

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, toward sustainable development of known oil reserves using the technology of Carbon Dioxide Enhanced Oil Recovery (CO₂EOR).



CO₂EOR: OPPORTUNITY FOR A NEW GENERATION

The CERM Project is an opportunity for rebuilding and expanding local expertise in CO₂EOR with a new generation of Engineers and Geoscientists. Many current team members have cross discipline training between petroleum engineering and geoscience, petroleum and mechanical engineering, and petroleum and chemical engineering. The CERM Project spans upstream, midstream and downstream operations: downstream operations focused on carbon capture, carbon emission accounting and carbon dioxide processing; midstream operations encompassing CO₂ collection and distribution and;

upstream operations targeted at subsurface characterization, well completions, CO₂ injection and fluid production facilities. The structure of the CERM Project will effectively use and develop local expertise and in doing so, reduce reliance on foreign CO₂EOR consultants. The new generation of professionals involved in the CERM Project will be able to share their CO₂EOR expertise within their respective organisations, eventually transferring knowledge throughout the energy industry.

Executive Editor

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At the time of publication, Petrotrin has been re-established under the new name – the **Trinidad Petroleum Holding Limited** – with four subsidiaries including Heritage Petroleum Company Limited. CO₂EOR projects are likely to fall under the Heritage Petroleum Company Limited which is charged with the “business of exploration, development, production, and marketing of crude oil”. If the Heritage Petroleum Company undertakes a vigorous drive to increase production, it is quite likely, that based on work previously undertaken by Petrotrin and recommendations of independent consultants and academics, that CO₂EOR will be considered for implementation.



Collaboration has been one of the pillars of the CERM Project from inception. Effective CO₂EOR requires collaboration through the value chain of CO₂ capture, compression, distribution, injection and co-production with oil and water. The cross disciplinary training of CERM Working Group members is perfectly suited to the challenge of integrating the process seamlessly from downstream to upstream operations. We have already begun to experience the benefits of synergy among the various institutions in our approach to planning, identifying hurdles and working toward effective solutions. Each stakeholder brings expertise, human and physical resources to the table so that efforts are not duplicated and the right checks and balances are undertaken in a timely manner among professionals. It is reasonable to expect that small operators may be involved in CO₂EOR and as such

opportunities can be generated in private companies within the energy sector industry. The structure of the CERM Project takes advantage of opportunities for early dialogue with the regulatory bodies of the energy sector. At the planning stages it is crucial to educate and advise state and private operators on safe and compliant practises. The anticipated coordinated efforts among all stakeholders is intended to reduce cost, and safety and financial risks. Employment opportunities are eagerly anticipated by recent graduates and many others who have been affected by the downturn in the energy sector. Carbon capture, transportation, utilization and storage requires expertise in engineering, geoscience, project management etc. to facilitate planning, implementation and operation at each stage. Apart from technical operations, public engagement and education require public relations, and safety and environmental studies targeted to introducing the application of CO₂EOR to the fenceline community.

The CERM Project is an opportunity for rebuilding and expanding local expertise in CO₂EOR with a new generation of Engineers and Geoscientists.



Photos courtesy UWI Marketing and Communications.

Left: Anastasia Baboolal receives her PhD in Geoscience from Professor Sir Hilary McD Beckles.

Right: Alix Eversley receives his BSc in Petroleum Geoscience at UWI Graduation Ceremony 2018.

So, what is standing between where we are now and where we envision Trinidad and Tobago to be with CO₂EOR? In short, clearly defined policy and immediate action. A survey conducted by the CERM Secretariat in May 2018 indicated that while over 90% of respondents agree that CO₂EOR can economically increase the country's oil production, 30% do not believe that CO₂EOR will be implemented in Trinidad and Tobago, even if the price of oil rises above US\$70/bbl in the next 3 to 5 years. These results show that while there may be

confidence in the technical and economic feasibility in the project, there is less confidence in other factors which determine whether or not CO₂EOR is implemented. A possible reason for this outlook is the absence of fiscal policy specifically for CO₂EOR and possible delays associated with the restructuring of the resource holder (CERM Newsletter Volume 1 Issue 4). Clearly defined policy and action by CERM's key stakeholders will signal to investors that CO₂EOR will be implemented in the short to medium term.

CERM | UPDATES

4th CERM Steering Committee Meeting

On August 15, 2018, the 4th CERM Steering Committee was held at the Ministry of Energy and Energy Industries, International Waterfront Centre, Tower C. Representatives from the majority of the key stakeholders were in attendance, including co-chairs Dr. David Alexander (UTT) and Distinguished Fellow Wayne Bertrand (UWI), Mrs. Penelope Bradshaw-Niles (Permanent Secretary, MEEI), CERM Project Coordinator, Dr. Lorraine Sobers (UWI) and Mr. Ramesh Chansingh (NGC).

Updates were provided on the MOU signing, the CERM Project Logical Framework and the CO₂EOR Process Mapping. The Steering Committee has agreed to meet again in November to assess the way forward in light of the changes being made to Petrotrin. The Steering Committee has also endorsed the launch of the CERM Website and Social Media (see back page).



CERM Project Coordinator
Dr. Lorraine Sobers

Climate Change Discussion



His Excellency
Serge Lavroff

The CERM Secretariat attended a Diplomatic Dialogue hosted by the UWI Institute of International Relations, and the Diplomatic Academy of the Caribbean (DAOC) in collaboration with the Embassy of France in Trinidad and Tobago on the topic, **Climate Change: A Challenge to Stability and Security in the World of Tomorrow. The Urgent Need for Climate Diplomacy** by His Excellency Serge Lavroff, Ambassador, Embassy of France. Issues discussed ranged from the impact of climate disasters on Small Island Developing States (SIDS) as well as the proposed implementation of a Climate Smart Zone in the Caribbean.

CERM Stakeholder Update | NGC Supports Future Energy Professionals

The National Gas Company of Trinidad and Tobago (NGC) is resolute in their commitment to sustainability within the energy sector. The following is a press release from NGC, highlighting the company's support of future energy professionals while honouring pioneers of Trinidad and Tobago's Energy Industry:

Trinidad and Tobago owes its success as one of the world's leading energy producers and exporters to the work of dedicated, pioneering individuals who led the way in the evolution of our energy industry, such as the late Trevor Boopsingh. The National Gas Company of Trinidad and Tobago Limited (NGC) in recognition of the important role of Mr. Boopsingh and other pioneers in the energy industry who laid the foundation for our current energy industry, established **The Trevor Boopsingh Energy Studies Scholarship Fund**. NGC has to date contributed TT\$1,000,000.00 to this fund, which will provide support to three undergraduate and one post graduate student annually for the period 2018-2024.

These scholarships provided to successful candidates forms part of NGC's Memorandum of Agreement (MOA) with The UWI that establishes the Trevor Boopsingh Energy Studies Scholarship Fund. The MOA, for the 2018-2024 period seeks to provide financial assistance to students in the energy and petroleum sectors. Specifically, Petroleum Engineering; Chemical Engineering; Civil Engineering with Environmental Science; Environmental and Natural Resource Management; Environmental Science and Environmental Science and Natural Resource Management. The Fund will not only assist the students financially with their academic studies but will also provide them with the opportunity to participate in NGC's undergraduate internship programme during the July/August vacation period. As such they will receive invaluable practical experience in the energy sector and the chance to learn from the best experts in their respective fields. The 2018 awardees, **Renisha Hercules**, **Vikki Lee** and **Jenna-Leigh Metivier** were recipients of three scholarships at The UWI's Undergraduate Awards Ceremony for Scholarships and Bursaries held at the university's campus recently.

FAST FACTS: CARBON CREDITS VS TAX



Carbon Credits

- * Can be standardized across regions
- * Provides the potential for rewarding operators that use few credits
- * Price controlled by market fluctuations
- * Allows operators to control their investment cost
- * Emissions may eventually be controlled and even reduced

Carbon Tax

- * Tax regimes specific to each government
- * Can be seen as a penalty instead of a reward
- * Tax rate regulated by governing body
- * Cost would not be controlled by operator
- * Emissions would continue to vary over time



RESEARCH AT UWI

Reservoir Studies (2014-2018)

CO₂EOR has been the topic of research for Faculty and Postgraduate students over the past fifteen years. Here is a sample of M.Sc. Petroleum and Reservoir Engineering research topics undertaken by graduates in the past five years.



Engineering Graduates at UWI Graduation 2018 (Photo courtesy UWI Marketing and Communications)



Cassandra Dewan

Evaluation of the Effect of Water Salinity, Water Viscosity and Injection Strategy on Heavy Oil Recovery as well as CO₂ storage in the Forest Reserve Field **(SPE Paper No. 191167)**

Kadija Hassanali

A Numerical Study of the Impact of Reservoir Permeability on Oil Recovery and Carbon Storage during CO₂ Huff and Puff Operations in Trinidad Heavy Oil Reservoirs



Janos Bobb

An investigation into the combination of Cyclic Steam Stimulation and Cyclic CO₂ Stimulation for Heavy Oil Recovery in Trinidad and Tobago **(SPE Paper No. 191161)**

Karuna Ramasray Moonan

An Investigation into the Viability of Steam Assisted Gravity Drainage Modified for Dipping Heavy Oil Reservoirs of the Manzanilla Formation, Soldado East Field **(SPE Paper No. 180793)**



Kabir Geerah

Comparison of the performance of CO₂EOR and CO₂ followed by Steam EOR for a Heavy Oil Reservoir

Sophia Jones

Comparison of the Impact of Dip and Vertical Transmissibility on Oil Recovery and Carbon Storage Using Water Over Gas Injection in the Forest Reserve Field, Trinidad **(SPE Paper No. 169961)**



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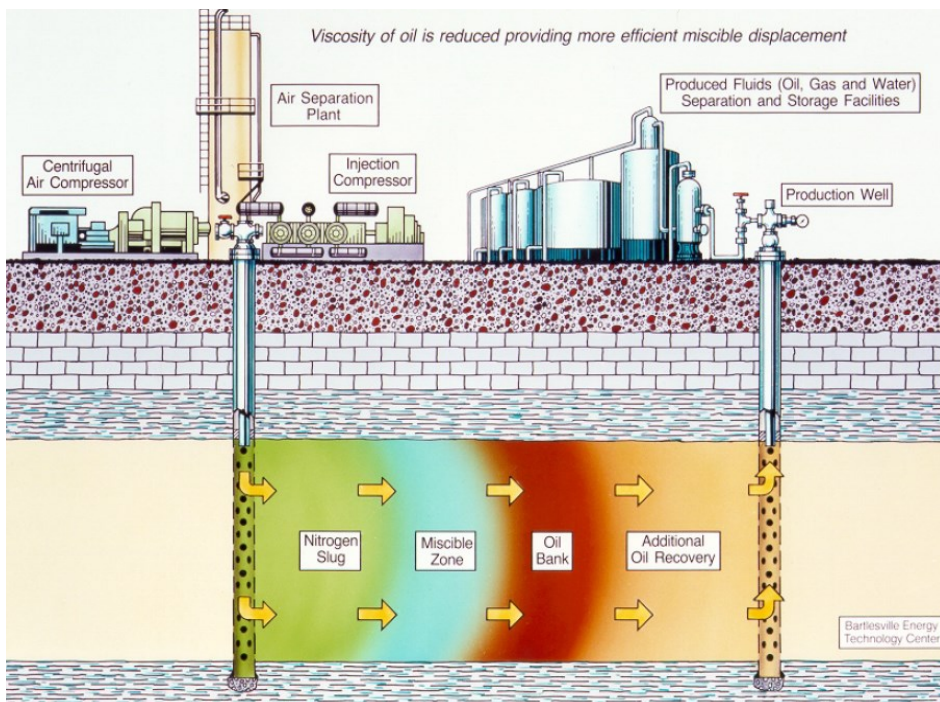
ENHANCED OIL RECOVERY METHODS

Nitrogen Injection

The use of nitrogen as an enhanced oil recovery method has been proven by a number of successful worldwide N₂ injection projects in the United States, Mexico and the North Sea. Nitrogen has poor solubility in oil and a lower viscosity than carbon dioxide, but its abundant supply, inert and non-corrosive nature; low production costs, and increased production makes it a viable option for both onshore and offshore EOR. Nitrogen flooding is suited for deeper reservoirs, (> 5,000 ft) due to the high injection pressure necessary to achieve miscibility, and light oil reservoirs (> 35 API) which are low in methane, but rich in ethane through hexane. It can also be used as a chase gas in miscible hydrocarbon or carbon dioxide floods.

Both N₂ and CO₂ have good potential for onshore and offshore gas injection. One major advantage of CO₂ over N₂ would be the potential for CO₂ sequestration and it's positive environmental impact. The table below highlights some of the differences between nitrogen and carbon dioxide injection.

Carbon Dioxide	Nitrogen
* Generally will recover more oil than N ₂	* Generally won't recover as much oil as CO ₂
* CO ₂ EOR reduces total carbon emissions	* Nitrogen EOR does not reduce carbon emissions
* Miscible or immiscible at reservoir conditions	* Immiscible at most reservoir conditions
* Cannot be generated offshore	* Can be generated offshore



Schematic diagram of N₂ flooding. Source: National Energy Technology Laboratory

How it works?

It is possible to generate miscibility at high pressures and through multiple contact with the in situ crude oil. Nitrogen recovers oil by vaporizing the lighter components of crude oil or through hydrocarbon enrichment.

Oil can also be produced by the gas drive mechanism in low pressure reservoirs.

At the surface produced nitrogen can be easily separated from produced oil.

GLOBAL OUTLOOK

COP 24: United Nations Climate Change Conference, Katowice, POLAND



This year, COP24 will take place from 3rd – 14th December 2018, in Katowice Poland. COP24 is the abbreviated title for the 24th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC). The main goals of COP24 will be to:

- 1) coordinate a plan that ensures the effective implementation of the Paris Agreement and
- 2) to facilitate discussions to support the implementation of national commitments.

TRINIDAD AND TOBAGO

Trinidad and Tobago has ratified the Paris Agreement and has declared its the Intended Nationally Determined Contribution (INDC) "to reduce overall emissions in the power generation, transportation and industrial sectors by 103 million tonnes of equivalent CO₂ emissions". Trinidad and Tobago has also committed to reducing public transport emissions by "an equivalent of 1.7 million tonnes by 2030".

CARIBBEAN SMALL ISLAND DEVELOPING STATES (SIDS)

All CARICOM countries are classified part of the SIDS. Each of these countries has their own intended nationally determined contribution, including a commitment to renewable sources of energy for electricity and transportation. While CARICOM SIDS are not the most significant contributors to global carbon dioxide emissions, they are more likely to experience the negative effects of climate change. The location and economic states of these SIDS make them vulnerable to climate-related natural disasters and coastal threats associated with sea-level rise (SLR).

CLIMATE NEUTRALITY

The Paris Agreement calls for climate neutrality, which is a sustainable approach to climate change that simultaneously allows for reduced emissions and preservation of national economies. A climate policy that calls for climate neutrality instead of total decarbonisation allows countries whose economies rely heavily on industrial processes that produce greenhouse gases to still function, as long as there are alternative means of reducing CO₂ emissions.

Poland, one third of which is occupied by forests, is on its way to achieving a balance between carbon dioxide emissions and sequestration by soils and forests. Their project, *Forest Carbon Farms*, makes use of previous scientific research that planting specific tree species can enhance the CO₂ absorption capacity of forests. At COP24, Poland will present their progress towards climate neutrality as well as propose new research on the economic impacts of CO₂ sequestration by forests as it pertains to the sustainable development of the world.



Photo Source: Green European Foundation

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