

CARBON DIOXIDE ENHANCED OIL RECOVERY ROAD MAP (CERM)

Collaboration for Efficiency, Resourcefulness and Maximization

The CERM Project is the innovative collaboration between academic institutions, The University of the West Indies (UWI) and The University of Trinidad and Tobago (UTT), and Government Energy Institutions- The Ministry of Energy and Energy Industries (MEEI), Heritage Petroleum Company and the National Gas Company (NGC) - toward sustainable development of known oil reserves using the technology of Carbon Dioxide Enhanced Oil Recovery (CO₂EOR).

CERM SURVEY RESULTS: PERSPECTIVES ON CARBON DIOXIDE EMISSION REDUCTION

Photo Credit: NGC



TABLE OF CONTENTS

■ CERM Survey	2
■ Test Your Knowledge!.....	4
■ CO ₂ EOR: A View from the Reservoir.....	5
■ Global Outlook On CO ₂ EOR.....	6
■ CERM Updates.....	7
■ CERM Spotlight.....	8

The focus of our 2nd CERM Survey is the opinion of our readers on Carbon Dioxide Emission Reduction in Trinidad and Tobago. The results show that most of our respondents place very high importance on this issue. Given that carbon dioxide emission accounts for the largest proportion of GHG emissions attributed to Trinidad and Tobago, the CERM Project is well placed to address this national concern.

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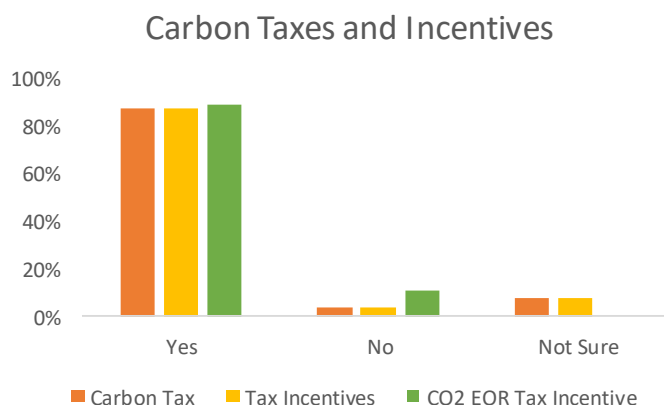
CERM SURVEY | CO₂ EMISSION REDUCTION IN T&T

In our last issue we presented the way forward for Carbon Capture and Utilisation and Storage in Trinidad and Tobago as outlined by Professor Andrew Jupiter at the 24th Session of the Conference of the Parties to the United Nations Framework on Climate Change (COP24) in Katowice, Poland. During a panel discussion Professor Jupiter highlighted the need for capacity building at educational institutions, international partnerships, national climate change workshops, public awareness, local R&D and demonstration projects. We can only move forward with these activities bolstered by the commitment and cooperation of individual citizens, public and private sectors. Our survey questions explore public perception of the efforts in each sphere and possible taxation options to create a fiscal regime for carbon pricing. The Ministry of Planning and Developments estimates that it will cost US\$2 billion for the country to cut CO₂ emissions by 103 million tonnes within the next 12 years. How can this be funded? Let's see what our readers think about the issue.



CO₂ Emission Reduction Tax Incentives or Tax Levy?

Last year when asked if they believed that the Government of Trinidad and Tobago should provide special tax incentives for CO₂EOR, 89% of our respondents supported such a carbon tax incentive, the remaining 11% did not. This year when asked if they would support a tax break for manufacturers which actively reduce their carbon footprint, 88 % of respondents said yes. It is interesting to note that the same proportion of respondents supported taxes to be levied on manufacturers which did not reduce their carbon footprint. Eight percent (8%) were not sure and four percent (4%) did not support tax incentives or tax levies.



These results shows that 1) respondents expect the cost of carbon emission reduction to be borne by manufacturers and, 2) respondents may not differentiate between tax levies and tax breaks. The support for the carbon tax is in keeping with *The U.S. Business Case for a Carbon Tax Forum* held in San Francisco last September. At this forum there was "a strong consensus that pricing carbon pollution is vital...". However, a recent study by Hasegawa et al (2018) warned that if a global carbon tax is implemented in isolation there is possibility that food security will be at risk due to increase cost of production for meats and vegetables and pressure to produce biofuels. We should also consider that the Global Institute for Carbon Capture and Storage (CCS) has found that in developed countries, "subsidies for CCS are implemented more commonly than carbon prices or taxes."

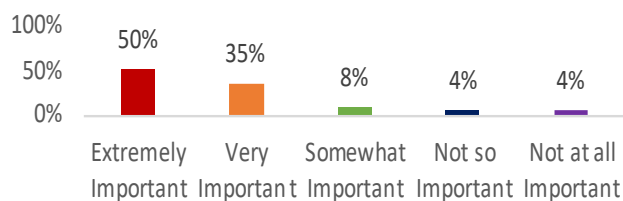


How important is it to reduce greenhouse gas emissions in T&T?

This willingness to levy taxes or provide tax incentives is underpinned by the importance placed on greenhouse gas emission (GHG) reduction. The majority of respondents (85%) believed that it was at the least, *very important*, that Trinidad and Tobago reduces its greenhouse gas emissions. It is also significant to note that 50% believe it is *extremely important* to reduce GHG emissions.

Although Trinidad and Tobago has a high carbon footprint per capita due to its petrochemical sector, overall the country emits less than 0.1% of the world's GHGs. Nevertheless, Trinidad and Tobago has demonstrated its commitment to reduce GHG emissions by ratifying the Paris Agreement on Climate Change. This commitment is in harmony with the importance of our survey respondents attribute to reducing emissions.

Importance of GHG Reduction in T&T



Officers of the Permanent Mission of Trinidad and Tobago to the United Nations displaying Trinidad and Tobago's Instrument of Ratification to the Paris Agreement.

Source: Ministry of Planning and Development



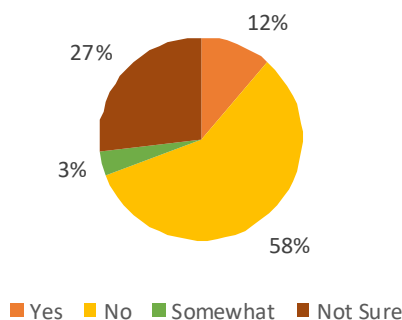
Commitment to action?

Approximately 70% of respondents to the CERM Survey believe that they actively make efforts to reduce their individual carbon footprint on a daily basis. However, there is less confidence in the efforts of the public and private sector. The survey results show that respondents believe that neither the government nor the private sector are making sufficient efforts to reduce the country's CO₂ emissions.

Twelve percent (12%) of the respondents believe that there is sufficient effort by the private sector to reduce GHG emissions, the majority (58%) are sure that there is insufficient effort by the private to reduce GHG. The outlook on the private sector is slightly better than the outlook for the government's efforts with 15% believing there was sufficient effort and 69% say that not enough is being done.

Twenty seven percent 27% indicated that they are not sure that there is sufficient effort by the private sector to reduce GHG emissions compared to 12% in the case of the government.

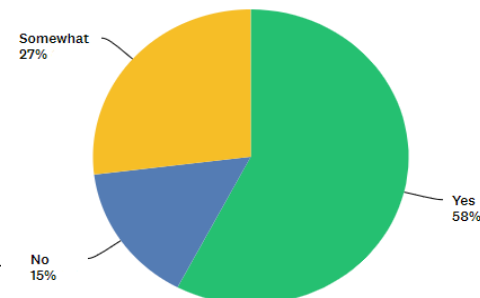
Sufficient efforts to reduce emissions in private sector





Present challenges vs Future Needs?

Given that inaction will more severely impact future generations than current gate keepers we asked the following question: *Do you believe that people under the age of 35 are more concerned about environmental issues than those in positions of senior management?* Fifty eight percent (58%) of the survey respondents believe that decision makers, senior management, are not as concerned about environmental while 15% disagree. The remaining 27% of respondents believed the statement was somewhat true. To place this result in context, bear in mind that sixty two (62%) of respondents to our survey are under the age of 40. Those under age 30 formed the largest age group (42%) .



Taken all together the survey results presents an interesting snap shot of public opinion. Most believe that CO₂ emissions is very important but not enough is being done by the government and the private sector to reduce GHG emissions. More than half believe that the decision makers do not have a sense of urgency or as much concern for environmental issues as entry to mid level employees. These results show that we need to continue the national conversation on what action needs to be taken in the short to medium term and how we can fund our commitment to reduce GHG emissions.

Please visit our website for previous survey results www.thecermproject.com

TEST YOUR KNOWLEDGE!



Have you been keeping up with the CERM Knowledge Series and Fast Facts? See how many questions you can answer correctly! See our website, www.thecermproject.com, for more.

- The main aim of CCS is to reduce global carbon dioxide emissions. True or False?
- The most common method of thermal recovery is _____.
- Enhanced Oil Recovery is also known as secondary recovery. True or False?
- What does WAG stand for?
- Miscibility is the formation of a single phase when two fluids are mixed. True or False?
- What common household oil has an API gravity that is greater than medium crude oil, but less than gasoline?
- Which of the following is not a CO₂ sink: oceans, respiration, forests and soils?
- The reliability of access to CO₂ is a fiscal challenge to CO₂EOR implementation. True or False?
- Which method would recover more oil, Nitrogen EOR or Carbon Dioxide EOR?
- Nitrogen is miscible at reservoir conditions, while carbon dioxide is not. True or False?

Answers:

1. True
2. Steamflooding
3. False
4. Water Alternating Gas
5. True
6. Olive Oil
7. Respiration
8. True
9. CO₂EOR
10. False

CO₂EOR: A VIEW FROM THE RESERVOIR PART I

It is easy to overlook the simple CO₂ molecule; it is inert, colourless and odourless. However, within the reservoir at the right temperature, pressure and oil composition, CO₂ can act as a solvent to recover medium and heavy crude oil. The average person may be surprised that carbon dioxide (CO₂), the gas which we exhale, can help bring oil to the surface. Of course much larger volumes and much higher pressures are needed for oil recovery. You may also be surprised to know that hundreds of millions of cubic feet of this gas is vented to the atmosphere on a daily basis from petrochemical plants and, in Trinidad and Tobago, none of it is currently used to bolster oil production. The good news is that CERM's key stakeholders are committed to harnessing CO₂ emissions for good use.

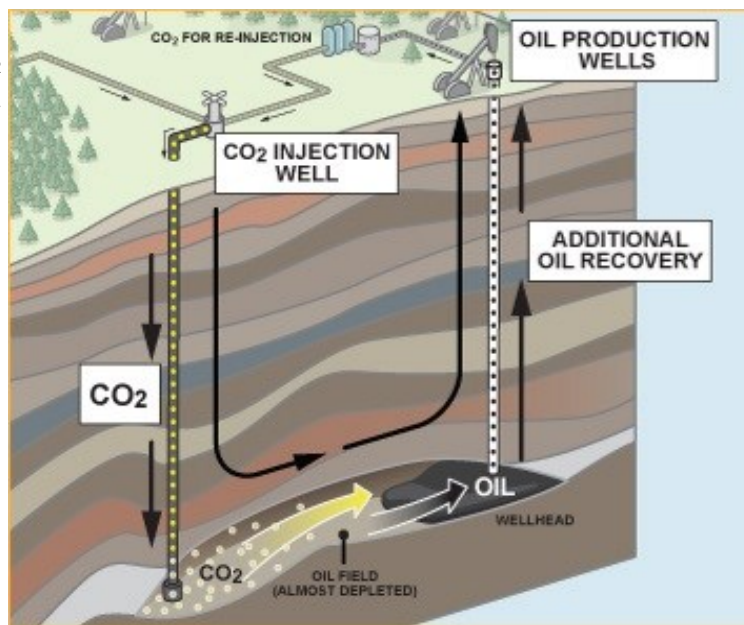
Crude oil is held within the pores of reservoir rock by capillary and viscous forces. There are several ways to reduce these forces and release oil from reservoir rock. Capillary forces, the forces that allow a liquid to find equilibrium in a drinking straw, can be reduced by changing the interfacial tension between crude oil, water and rock grains. Viscous forces can be reduced with the addition of heat or a solvent. For example, crude oil can be removed from the rock using soap-like chemicals (surfactants, alkali), heat (steam) or certain types of volatile liquids (alcohol or light hydrocarbons).

CO₂ can also be used to displace crude oil from the pore spaces of reservoir to a production well. The primary mechanism of microscopic displacement is the dissolution of CO₂ in crude oil. When CO₂ dissolves in oil, the oil swells and oil viscosity decreases. The extent of dissolution is controlled primarily by the reservoir pressure, crude oil composition and CO₂ concentration.

If the reservoir pressure exceeds a threshold known as the minimum miscibility pressure (MMP) CO₂ is completely soluble in crude oil and the process is described as a miscible displacement. An immiscible displacement process occurs when that threshold pressure is not achieved for the given crude oil composition with pure CO₂.

An immiscible displacement process can become a miscible process if a different fluid mix is

injected into the reservoir. In other words, we can manipulate the threshold pressure, the MMP, by changing the concentration of CO₂ and other additives in the injection stream. A relatively small amount of liquefied petroleum gas (LPG) can lower the MMP. Conversely, nitrogen and methane injected into the reservoir increases the MMP.



Source: Clean Air Task Force, available at: http://www.coal-transition.org/pages/carbon_storage/30.php

GLOBAL OUTLOOK | CO₂EOR



Bahrain

In February this year, OilandGas.com Middle East reported that Bahrain's Oil Minister, Shaikh Mohammed bin Khalifa Al-Khalifa, formally met with Saudi Aramco's Chief Technology Officer (CTO), Ahmad Othman Al-Khowaiter. The meeting facilitated the signing of an agreement to begin cooperation to increase oil production and "leverage carbon dioxide injection technologies". The cooperative effort will encompass a CO₂ transport and distribution network.



Source: Power Engineering International

Photo credit: OilandGas.com (Middle East)

Abu Dhabi

The Abu Dhabi National Oil Company (ADNOC) operates Al Reyadah (pictured above) is the only commercial Carbon Capture Utilisation and Storage (CCUS) operating in the region. Al Reyadah has the capacity to capture 800,000 tons of CO₂ per year from the Emirates Steel Industries. At the International CCUS Summit held last November, ADNOC's Executive Director, Omar Suwaina Al Suwaidi stated: " Not only does the technology help address environmental concerns by safely locking away CO₂, but it also enables valuable and cleaner burning gas, previously used to enhance oil recovery, to be leveraged for other purposes." He also announced the expansion of CO₂ capture, storage and utilization at the Habshan-Bab gas processing facility or the Shah gas plant.



Continued from page 8

Fuel switching is one of the strategies adopted by the Government to reduce the country's CO₂ footprint. Reducing the national fuel subsidy bill is a major driver in the promotion CNG as an alternative to traditional fuels. NGC CNG has estimated that a fuel subsidy of \$1.5 billion can be avoided in the next five years with the conversion of taxis, maxis and fleet vehicles.



NGC CNG Company Limited is a subsidiary of the National Gas Company of Trinidad and Tobago Limited

CERM UPDATES | SCM & GOALS

5th CERM Steering Committee Meeting

The Fifth Steering Committee Meeting (SCM) of the CERM Project was held on January 29th, 2019. The meeting was chaired by co-Chairs Wayne Bertrand (UWI) and Dr. Donnie Boodlal (UTT).



Outgoing CERM Steering Committee Co-Chair, **Dr. DAVID ALEXANDER** (UTT)

Dr. Boodlal replaces Dr. David Alexander as co-chair appointed to the Steering Committee to represent UTT. We take this opportunity to thank Dr. David Alexander for his invaluable contribution to the CERM Project. Dr. Alexander has been instrumental in the formation and the guidance of the CERM Steering Committee from the very beginning.



Incoming CERM Steering Committee Co-Chair, **Dr. DONNIE BOODLAL** (UTT)

We welcome Dr. Donnie Boodlal as CERM co-chair, he is the Working Group Leader for the CO₂ Capture Working Group and has

been a Steering Committee Member for the past two years. We look forward to his leadership in his role as Co-Chair of the Steering Committee.

2019 Goals

The CERM Steering Committee has established five goals for 2019 which were highlighted in our last CERM Newsletter, the February 2019 issue. We have already made progress in key areas including two CO₂ Transportation Studies conducted by the Chemical and Process Engineering Unit of the Chemical Engineering Department, UWI.



CERM SPOTLIGHT | THE CNG SWITCH

Compressed natural gas (CNG) can be used as an alternative fuel to gasoline and diesel in combustion engines. Although CNG is a fossil fuel like traditional fuels it is more efficient, emits about 30% less carbon dioxide and, in Trinidad and Tobago, costs 70-80% less than super gasoline and diesel.

The National Gas Company of Trinidad and Tobago (NGC) has been give the task to “accelerate and expand the use of CNG” in Trinidad and Tobago. The focus of the first phase has been the construction of fuel stations and conversion of vehicles. There are now 17 refueling stations across both islands and several promotions have been held to incentivize the switch to CNG (Continued on page 7)



Pump price (TTD/litre) in Trinidad and Tobago as of May 2019

Photo Credits: NGC CNG

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