

**White Paper**  
**The Greening of the Conventional Oil Industry – Meridian Energy Group, Inc.**  
Green Investment Highlights

## Introduction

Meridian Energy Group, Inc. was formed by a group of North Dakota residents who wanted to create job opportunities in their home state. The company that they formed is now building the Davis Refinery in North Dakota, and now has plans to build similar facilities in other shale basins in the US. The Davis Refinery (*"Davis"*), is a 49,500 barrels per day full-conversion crude refinery in Billings County, North Dakota - heart of the Bakken. Davis is the:

- ❖ First full-conversion refinery built from the ground up in the US in over 40 years;
- ❖ Cleanest refinery ever built anywhere in the world, producing the cleanest fuels in the US
- ❖ First major refinery built by a development-stage firm; and,
- ❖ Model for additional similar refineries in other Shale Basins.

Davis has the distinct advantage of being a greenfield, innovative, advanced technology project, which will be the most efficient, smartest, ultramodern refinery ever built. It utilizes a distributed business model, self-funded and completely independent in its design and operation. The Davis Refinery will serve as Meridian's winning formula in future Shale Basin projects into the coming years.

In developing Davis, Meridian created valuable trade secrets and corporate know-how relating to the design and operation of compact and environmentally benign refineries serving niche markets and able to achieve early cash flows via faster air quality permitting as a Synthetic Minor Source (*"SMS"*) see table 1. Meridian was issued the Permit to Construct by the North Dakota Department of Health (*"NDDoH"*) – Air Quality Division in June of 2018. Meridian intends to enhance shareholder value by applying this know-how to additional projects in other domestic shale basins.

## Discussion

The Davis Refinery is designed to meet the requirements of the State of North Dakota's Department of Health in connection with major areas of environmental concern, including air and water quality and waste disposal.

The Davis physical and operational design includes implementation of state-of-the-art, lowest achievable emission rate (*"LAER"*) technology, and air pollution control equipment considered best available control technology (*"BACT"*) to minimize emissions throughout the plant. The refinery's physical and operational design even includes BACT requirements and controls that would be considered maximum achievable control technology (*"MACT"*).

A greenfield refinery like the Davis Refinery is not burdened with the need to make the new operating units work in conjunction with pre-existing legacy operating units that might also represent old technology. This will ensure that the Davis plant can leverage the latest technology from the ground up and can much more easily and efficiently comply with modern environmental and safety requirements.

Clean fuels technology refers to the application of modern chemical and process design, information and controls technology, and environmental engineering to ensure that the Refinery operates with minimal waste and inefficiency. Clean fuels technology leveraged in the Davis Refinery will ensure its operation and products comply with all regulatory requirements.

The Davis Refinery is designed to already meet EPA standards thru 2020, including:

- Gasoline & diesel already exceed EPA Clean Fuels specs. These specs are a challenge to older refineries, requiring

large on-going investment.

- Residual oil will qualify as low-sulfur fuel oil. This will allow for sales into the marine bunkering market in the Great Lakes, Gulf Coast or West Coast for the foreseeable future.

The Davis Refinery has a high Nelson Complexity Index (>9), enabling the Refinery to respond to further tightening of regulations as well as even the most complex domestic refiners. For reference, topping plants have a Nelson Complexity Index of 2 – 4, full conversion refineries are 5 – 10, and highly complex refineries are 10 -15.

## **Permit to Construct as Synthetic Minor Source**

### **Control Solutions - Advanced Technology**

An example of how Meridian will ensure the required strict air quality standards are met, a comprehensive and enhanced Smart LDAR program will be used to monitor fugitive emissions throughout the plant. This innovative solution greatly exceeds the current minimum regulatory requirement, which mandates periodic (monthly or quarterly) walkthroughs of the facility to monitor each potential source of unintended leaks, leveraging a hand-held screening device, and for repairs to be completed within a certain timeframe. Unintended leaks usually account for a large percentage of hydrocarbon emissions at refineries.

For this reason, and to minimize the potential for unintended leaks at the Davis Refinery, Meridian's LDAR program will utilize OGI (Optical Gas Imaging technology) to continuously scan the facilities. Because fugitive gases are normally invisible to the human eye, OGI cameras employ specialized infrared filters which allow them to "see" gas should it ever escape. The Smart LDAR proposed by Meridian will allow automated early detection and notification of unintended leaks as they appear, and the visual confirmation provided by OGI will be extremely useful in pinpointing the exact source to begin the repair process immediately. Since 2015, OGI has been identified by the US EPA as the "Best System of Emission Reduction" for detecting fugitive emissions from new equipment installation, upgrades, and modified sources.

### **Software systems**

The Davis Refinery will utilize the latest generation of digital technology from the ground up to provide the most efficient and powerful data handling environment. This will include technologies such as a wireless smart grid, advanced process control, integrated field data management and predictive analytics to optimize the operation in real-time. In totality, these systems will generate intrinsic benefits in equipment reliability, health and safety, and environmental compliance.

### **Waste Gas Recycling**

In addition, the Company has designed major aspects of the Davis refinery systems to incorporate vapor capture to minimize fugitive emissions from the plant. Again, the combination of these efforts resulted in the ability to pursue permitting of this facility as a synthetic minor source. These methods and calculations have been confirmed by both engineering and permitting teams responsible for making the Davis Refinery an operational reality.

Technology has changed a great deal over the past forty years, and the Davis Refinery will operate with almost no flaring at all. Forty-year-old refineries flared their waste gases, while Meridian's innovative design will capture those gases via a vapor recovery unit and recycle them for use in running our heater and boiler systems. As detailed in the Permit to Construct documents and engineering backup, flaring will only occur during unusual conditions and be limited to a maximum combined total of a 168 hours per year.

The main difference in Meridian's design, versus what is typically found in older refineries, is that the elevated flare stacks will merely be a backup system, in case of upsets or malfunctions, to the ground-level enclosed flare. And even the

enclosed flare is a backup to the refinery wide vapor recovery system, which is to be designed to capture any minor relief flows from normal Davis operations. Therefore, during normal operating conditions, the flares are not expected to be burning any gases except for the natural gas required to keep the pilots lit. This is what the regulators refer to as a cascaded flare system.

### **State-of-the-art Environmental Technology**

Heaters will be equipped with low NOx burners that will greatly reduce NOx during the combustion process. Additionally, Heater stacks will have Selective Catalytic Reduction converters that uses a catalyst reaction technology to greatly reduce the NOx emissions in the flue gas. Those heater stacks will have flue gas analyzers equipped with zirconium oxide sensors that will help monitor and control heater stack emissions.

Davis Refinery piping & equipment flanges will be torqued per API torquing specs to help greatly reduce the amount of VOC emissions from the site. Further, pump suction strainer piping will have 2" drains to enable debris to be quickly & easily washed off the screen rather than have to steam the pump hydrocarbons to the flare before physically taking the piping apart to remove the screen for cleaning.

### **Refined Product**

By building the Davis Refinery close to the oil producers, Meridian can enter into long-term supply arrangements with producers that make them stronger financially, and at the same time reduce its feedstock costs substantially. This will also enable Meridian to provide local and regional fuel consumers with additional competitive choices, which will result in reduced costs and increased service levels to those consumers.

## **Carbon Investment**

### **Green House Gases**

In order to understand the dynamics of CO2 emission reductions and mitigation choices, it is important to study the abatement costs of possible mitigation options of CO2 emissions at refineries. Abatement cost (\$/tCO2e) is a measure of reducing pollution and represents the net cost per ton of CO2 reduction over the lifetime of the measure. Meridian estimated the abatement cost (\$/mt CO2) for the Davis Refinery and for typical gulf coast refineries for using new technology to replace older technology. The estimated abatement cost for the Davis Refinery case is \$15.15/mt CO2e and for a typical refinery case it is \$26.84/mt CO2e. The lower cost is attributed to using all new technology on the entire plant from the start and also for a lower overall capital cost basis.

The total reduction in GHG emissions in mt CO2e for every one-million-dollar investment shows that Davis total CO2 emission reduction potential is 2200 mt CO2e, while a typical refinery has a reduction potential of 1242 mt CO2e. Davis Refinery is more cost effective at CO2e reduction than any other refineries studied and is more cost effective than wind (least GHG reduction potential at 1212 mt CO2e) or solar (GHG reduction potential at 1786 mt CO2e) technologies. The only technologies more effective than Davis are geothermal (GHG reduction potential at 3571 mt CO2e) and plug-in hybrid electric cars (highest GHG reduction potential of 4916 mt CO2e, when accounting for the emissions of the electric power generation).

The North Dakota Davis Refinery has the lowest emission rates for NOx, CO, SOx, VOC, PM 2.5, PM 10 and GHG emissions compared to typical gulf coast refineries.

Table 1

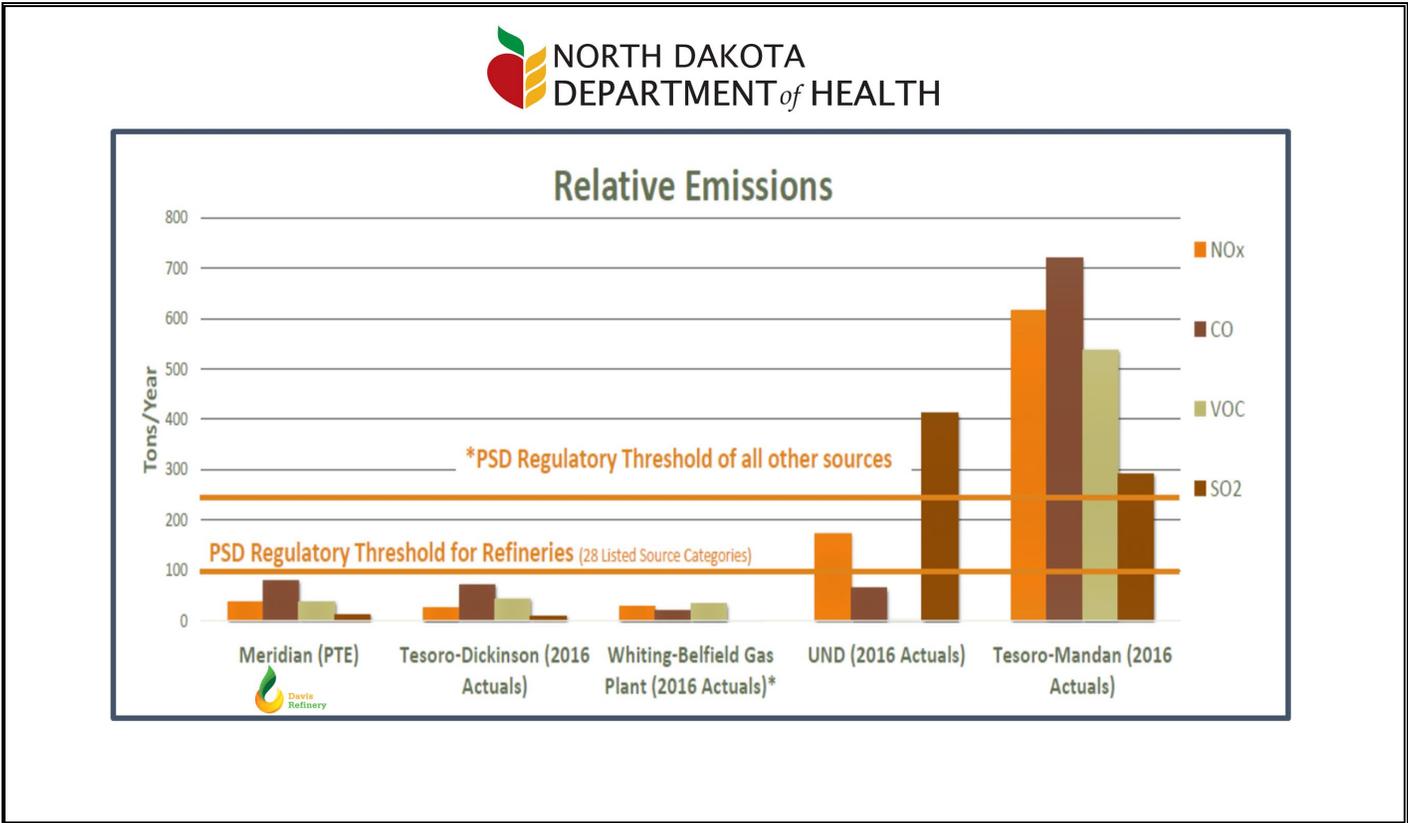


Table 2



### Theodore Roosevelt National Park

Average (2013-2017)		Emissions, Ton per year (TPY)			
Traffic Count	Total Vehicle Miles	Hydrocarbons (as VOC)	CO	NOX	PM Tot
96,850	1,743,300	70	904	313	313

Estimated emissions from Meridian Refinery at full production **49,500 bpd**

#### North Dakota Davis Refinery

Emissions, Ton per year (TPY)			
Hydrocarbons (as VOC)	CO	NOX	PM Tot
62	80	39	13

**Table 3**

Table 1: Total reduction in GHG emissions (mt CO<sub>2</sub>e) for every one-million-dollar investment.

<b>Technology</b>	<b>Assumed Life Span (years)</b>	<b>\$GHG Abatement Cost / mt CO<sub>2</sub></b>	<b>\$ 1million Investment will result in reduction of GHG emissions in mt CO<sub>2</sub>e</b>
<b>High Penetration Wind</b>	25	33.00	1212
<b>Typical Refinery</b>	30	26.84	1242
<b>Nuclear</b>	40	14.00	1786
<b>Solar-Photovoltaic</b>	20	28.00	1786
<b>Low Penetration Wind</b>	25	19.60	2041
<b>Davis Refinery</b>	30	15.15	2200
<b>Geo-Thermal</b>	50	5.60	3571
<b>Cars Plug-in Hybrid</b>	10	15.40	6494