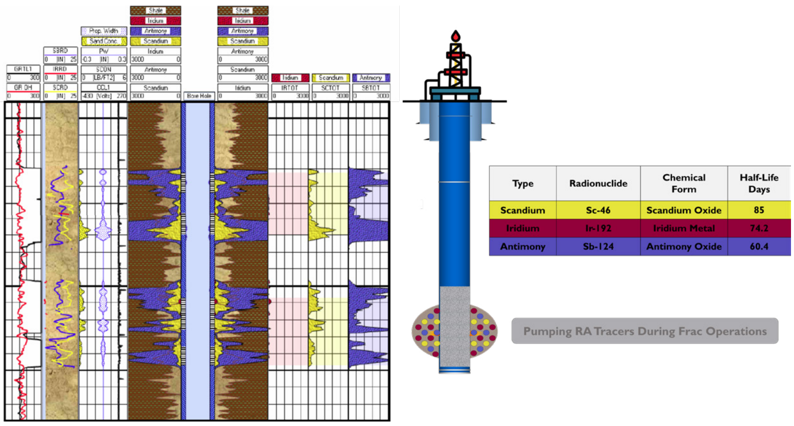

Figure 1: Radioactive tracers logs representation
(Scandium - Sc-46 in yellow Antimony - Sb-124 in blue)

Environmental and Health Impact

Radioactive tracers are compounds with both internal and external exposure hazards to humans; they emit highly energetic gamma/beta radiation which can cause localized damage if ingested, inhaled or absorbed by the skin. Externally, both beta and gamma radiation can cause localized damage to exposed areas.
Concerns have been expressed that radioactive tracers may return to the surface with flowback and during blowouts. Wastewater from the wells is released into surfaces and wadies, injected into wells, and evaporated from ponds. Recycling the wastewater has been proposed as a solution but has its limitations.

Most of these hazardous substances have not been assessed for toxicity or persistence as they relate to the hydraulic fracturing process. Additionally, waste water produced by fracking is contaminated with these hazardous substances as well as other persistent and toxic contaminants, and is reused in numerous processes or released, partially “treated,” into waterways. Eliminating operations with these materials reduces risk of exposure hazard for field personnel to zero.

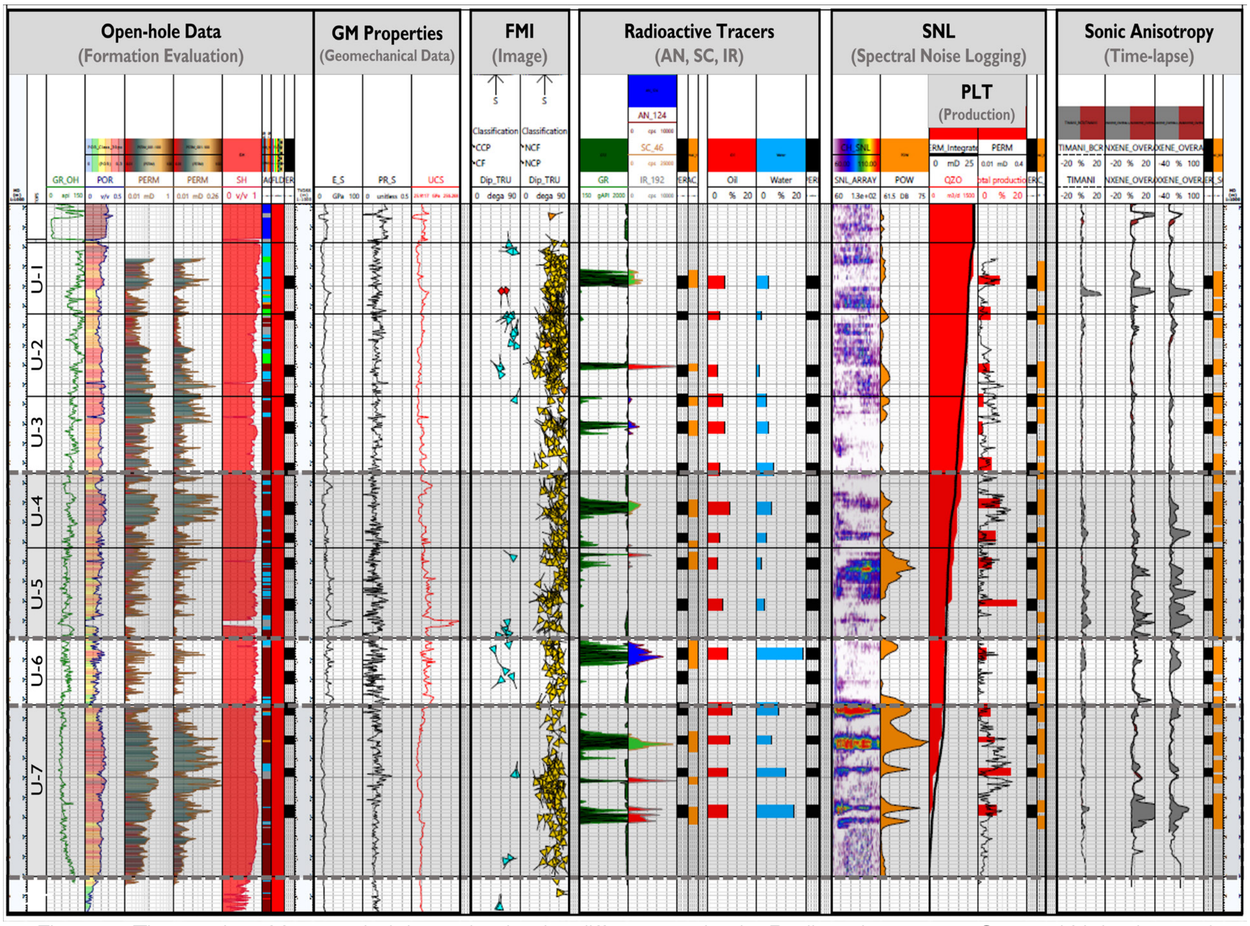

Figure 2: The results of fracture height evaluation by different methods: Radioactive tracers, Spectral Noise log and sonic anisotropy. (Black flag shows perforation flags and yellow flag shows fracture height from different methods

The Saviour: Time-Lapse Sonic Anisotropy

The time-Lapse sonic anisotropy acquisition is a novel environmentally friendly and cost-effective method for hydraulic fracture geometry evaluation. The sonic anisotropy measurements comparison taken before and after the hydraulic fracturing job allow estimating differential acoustic anisotropy and enables hydraulic fracture geometry evaluation. The method replaces radioactive tracers and eliminates any risk of radioactive contamination, high cost, and complex hydraulic fracturing microseismic monitoring (HFM) operation which requires well monitoring.

Advanced sonic anisotropy logging tool, using a broader range of frequency acquisition, was used to enable shear measurement in cased hole environments over the silicilyte -pre-Cambrian tight Athel reservoir- before and after the hydraulic fracture treatment. The Amplitude and anisotropy changes after a hydraulic fracture have been measured using sonic anisotropy logging and used to infer fracture height. The sonic anisotropy can be evaluated above and below the perforated interval to investigate hydraulic fracture height growth away from the wellbore, potentially visualizing a greater distance than available with radioactive tracers.

The method was successfully implemented in Greater Birba fields in the Sultanate of Oman, during hydraulic fracturing operations. Results were compared and validated with radioactive tracers data, spectral noise log and microseismic monitoring data. This was a first use of sonic anisotropy measurements for fracture geometry evaluation in Petroleum Development Oman (PDO) and the Gulf Cooperation Council (GCC) region.

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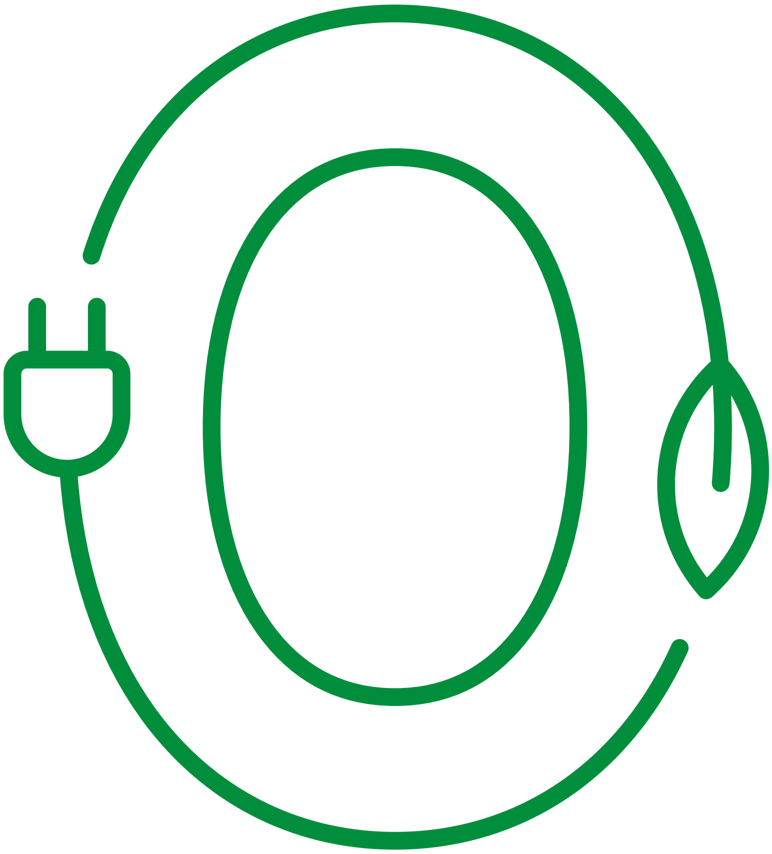


The Path to Net Zero Emissions in 2050

The picture of climate change, its causes, and how to mitigate its impact has become clearer as a result of the integrated working group›s efforts and the Intergovernmental Panel on Climate Change›s Assessment Reports (IPCC). Multiple integrated lines of scientific evidence based on over 14,000 scientific publications found that well-mixed greenhouse gas (GHG) concentrations increased to annual averages of 410 ppm for carbon dioxide (CO2), 1866 ppb for methane (CH4), and 332 ppb for nitrous oxide (N2O) in 2019 [IPCC, 2021]. The observed increase is due to human-caused emissions, which contributed to the decrease in Arctic sea ice area between 1979-1988 and 2010-2019 (decreases of approximately 40% in September and 10% in March) [IPCC, 2021]. It has also contributed to the decrease in Northern Hemisphere spring snow cover since 1950, as well as the observed surface melting of the Greenland Ice Sheet over the last two decades. Figure 1 depicts the annual average change in global surface temperature as observed and simulated using both human and natural factors, and only natural factors (both 1850–2020) [IPCC, 2021].

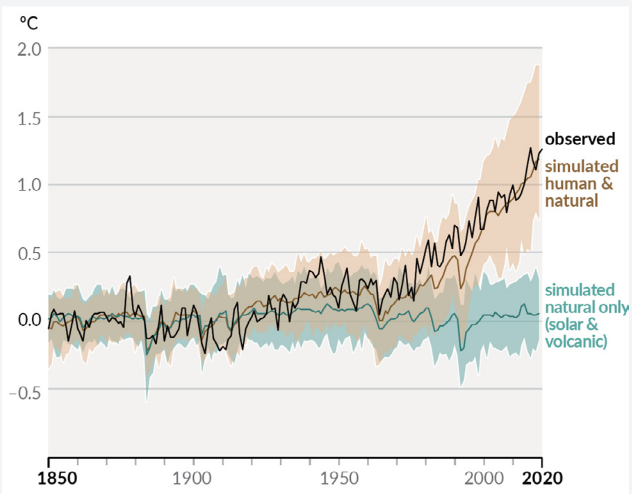
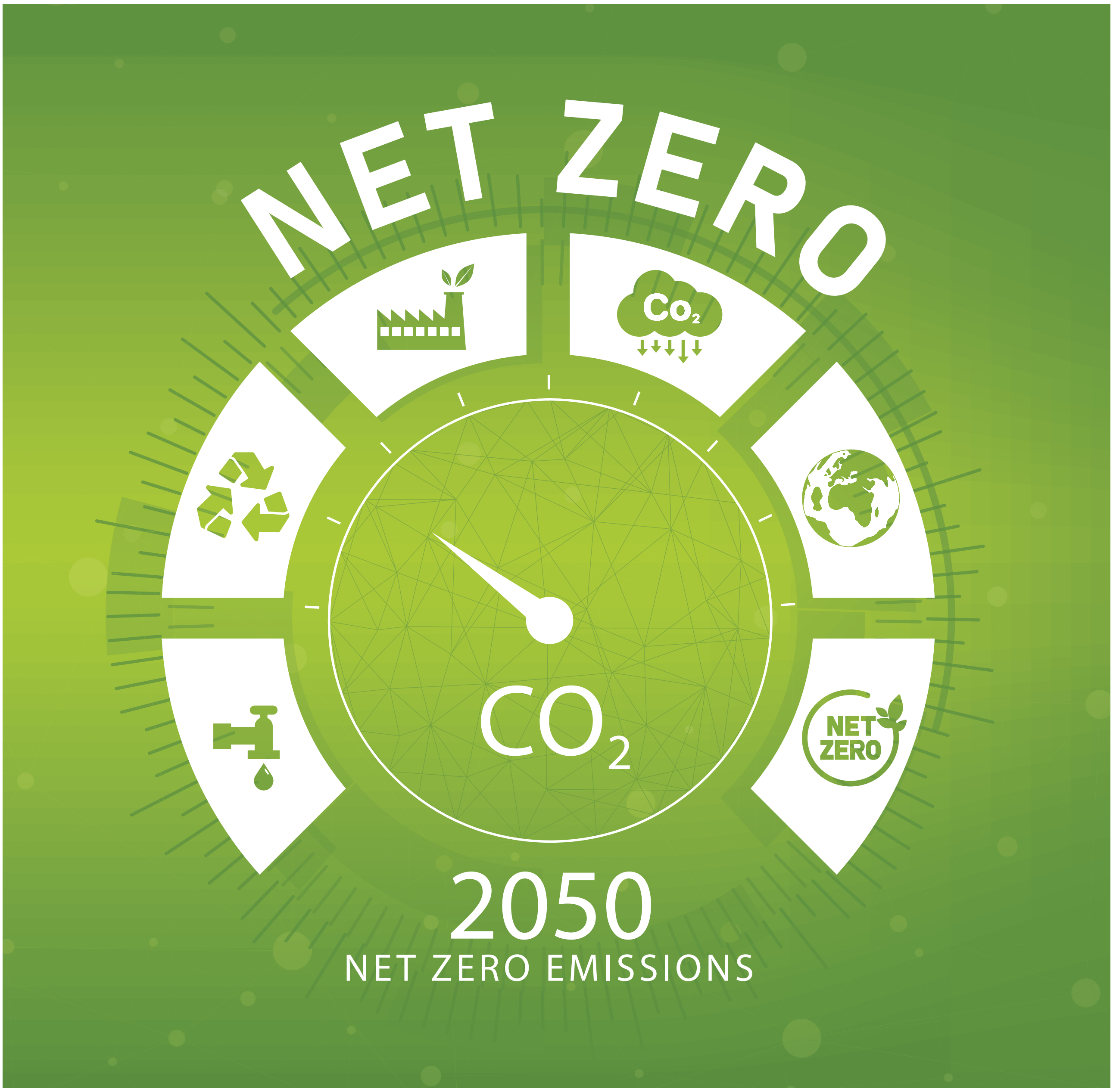


Figure1: Change in global surface temperature (annual average) as observed and simulated using human & natural and only natural factors (both 1850–2020), [IPCC, 2021].



1- Global pledge to achieve net zero emissions

To address the climate crisis, which has been identified as humanity›s most important and urgent challenge, 33 countries and the European Union have set clear goals, either through legislation or policy documents. Also, a net zero target has been proposed or is being considered by more than 100 countries [ECIU, 2022]. This is consistent with the Paris Agreement goal of limiting global warming to well below 2 degrees Celsius, preferably 1.5 degrees Celsius, compared to pre-industrial levels [UNFCCC,2022]. The Paris Agreement is based on a five-year cycle of countries taking increasingly ambitious climate action. Countries should submit their climate action plans, known as nationally determined contributions (NDCs), which include plans for reducing greenhouse gas emissions [UNFCCC,2022]. In addition, many companies, cities, and institutes have joined the United Nations› Race to Zero. As of September 2022, there were 11,309 non-state actors, including 8,307 companies, 595 financial institutions, 1,136 cities, 52 states and regions, 1,125 educational institutions, and 65 healthcare institutions joint the race to zero emissions by 2050 [Race to Zero, 2023].

2- Global Energy Sector pathway to net-zero CO_2 emissions in 2050

The International Energy Agency (IEA) published Net Zero by 2050: A roadmap for the Global Energy Sector in 2021, which outlines a narrow but achievable path for the global energy sector to reach net zero emissions by 2050. However, a lot has happened in the short time since that report was released. According to the report, CO2 emissions from the energy sector decrease by more than one-third between 2021 and 2030 in the NZE Scenario, falling from 36.6 Gt of CO2 today to 21 Gt Of CO2 in 2030 [IEA, 2021]. Achieving such a reduction requires massive collaboration between governments, industry, and academia. In its report, the IEA has outlined energy efficiency, behavioral changes, electrification, renewables, hydrogen and hydrogen-based fuels, bioenergy, and carbon capture, utilization and storage (CCUS) as key pillars of the global energy system (Figure 2).

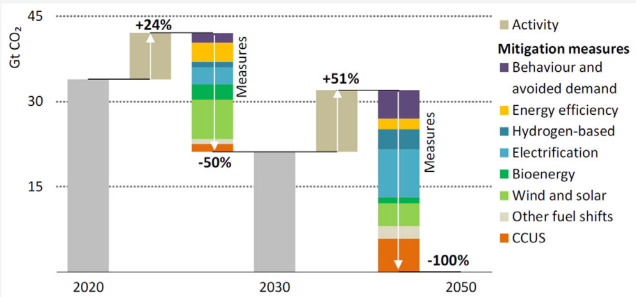


Figure2: Emissions reductions by mitigation measure in the NZE, 2020-2050 [IEA, 2021].

Solar, wind, and energy efficiency account for roughly half of the NZE's emissions reductions to 2030, with electrification, CCUS, and hydrogen ramping up after that. It is worth noting that in many countries, wind and solar PV continue to be the most cost-effective options for new power generation.

CCS is also viewed as a crucial climate mitigation tool that can play an important role in decarbonizing the energy sector. It has been steadily increasing since the 2015 Paris agreement. According to the Global CCS Institute, there are 135 commercial CCS facilities (two suspended) around the world, with 71 projects planned for 2021. Three facilities in the United Arab Emirates and Saudi Arabia already capture 10% of global CO2 each year about 3.7 Mtpa [Global CCS Institute,2022].

The transition to a net-zero-emissions world will provide opportunities for businesses and countries, such as decarbonizing processes and products and replacing high-GHG-intensive processes with low-GHG-intensive processes. However, an additional $3.5 trillion in capital spending on low emissions assets is required every year for the next 30 years. Furthermore, by 2050, the transition could result in a gain of approximately 200 million direct and indirect jobs and a loss of approximately 185 million direct and indirect jobs globally [Mckinsey,2022].

3- Oman pathway to net-zero CO_2 emissions in 2050

Oman›s net emissions were approximately 90Mt CO2e in 2021, with five sectors accounting for 95% of net emissions: industry, oil and gas, power, transportation, and buildings. If nothing is done, Oman›s emissions will rise by 16% to 104 Mt CO2e by 2050, according to the recently released report by the Oman Vision 2040 office The Sultanate of Oman›s National Strategy for an Orderly Transition to Net Zero. In October of 2022, Oman has pledged to achieve net zero emissions by 2050, in line with the Paris Climate Agreement›s goal. Several mega-scale projects have been announced to decarbonize various sectors such as the hard-to-abate industry and power sectors, by leveraging Oman›s widely available solar and wind energy resources. The country intends to increase its renewable energy share to 30% by 2030, rising to 35-39% by 2040. The current major solar and wind energy projects are the PDO-funded projects such as Amin Solar photovoltaic Independent Power Project, Miraah Solar Project, and Car Park Solar Panel Project. Also, the government has commissioned the 500 MW Ibri Solar PV Project in Northeast Oman-Ibri and Dhofar Wind Power [Amoatey et al., 2022]. Oman›s renewable electricity capacity is expected to grow by 4.8 GW between 2022 and 2027, with solar PV installations accounting for the majority of the increase [IEA, 2022]. Oman is also has an excellent and strategic location for green ammonia production. It plans to produce one million tonnes of green hydrogen by 2030, with a total investment of more than $20 billion in the green hydrogen sector by that time [Muscat Daily, 2022].

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Zero Flaring goal

This article details the concept selection process undertaken to comply with the goal of zero routine flaring from oil producers by 2030 (MEM/MO/1128/2/1/3032/2021). Committing to this initiative supports the goals of Paris Climate Agreement; as ZRF by 2030 can be submitted as a nationally determined contributions (NDC) towards the goal of rechaining net zero by 2050.

This study was initiated by OQ EP concept team to study and recommend the best concept to recover the associated gas produced from Block 60 on-plot facilities. The project went through feasibility assessment where various concepts were developed via brainstorming/divergent thinking. The technically & economically feasible options progressed to concept selection where opportunities for further optimization are being explored.

In the concept selection study, several decisions were identified including source of gas recovery (tie-ins), gathering system, pressure boosting options and flare gas recovery technologies (FGR). These decisions are evaluated and screened based on selection criteria and critical success factors, which were derived from the project value drivers. The decisions and recovery technologies are assessed against GHGs emissions, life cycle cost LCC, sources of revenue and technical robustness. This article highlights the feasible technologies for FGR as applied for associated gas for a flow range from 0.5 MMSCFD to 3 MMSCFD.

Objective/Scope:

To reach the objective of zero routine flaring with minimum carbon footprint from Bisat oil processing facilities by 2030, a concept development process was initiated to recover 0.5-3 MMSCFD of flared gas. This study, which is currently still under concept development, aims to enhance the economical attractiveness to meet the Zero routine flaring by 2030.

Methods, Procedures, Process:

Available gas recovery technologies were identified through market research and identification of suitable conventional technologies. The technologies considered included standalone skids, and export of recovered flare gas from OQ oil production facilities to OQ gas processing facilities 32 km away from FGR. The second option deemed attractive due to the proximity of the stations.

The technologies assessed include the following:

1. Gas to Power:
   a. Power generation and use by OQ (Gas Engines/ Turbines/ Microturbines)
   b. Power generation and use by (External contractor)
2. Gas to Liquid
3. Gas export to Existing gas processing plant (32 km away)
   a. a.Wet Gas
   b. b.Dry Gas
4. Construction of a gas processing plant
5. Gas to LPG/LNG/CNG/NGL

Figure 1.1 below illustrates FGR technologies. A great portion of the study was dedicated towards identifying meaningful and comprehensive concept selection criteria; especially as associated gas tends to decline over time. The criteria selected as per identified critical success factors that include compliance to regulations, (Greenhouse gases) emissions in relevance to the existing baseline, economic performance, applicability for carbon credit, onstream date and technical robustness. Moreover, to further cater for the fluctuation in the associated gas production; the impact of modularisation of technology was investigated. In addition, the contracting strategy was tested against the economic performance.

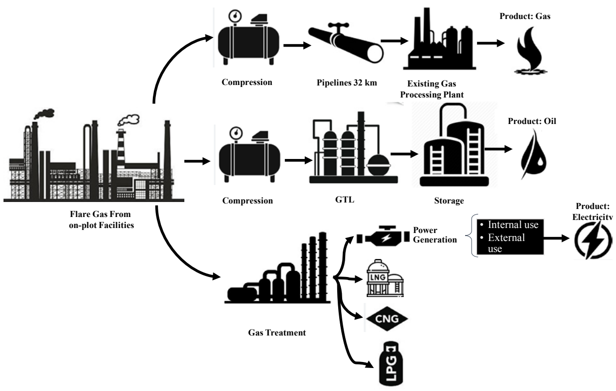

Figure 1.1: Technologies Schematics

Results, Observations, Features:
Summary of technically and economically feasible FGR technologies:

Options Recovery technology		Reduction in GHG emissions from baseline	LCC	Contract strategy	Source of revenue	Features
Gas to Power	Gas Engines/Turbines/ Microturbines	52-80%	M	EPC	Power & Carbon credit	- Proven technology
	Power generation and use by (External contractor)	17%	L	DBOOM & JV	flared gas sold to external contractor	- Modular design applicable - No Cost to install or operate the vendor will buy the gas.
Gas to Liquid		86%	M	DBOOM/T & Lease	Crude oil or Synthetic Diesel	- Modular skid - Easy to install - Flexibility of spiking synthetic crude/diesel to the export crude.
Gas to Existing gas processing plant (32 km away)	Wet Gas	98%	M	Lease & EPC	Export gas & carbon credit	- Proven technology - Higher pipeline & compressor cost - Excluding dehydration system.
	Dry Gas	80%	M	Lease & EPC	Export gas & carbon credit	- Proven technology - Dehydration package cost - Reduced pipeline cost - Higher OPEX cost

Table -1 Summary of feasible FGRs

Options of Gas to export have been excluded from further evaluations as they require a new mini gas treatment plant (High cost) which is not justified when an existing Gas processing plant is available in Block 60 (32 km away). The same is applicable for LPG/LNG/CNG option as gas processing will also be required. Moreover, challenges regarding logistics, marketing, sales permitting were also identified leading to a low technical robustness of this recovery option. The options deemed feasible as listed in Table 1 Summary of feasible FGRs are undergoing a comprehensive optimisation to improve economic competitiveness of the concepts while maintaining the core goal of achieving zero routine flaring. For the gas to power option, microturbines were discarded due to higher GHGs emissions & costs. Moreover, the attractiveness of a leased contracting strategy is currently undergoing analysis, to reduce CAPEX and improve modularisation and thus flexibility of the selected technology. This is expected to improve the NPV of this option. For Gas to liquid options, revenue production through sale of synthetic diesel is being investigated this will generate more revenue than spiking the product to the export crude. However, the involved logistics is likely counter the added value generated.

The biggest opportunity of optimisation noted thus far for the project economics, overall energy efficiency and cost is observed in pressure boosting technologies. Where static pressure boosting are being investigated. In this option available motive fluid such as produced water or export gas can provide motive to pressurise the recovered flare gas. This will remove the power cost associated with the use of rotary equipment and will reduce the GHGs emissions as no additional power will be imported. Moreover, this improves the energy efficiency for the block as a waste stream (produced water for disposal) would be re-utilized to improve revenue production. In addition, static pressure boosting equipment can offer a greater flexibility for gas handling meeting the fluctuation expected with associated gas production.

The takeaways from the concept study which is still under progress is that reaching 2030 by ZRF which is an environmental objective by principle can be an opportunity for revenue generation through comprehensive investigation of gas recovery technologies.

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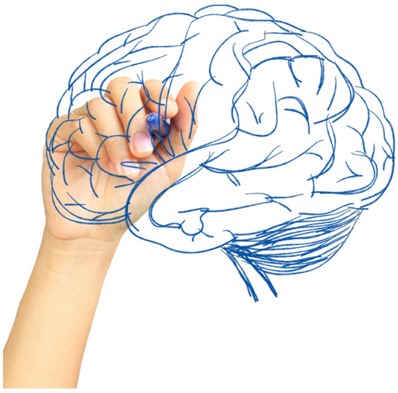

Neurodiversity in the Workplace

Mental health awareness has significantly risen all around the world, with many finding themselves relating it to certain conditions, or even more likely, recognising the conditions' traits in someone around them. People are more conscious of the neurological differences there are between individuals. Autism, ADHD, and other neurological conditions have always existed, but the resources to identify them were not as accessible. In the workplace, neurodiverse people provide different views and unique sets of skills. They are typically more conscious of patterns, able to see them where a typical person cannot, and extremely efficient in processes requiring repetitive tasks, where a typical person is prone to losing interest and attention, thus making mistakes. Companies are striving to recruit neurodivergent individuals due to the skills they bring, creating application processes that do not hinder them and providing them the support to develop and excel once recruited.

"Diversity and Inclusion" is a highly echoed phrase we have all been hearing in the past years, but what first comes to mind when that is said is always women and or ethnicities. There is another type of diversity often overlooked: neurodiversity. Neurodiversity implies the differences in the way a person's brain functions, technically, behaviourally, and socially. A person with typical thinking and behavioural patterns is considered "neurotypical", whereas someone displaying atypical behaviour is "neurodivergent" – this includes autism, attention deficit hyperactivity disorder (ADHD), dyslexia and other conditions.

Have you ever seen someone bounce their legs while focusing on a task? This is often seen in people with ADHD, where repetitive movement can help them concentrate better. What about the person that clicks their pen nonstop? This can be a form of stimming, where a neurodivergent person, often autistic, repeats a movement or sound to calm and manage different emotions, from anxiety to anger to happiness.

Still can't think of anyone with neurodivergent traits? Let us look back at the scientists we all know. Although he had not been diagnosed, Albert Einstein depicted developmental traits very prominent in the neurodivergent society, such as delayed speech and echolalia - the act of repeating phrases to oneself. Autism experts also think Bill Gates is autistic, noticeably so in his motions when concentrating and the monotonous voice in his speeches (History's 30 Most Famous People With Autism, 2022).

While these are the obvious noticeable traits, neurodiverse people have been proven to excel in abilities making them ideal for certain jobs. Take autists as an example, while autism is a spectrum, the mental capabilities of an autist allow them to recognise patterns and complete repetitive tasks, with strong focus and attention to details. This is why companies that offer coding or software testing jobs often look for autistic workers (Walkowiak, 2021).

With all the advantages of having a neurodivergent mind in the workplace, several companies have created a special recruiting process to ensure the exceptional talents are not disadvantaged by the typical recruiting process, created by and for the neurotypicals. Microsoft, for example, devised its Neurodiversity Hiring Program, where after the candidate succeeds in the first -usually online- technical assessment, they are invited to a hiring event that caters for the needs of the candidates in terms of development and preparation for the interview (Neurodiversity Hiring | Global Diversity and Inclusion at Microsoft, n.d.). Another company that created another path for neurodivergent individuals is Ford Motor Company through their FordWorks program. This program actually eliminates the interview from the application process, allowing the prospective employee to showcase their talents in a different way (Ford Program Focuses on Hiring People With Autism | Recruiting News Network, 2020).

The application and recruitment process are not the only way neurodivergent people are accommodated, neurodivergent people sometimes need simple but crucial help, such as minimising unwritten rules. Writing rules down helps provide the clarity and transparency, making it easier for a neurodivergent person to acknowledge and remember them (Neurodivergent: What It Is, Symptoms & Types, 2022). Writing is also handy when giving instructions or asking for tasks to be completed, or simply when communicating as it gives more time to understand and respond accordingly.

Neurodiversity provides a stronger team in the workplace by bringing together people with different mental capabilities, as well as enabling individuals that would often be unintentionally outcast to perform, thrive and excel. While some traits may be perceived as "weird", simply being aware why they are there can change our perception to more accepting and even perhaps embracing, as our differences only pull us upwards.

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Career path planning: Get comfortable with the unknown

With rapid changes in the workplace and Oman taking giant steps towards an energy transition, professionals will likely face growing uncertainties around their career paths which can feel uncomfortable. This article explores how to make peace with uncertainty and its importance for continued self-growth.

So, what happens if things don't go to plan? In Oman, nearly 19% of our total population are made up of young people, including graduates and young professionals who are entering a transitioning labor market.

A recent survey on professionals in the Middle East found that four in five professionals have considered changing their career paths completely; Over 50% said because it was to 'find their real passion'. Opting for a career change can cause 'scary' uncertainty, but why do many of us fear the unknown?

Dealing with the unknown

Researchers have found that any element of unpredictability significantly increases people's discomfort. A psychology professor in Canada, Nicholas Carleton said "In most cases, uncertainty appears to be a core element of anxiety."

But why do we react this way? the brain is constantly trying to predict what will happen next, allowing it to prepare the body and mind in the most effective way possible. However, in a fast-changing world, uncertainty is inevitable. So, how can we make the most of it?

How to take advantage of the unknown

Career uncertainty has proven to have its advantages. Dr. Deepak Chopra, a best-selling author, medical doctor, and a leader in mindfulness said, "Real success is built upon making peace with uncertainty and turning the unknown into a field of creative possibilities."

Discover unexplored possibilities. Not having a fixed destination allows us to think about career paths we may have never considered, unlocking a series of 'creative possibilities' like Dr. Deepak mentioned. So, instead of asking, "How do I get out of this uncertainty?" ask yourself "What does this uncertainty free me up to do that I normally wouldn't?"

Learn from beyond your comfort zone. Greater exposure to what makes us 'uncomfortable' can deliver an environment of learning and growth. Although this may seem like it may alleviate the discomfort initially, research has found that gentle encouragement outside of a person's comfort zone will help us reach a realization that the situation is not as bad as we anticipate.

Be adaptable. In today's changing world, adaptability is an important quality not only for professional growth, but for one's happiness. Jay Shetty, an English author, and life coach said "Just because you make a plan, doesn't mean It can change down the road" Adapting our expectations and knowledge to suit a new reality rather will allow for an easier career transition.

Define your own career. Defining career futures in terms of skills rather than jobs widen the field of career paths and possibilities that a professional can take. Take this 'uncertain' time as a time of reflection; to review current skills, competencies and choices that are more aligned with your passion.

Overall, times of change and uncertainty can be treated like a 'blank canvas'; paint on it what you will, unleash new paths, and keep an open mind.

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How Do I See the Future of Energy Industry of Oman?

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Process Engineer
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The future holds great potential for Oman in the green energy sector. As Oman has set a goal of reaching net zero by 2050, the government has taken big strategic jumps to reach this goal.

The future of Oman as I see it can be divided into three stages. Taking the first stage from today to 2030 many research, trials and pilots are ongoing to measure the full potential of Oman for renewable energy and green Hydrogen production.

Between 2030 to 2040, Industries would begin to shift towards green hydrogen, hence reduce naturally gas consumption. From 2040 till 2050 a great shift will happen in Oman as manufacturers producing cleaner products will have higher demand in the global market. From my point of view I see that great work is done towards green hydrogen and renewable energy production and that Oman would be one of the main providers and exporters of green energy to the world.

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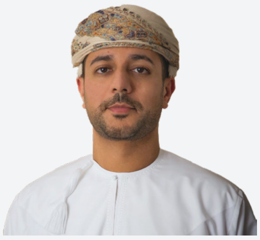
Geology Lab Chemist
Shuram Oil and Gas

As the globe is switching to unconventional sources of power production along with the net zero goal by 2050, Oman chances to create a sustainable energy sector is so high. A lot of new discoveries of gas fields has been launched which can secure the energy for the coming years beside the existing oil production.

Oman also got a high potential of the natural resources to generate a renewable clean power either by direct power generation with solar and wind technologies or with the indirect such as the green hydrogen.

The challenge is will always be with the technologies, investments and proper strategic plan to earn the benefits of all this resources without compromising the need of the coming generations. In my opinion, the courage of the decision making and capturing opportunities is the route of making Oman one of the most dependent centres of energy sector in the region and is the way to achieve sustainable energy future in the country.



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Quality Engineer
Petroleum Development
Oman

Having access to several sources of energy, the outlook of Oman's energy industry remains stable in spite of the Sultanate's commitment to achieve net zero emissions by 2050, in line with the Paris Climate Agreements.
The recent announcement by The Ministry of Energy and Minerals to award long-term concession blocks for green hydrogen developers among other incentives affirms the Sultanate's desire to become a pioneer in this promising industry and its plan of building a hydrogen centric economy by 2040.
Factors such as geographical location close to emerging markets, both renewable and non-renewable energy resources and clear energy policies will surely play a significant role in enabling the Sultanate's capitalization in this sector which will reflect positively on the future of its energy industry.

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Oman is undergoing a major transformation in its energy industry, as the country aims to prepare for the future of energy and reduce its carbon footprint.
The current energy landscape in Oman is dominated by the oil and gas sector, which accounts for more than 75% of the country's total energy production. However, Oman is aware that the demand for oil and gas is likely to decline and is taking steps to diversify its energy mix. In recent years, the country has launched a number of initiatives aimed at developing renewable energy projects such as solar and wind power, as well as green hydrogen initiatives, and maximizing the benefits of Carbon Capture Utilization and Storage (CCUS).
The country has also set a target of net-zero emissions by 2050. In the short term, the oil and gas sector is likely to continue to dominate, but the government will continue to focus on diversifying the energy mix and reducing its carbon footprint. In the medium term, renewable energy sources, hydrogen and CCUS are likely to see significant growth. In the long term, Oman is well positioned to play a key role in the global energy transition, leveraging its strong focus on sustainability and the environment.

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