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April 9, 2018

The Honorable John Barrasso
Chairman, Committee on Environment and Public Works
410 Dirksen Senate Office Building
Washington, DC 20510

The Honorable Tom Carper
Ranking Member, Committee on Environment and Public Works
456 Dirksen Senate Office Building
Washington, DC 20510

Ref.: Committee deliberations on the USE IT Act

Dear Chairman Barrasso and Ranking Member Carper,

I support this legislation and give it due consideration. Carbon dioxide (CO_2) is the waste from the combustion of fossil fuels and is a valuable feedstock for the conversion to fuels such as Ethanol, Methanol, Gasoline, Diesel, and/or Jet Fuel.

CASE-I. APPLICATION OF CO_2 TO THE PRODUCTION OF ETHANOL:

Subject: Application of B-T-E's Patented SMR+® CO_2 Conversion Technology to Corn-Ethanol Plant; Increasing Ethanol Production from Corn-Ethanol Plant by converting byproduct CO_2 Emissions from the Corn-Ethanol plant to Ethanol; **[Grant for Feasibility Study]**

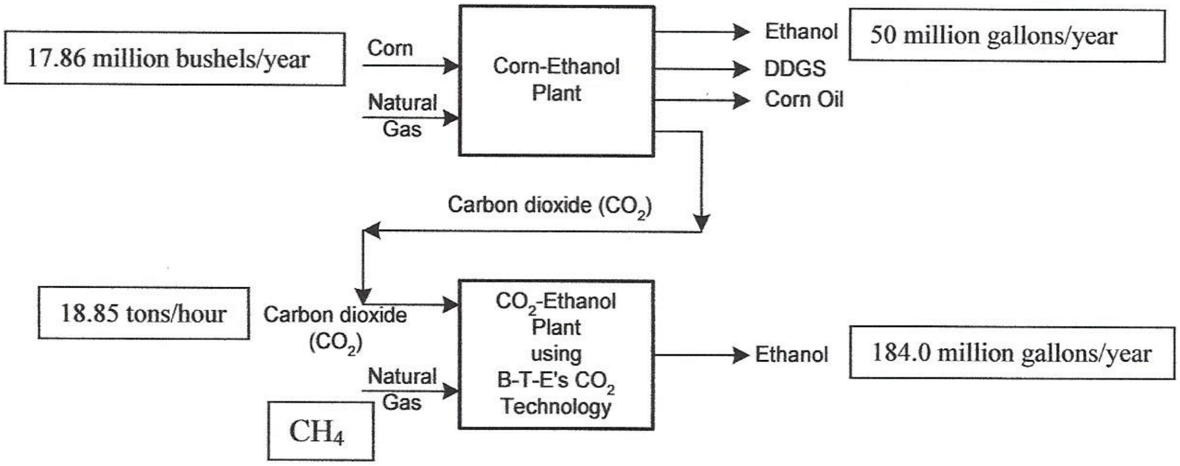
Executive Summary: B-T-E's patented SMR+® technology increases Ethanol production from a Corn-Ethanol plant by converting byproduct CO_2 emissions into additional Ethanol. This patented technology applies to site specific location by building or utilizing an existing Corn-Ethanol plant in an area and by constructing a CO_2-Ethanol plant adjacent the Corn-Ethanol plant. **This new technology will financially benefit the site specific location and create over 100+ jobs.** A facility with a combination of a Corn-Ethanol plant and a CO_2-Ethanol plant should be considered by conducting a feasibility study to determine site specific economics for a site specific location. **[Grant for Feasibility Study for a Site Specific Location.]**

B-T-E's patented CO_2 conversion technology has seven (7) U.S. patents, one (1) Canadian patent, one (1) Japanese patent, one (1) Indian patent, one (1) Brazilian patent, twelve (12) European patents, and other patents pending. **B-T-E owns and holds the rights to the Patented B-T-E CO_2 Conversion Technology.**

A patented SMR+® technology increases Ethanol production from a Corn-Ethanol plant by converting byproduct CO_2 emissions into additional Ethanol. As illustrated below, CO_2 emissions from a Corn-Ethanol Plant are converted into additional Ethanol in the CO_2-Ethnaol Plant using B-T-E's patented CO_2 conversion technology. The combined plant operations would make it the most efficient Ethanol facility in the United States.

Description and Preliminary Economics of Corn-Ethanol Plant & CO_2-Ethanol Plant Facility:

1. **An illustration of a Corn-Ethanol & CO_2-Ethanol Facility is shown below:**



CO_2 + CH_4 + H_2O → Reformer (SMR+®) → Syngas (CO & H_2) → Ethanol (Fermentation Process - Commercially existing)

2. **Preliminary Economics are shown by considering the additional cash revenue to the bottom line of an Ethanol Facility using B-T-E's SMR+® patented technology. Case below will be presented for the Ethanol Facility and will use the CO_2 emissions from a 50 MM GPY Corn-Ethanol Plant. Carbon dioxide (CO_2) emissions from the 50 MM GPY Corn-Ethanol plant are 18.85 tons CO_2/hour.**

   Case: Economics of a CO_2-Ethanol Plant, B-T-E's SMR+® Catalytic CO_2-Ethanol Process: Production cost includes CAPEX (ISBL & OSBL) and OPEX (includes Labor & Maintenance), **Natural gas at $2.733/MM** Btu, and **Electricity at $0.0693/kWh**. Capital considered at 6% for 20 years. A Greenfield plant was considered with the OSBL/ISBL at 0.50 ratio.

<u>CO_2-Ethanol Plant:</u> 184.0 MM GPY **(B-T-E's SMR+® Catalytic CO_2-Ethanol Process);**
Production Cost = $0.490/gallon Ethanol produced
(30.7 MW of Utility Power, Net Export to the GRID.)

SMR+® CO_2-Ethanol Process: CO_2 + CH_4 + H_2O to Reformer (Syngas) to Fermentation (Ethanol)

Note: CO_2 + CH_4 + H_2O to Syngas uses B-T-E's patented SMR+® Catalytic CO_2 Conversion Technology

<u>Revenue:</u> (Selling Price = $1.4600/gallon Ethanol)
184.0 MM GPY x $1.4600/gallon Ethanol selling price = $268.6 MM/yr
Revenue = $268.6 MM/year

<u>Cost of Production:</u> (Production Cost = $0.490/gallon Ethanol)
184.0 MM GPY x $0.490/gallon = $90.16 MM/yr
Cost of Production: $90.16 MM/year

<u>Net Revenue</u> = ($268.6 - $90.2 MM/yr) = $178.4 MM/year

TIC = $541 MM; Total Installed Cost (TIC), (Greenfield Plant)
Payout = 3.0 years

From the analysis, the CO_2-Ethanol plant generates 30.7 MW of Utility Power, Net Export to the GRID.

NOTE: "NO SUBSIDIES" WERE USED IN THE ABOVE ECONOMIC EVALUATIONS.

RIN's were "NOT" considered in the economic evaluation in this correspondence but "for the record only": 2018 year RINs D6 (Corn Ethanol) \$0.450/gallon and 2018 year RINs D5 ("Other" Adv. Bio.) \$0.640/gallon; Chicago Board of Trade, 3/29/2018.

3. Economics of a Corn-Ethanol Plant & CO_2-Ethanol Plant Facility and Considering RINs

Using RINs, a Corn-Ethanol Plant and CO_2-Ethanol-Ethanol Plant Facility becomes more profitable and capital investment can be repaid in fewer years. NOTE, the Corn-Ethanol plant & CO_2-Ethanol plant Facility is profitable even if RINs are "no longer" available. Thus, the combined two plants can be profitable without RINs but a stand-alone Corn-Ethanol plant may not be profitable in the future.

In addition, RIN's D6(Corn Ethanol) would likely be obtained for the Corn-Ethanol Plant and RIN's D5("Other" Adv. Bo.) would likely be obtained for the CO_2-Ethanol Plant.
Under these conditions for just a couple of years, the Ethanol Facility becomes a "CASH COW."

4. At this time a likely approach would consist of:

a. First, have a study (feasibility study) done by a large independent engineering firm to assess the technical and economic feasibility for a Corn-Ethanol Plant & CO_2-Ethanol Plant Facility using B-T-E's New Patented CO_2 Conversion Technology. Such a feasibility study would be done by B-T-E, Inc. and an independent engineering firm. Likely, such as feasibility study could be done with a grant from the Federal Government.

   Currently, estimated cost for the feasibility study would be less than \$350,000.

b. Second and based upon the feasibility study results from above, a project would be initiated to construct a Pilot Plant to verify and optimize the new technology from CO_2-Ethanol production.

   Then, investors would participate in the construction, completion, and operation of the Corn-Ethanol Plant & CO_2-Ethanol Plant Facility.

   Likely, the B-T-E's CO_2-Ethanol Process could be pilot plant tested using a slip stream of Carbon dioxide (CO_2) from one of an existing Corn-Ethanol plants at that location. This approach and any other considerations would be determined in the feasibility study. This pilot plant would prove out the process from CO_2 feedstock to Ethanol production.

   Note, B-T-E's CO_2 Conversion Technology to SYNGAS has already been pilot plant tested (experimentally verified). A pilot plant operation from CO_2 feedstock to SYNGAS to Ethanol production is logical to test out the entire process from beginning to end. The feasibility study will provide valuable information for making that decision.

CASE-II. APPLICATION OF CO_2 TO THE PRODUCTION OF GASOLINE:

The CO_2 Opportunity & Patented SMR+® Catalytic Technology: Coal-Fired Power Plant Emission Source to Gasoline, Diesel, Jet Fuel, and/or Hydrogen

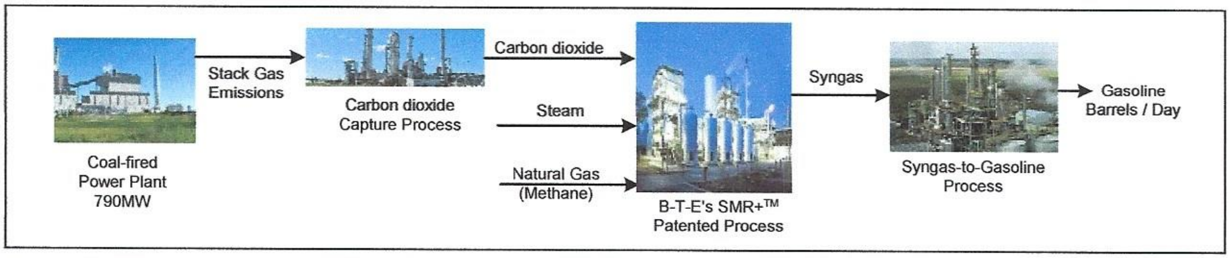
An economical commercial process is needed to provide an incentive for the utility industries to engender win-win support for Governmental regulations on Carbon dioxide (CO_2) emissions.
Current approach to mitigating CO_2 emissions is carbon capture and sequestration (CCS) which involves CO_2 capture followed by CO_2 sequestration involving costly CO_2 compression, transportation, underground storage and/or used for Crude Oil recovery from reservoirs.

Recently, an alternative proprietary catalytic process has been developed for mitigating CO_2 emissions which solidifies the aims of both parties, i.e., industry and government. The recent alternative "catalytic" process by B-T-E, Inc. was developed for mitigating CO_2 emissions from industrial plants by conversion to fuels and is in addition to the previously published "non-catalytic" B-T-E process, [Ref. 11]. The catalytic process converts CO_2 into Syngas (CO & H_2) with B-T-E's patented catalytic process technology and further conversion to fuels such as Gasoline, Diesel, Jet Fuel, Hydrogen, Methanol, and/or Ethanol with established mature technologies, [Refs. 1,2,3,4,8]. The patented technology for the conversion of CO_2 to Syngas was developed by Bio-Thermal-Energy, Inc. (B-T-E, Inc.) and has seven (7) U.S. patents, one (1) Japanese patent, European Patent (EP), and other patents pending, [Ref. 5].
B-T-E's proprietary catalytic technology is referred to as the patented SMR+® process.

The Process

Figure 1 provides a pictorial representation of the new catalytic technology as used for the conversion of CO_2 emissions from a representative coal-fired power plant (790 MW) to gasoline, with an estimated production of 137,200 barrels/day.

Fig. 1 Carbon dioxide Conversion to Gasoline using B-T-E's SMR+™ "catalytic" Technology



The over-all process, from CO_2 to fuels (using B-T-E's technology and a comparable coal-fired power plant) is comprised of these three steps:

Step 1 – Capturing Emissions

Coal-fired stack gas emissions are sent to a carbon dioxide capture plant to remove CO_2 from the stack gas. The stack gas is comprised mainly of Nitrogen (about 70% vol.), water, CO_2 (about 20%), and impurities of SO_2, NOx, and mercury. CO_2 capture system can recover up to about 90% of the CO_2 from the stack gas such as by Shell Oil Company CO_2 capture system.

Step 2 – Conversion to Syngas

CO_2 is then converted to Syngas (mostly CO & H_2) with B-T-E's proprietary technology in a CO_2-to-Syngas process plant. Note, B-T-E's novel technology has been proven experimentally on a gasification pilot plant with a capacity of 12.5 TPD (tons per day). Pilot plant tests have experimentally verified a reduction of CO_2 of about 70 percent, with significant improvements anticipated with further optimization.

This second step involves B-T-E's patented SMR+® catalytic technology. Carbon dioxide (CO_2), natural gas (methane, CH_4), and steam are fed to a Reformer to produce Syngas as illustrated below:

CO_2 + Methane (CH_4) + Steam (H_2O) → Syngas (CO & H_2)

Note, this step uses the typical Steam-Methane Reformer process but B-T-E's SMR+® Catalytic process utilizes an independent external supply of Carbon dioxide (CO_2), U.S. 9,212,059.

Step 3 – Conversion to Gasoline

Syngas is then fed to a syngas-to-gasoline plant for the conversion of syngas to gasoline, such as by using ExxonMobil's GTL (gas to liquids) process, as illustrated:

Syngas (CO & H_2) → Gasoline

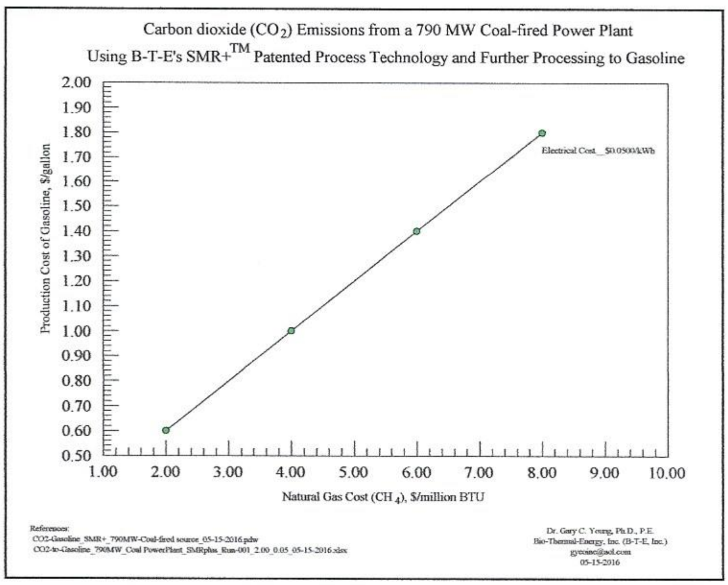
The Economics

With B-T-E's recently patented SMR+® catalytic process coupled with CO_2 Capture process and GTL process to Gasoline, the over-all process to convert CO_2 emissions from a coal-fired power plant into Gasoline becomes:

CO_2 + Methane (CH_4) + Steam (H_2O) → Syngas (CO & H_2) → Gasoline

Figure 2 illustrates the overall economics of using carbon dioxide emissions from a representative 790-MW coal-fired power plant to produce gasoline, using B-T-E's SMR+® proprietary technology, in terms of gasoline production costs as a function of the wholesale natural gas price and retail industrial rate for electricity.

Fig. 2 Gasoline Production Cost using B-T-E's SMR+® Technology



In our case, the 790 MW Coal-fired plant produces stack gas emissions of 775.1 tons/hour carbon dioxide, which in turn can produce about 137,200 barrels/day of gasoline. Production cost includes Total CAPEX (ISBL & 50% of ISBL as OSBL), OPEX including labor & maintenance, with capital financing cost at six percent for 20-years. Cost includes CO_2 capture and environmental requirements. (Ed. – CAPEX denotes capital expenditures; OPEX denotes operating expenses; ISBL and OSBL denote "inside battery limits" and "outside battery limits.")

Using today's economic parameters for wholesale cost of natural gas, the cost of electricity, and the current low prices for gasoline at the pump, we can show that the proposed CO_2-to-Gasoline process is more economical than the conventional method of producing gasoline by refining crude oil.

For example, if crude oil is selling at about $30+/barrel, and if regular-grade gasoline is selling at the pump at a price of about $1.90 per gallon, we can break down the per-gallon (gasoline) costs for the conventional crude oil refining process as shown in Figure 3.

Fig. 3 Gasoline Production Costs – Conventional Refining

	As Cost of Regular Gasoline at the Pump
Taxes	$0.453 / gallon gasoline
Distribution & Marketing	$0.256 / gallon gasoline
Refining	$0.473 / gallon gasoline
Crude Oil	$0.788 / gallon gasoline
Total	$1.970 / gallon gasoline

Refer again to Figure 2, illustrating the economics of the proposed process, using SMR+® technology, for producing gasoline from CO_2. The graph shows that with natural gas prices at wholesale at $2.00/MMBtu and electricity prices at $0.050/kWh, the production cost of gasoline will come in at about $0.60/gallon. The non-catalytic process (Ref. 11) would have a production cost of over $1.00/gallon. As another example, with natural gas at $4.00/MMbtu and electricity at $0.050/kWh, the production cost of gasoline will come in at about $1.00/gallon.

In the economic analysis, cost of CO_2 capture was equivalent to $45/ton CO_2 captured.

By contrast, Figure 3 indicates that the production cost of gasoline using the conventional process of refining crude oil will run $1.261/gallon. That cost represents $0.473 per gallon for refining plus $0.788 for the crude oil commodity. Thus, our analysis indicates that the proposed CO_2-to-gasoline process using SMR+® catalytic technology is competitive with crude-oil refining.

The Other Advantages

Consider the positive attributes of B-T-E's proposed patented SMR+™ CO_2-to-gasoline process:

- B-T-E's patented SMR+® process for CO_2 conversion to Syngas is a catalytic process using the conventional Steam-Methane-Reforming (SMR) process but unique by using an additional independent external feed of low cost Carbon dioxide (CO_2);
- A 60-percent reduction of CO_2 from coal-plant stack gas emissions;
- One gallon of gasoline from about 5.81 lbs CO_2 emissions;
- An environmentally sound process;
- Saves jobs and capital by avoiding closure of coal-fired power plants;
- Produces liquid fuel (gasoline, diesel, and/or Jet Fuel) from Coal-Fired Power Plant Emission;
- Utilizes low cost raw materials, such as CO_2, and natural gas from directional drilling and "fracking" of shale deposits;
- B-T-E's unique and patented catalytic SMR+® process can be used to produce other fuels or chemicals, such as Methanol, Ethanol, etc.

In summation for B-T-E's SMR+® CO_2-to-Syngas-to-Gasoline application to a Coal-fired Power Plant, B-T-E's technology would benefit both the Coal-Fired Power industry and Governmental EPA environmental regulatory agencies. It is a win-win proposition created by "novel" technology for all to benefit: jobs, business assets, environmental, and United States' energy independence.

One could envision a Company's 790 MW Coal-fired Power Plant as supplying the current stack gas emissions, (including any environmental issues), steam, and electricity to a "new" customer's CO_2-Gasoline facility which consists of a CO_2 Capture Plant, SMR+® Catalytic CO_2 Conversion Plant, and the CO_2-to-Gasoline, Diesel, and/or Jet Fuel plant. In other words, the Coal-fired Power Plant supplies energy to a new customer, i.e., the customer's CO_2-to-Gasoline/Diesel/and/or Jet Fuel facility. A new customer is created for the Coal-fired Power Plant.

B-T-E's unique SMR+® patented CO_2 conversion technology is a game changer for the economic potential of producing fuels and chemicals from Carbon dioxide (CO_2) and placing the United States on the pathway to energy independence.

Grants are needed for the feasibility study(s) of the Corn-Ethanol Plant & CO_2-Ethanol Plant Facility and the CO_2-Gasoline Facility based upon B-T-E's Patented CO_2 Conversion Technology.

These feasibility study(s) and future project(s) will need the cooperation and participation of the City, State, Federal, and other parties if a site specific location is selected for the pilot plant and/or commercial facility.

I appreciate the opportunity to express my opinions on this legislation. If you have questions, please call me at ph. 319-373-5191 or cell ph. 319-310-6866.

Sincerely, Gary C. Young 04/09/2018

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| Clean Fuels
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Mitigate CO_2 emissions from industrial plants by conversion to fuels

Hydrocarbon Processing | FEBRUARY 2017, p. 47

G. C. YOUNG, Bio-Thermal-Energy Inc., Cedar Rapids, Iowa

Mitigate CO_2 emissions from industrial plants by conversion to fuels

An economical commercial process is necessary to provide an incentive for the utility industries to engender win-win support for government regulations on carbon dioxide (CO_2) emissions.

A standard approach for mitigating CO_2 emissions is carbon capture and sequestration (CCS), which involves CO_2 capture, sequestration and costly CO_2 compression, transportation and/or underground storage used for crude oil recovery from reservoirs.[1]

An alternative proprietary catalytic process[a] for mitigating CO_2 emissions from industrial plants by conversion to fuels has been developed to solidify the aims of both industry and government.[2,3] This is in addition to a previously published "non-catalytic" process.[4] The catalytic process technology converts CO_2 into syngas [carbon monoxide (CO) and hydrogen (H_2)], with further conversion to fuels, such as gasoline, diesel, jet fuel, H_2, methanol (CH_3OH) and/or ethanol (C_2H_6O), with established, mature technologies.[1,2,5,6,7] The technology consists of seven US patents, one Japanese patent, one European patent and other patents pending.[3]

THE PROCESS

FIG. 1 provides a pictorial representation of the technology as used for the conversion of CO_2 emissions to gasoline from a representative 790-MW, coal-fired power plant. The overall process, from CO_2 to fuels, comprises three steps.

Step 1—Capturing emissions. Coal-fired stack gas emissions are sent to a CO_2-capture plant to remove CO_2 from the stack gas. The stack gas is comprised of approximately 70 vol% nitrogen (N_2), water (H_2O), CO_2 (20%) and impurities of SO_2, nitrogen oxides (NO_x) and mercury (Hg). A CO_2-capture system, like that of Shell Oil Co.,[8] can recover up to 90% of the CO_2 from stack gas.

Step 2—Conversion to syngas. CO_2 is then converted to syngas. The proprietary technology has been proven experimentally on a gasification pilot plant with a capacity of 12.5 tpd.[9] Pilot-plant tests have verified a 70% reduction of CO_2, with significant improvements anticipated with further optimization. This second step involves the catalytic technology that feeds CO_2, natural gas and steam to a reformer to produce syngas, as illustrated in Eq. 1:

$$CO_2 + \text{methane } (CH_4) + \text{steam } (H_2O) \rightarrow \text{syngas } (CO \text{ and } H_2) \quad (1)$$

Note: This step uses a typical steam methane reformer process, but the proprietary catalytic technology utilizes an independent external supply of CO_2.[3]

Step 3—Conversion to gasoline. Syngas is then fed to a syngas-to-gasoline plant for conversion, such as the use of a gas-to-liquids (GTL) process.[5]

The economics. By combining the catalytic process, CO_2-capture process and GTL process, Eq. 2 illustrates the overall process to convert CO_2 emissions from a coal-fired power plant into gasoline:

$$CO_2 + \text{methane } (CH_4) + \text{steam } (H_2O) \rightarrow \text{syngas } (CO \text{ and } H_2) \rightarrow \text{gasoline} \quad (2)$$

FIG. 2 illustrates the overall economics of using CO_2 emissions from a representative 790-MW, coal-fired power plant to produce gasoline, in terms of gasoline production costs as a function of the wholesale natural gas price and retail industrial rate for electricity.

In this case, the plant produces stack gas emissions of 775.1 tph of CO_2, which, in turn, can produce 137.2 Mbpd of gasoline. Production costs include:

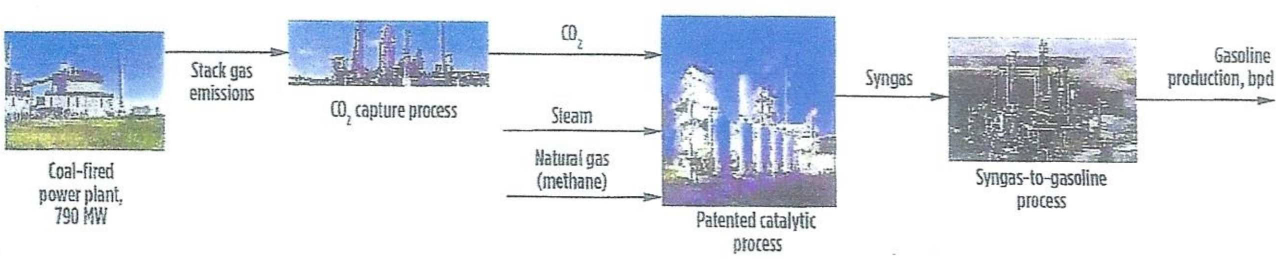

FIG. 1. CO_2 conversion to gasoline using proprietary catalytic technology.

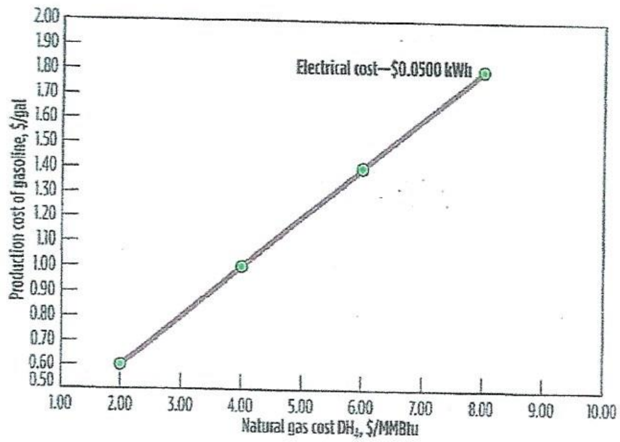

FIG. 2. Gasoline production cost using the proprietary catalytic technology.

TABLE 1. Gasoline production costs, conventional refining

	As cost of regular gasoline at the pump
Taxes	\$0.453/gal gasoline
Distribution and marketing	\$0.256/gal gasoline
Refining	\$0.473/gal gasoline
Crude oil	\$0.788/gal gasoline
Total	\$1.970/gal gasoline

- Total capital expenditures (CAPEX) and inside battery limits (ISBL), with 50% of ISBL as outside battery limits (OSBL)
- Operating expenditures (OPEX), including labor and maintenance
- Capital financing cost at 6% for 20 yr
- CO_2 capture and environmental requirements.

Using recent economic parameters for the wholesale cost of natural gas, the cost of electricity and recent gasoline pump prices, it was shown that the proposed CO_2-to-gasoline process is more economical than the conventional method of producing gasoline by refining crude oil.

For example, if crude oil is selling for more than \$30/bbl, and if regular-grade gasoline is selling at a pump price of approximately \$1.90/gal, then the per-gal costs for the conventional crude oil refining process can be calculated as shown in TABLE 1.[10]

FIG. 2 shows that with wholesale natural gas prices at \$2/MMBtu and electricity prices at \$0.05/kWh, the production cost of gasoline is estimated to be \$0.6/gal. The non-catalytic process would have a production cost of more than \$1/gal.[4] With natural gas at \$4/MMBtu and electricity prices at \$0.05/kWh, the production cost of gasoline is estimated to be \$1/gal. In the economic analysis, the cost of CO_2 capture is equivalent to \$45/t.

By contrast, TABLE 1 indicates that the projected production cost of gasoline using the conventional process of refining crude oil will be \$1.261/gal. That cost represents \$0.473/gal for refining, and \$0.788/gal for the crude oil commodity. Therefore, the analysis indicates that the proposed CO_2-to-gasoline process using the catalytic technology is competitive with crude oil refining.

Additional advantages. Positive attributes of the CO_2-to-gasoline process include:

- Reduces CO_2 from coal-plant stack gas emissions by 60%, lowering environmental impact
- Yields 1 gal of gasoline from approximately 5.81 lb of CO_2 emissions
- Protects jobs and capital by further utilizing coal-fired power plants
- Utilizes low-cost raw materials, such as CO_2 and natural gas from directional drilling and fracking of shale deposits
- Produces other fuels or chemicals, such as CH_3OH, C_2H_6O, etc.
- Creates a new market for coal-fired energy producers—i.e., the customer's CO_2-to-gasoline/diesel/jet fuel facility. HP

NOTE

[a] B-T-E's SMR+ CO_2 conversion to syngas technology is a catalytic process using a conventional steam methane reforming process with an additional independent external feed of low-cost CO_2.

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GARY C. YOUNG is the Owner/President of GYCO Inc. (d.b.a. Bio-Thermal-Energy Inc./B-T-E Inc.). He has spent the last 15 years operating his own consulting engineering company, performing process and project economic analyses on industrial and commercial plants and processes, and developing B-T-E's patented CO_2 conversion to syngas. Dr. Young has more than 50 years of experience in the research, development, economic assessment and commercialization of industrial processes. His industry knowledge extends to research and development, design, construction and operations in coal gasification, biomass gasification, waste gasification, CO_2 conversion to fuels/energy, gas processing, food processing, pharmaceutical processing, agricultural and industrial processing, and enhanced energy recovery. Dr. Young holds BS and MS degrees and a PhD, all in chemical engineering, from the University of Nebraska, and is a licensed professional engineer in California, Texas, Illinois, Iowa and Wisconsin. He holds several patents and has produced numerous articles, publications and presentations around the world.

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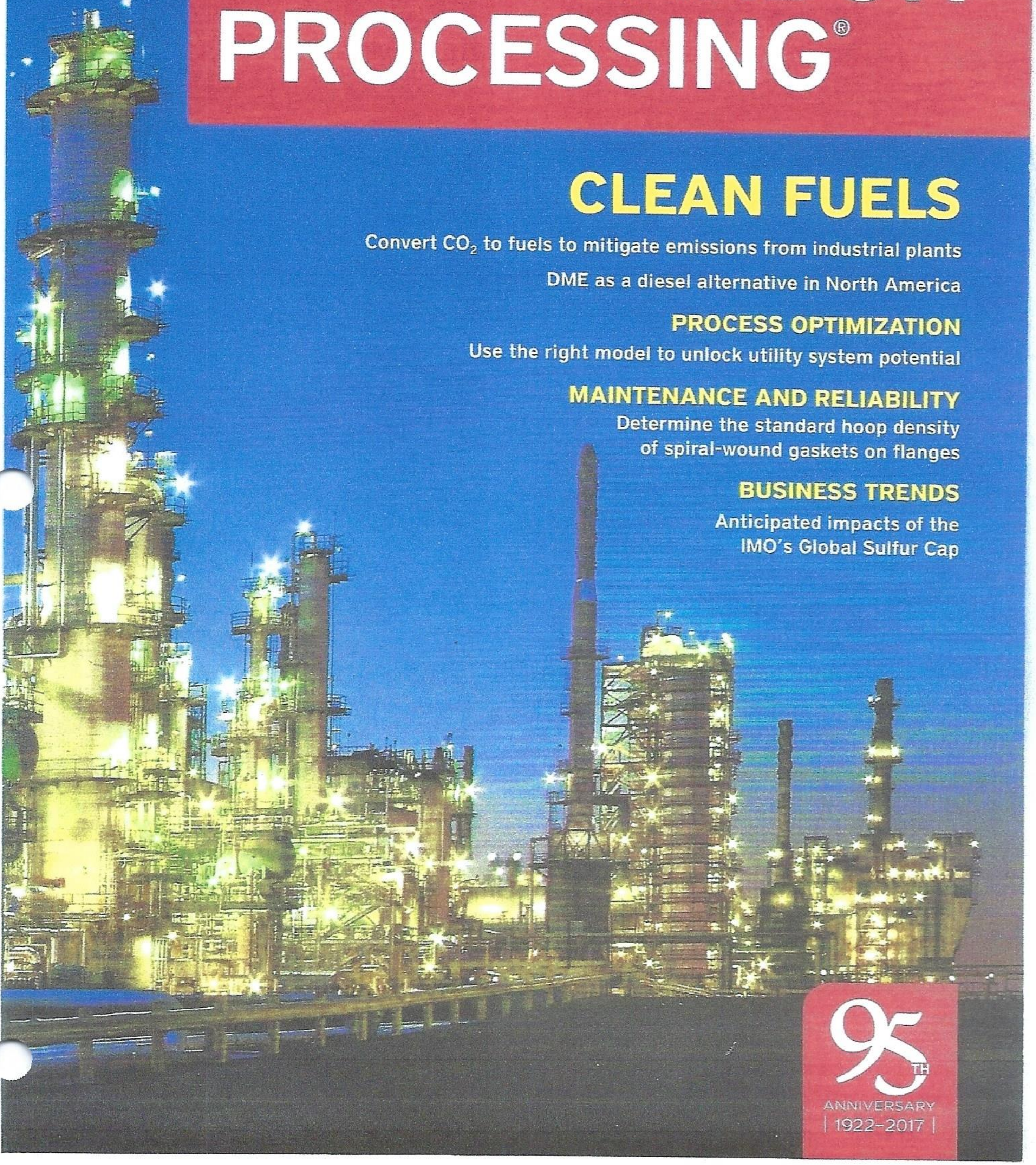

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