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(54) **CARBON DIOXIDE PIPELINE**

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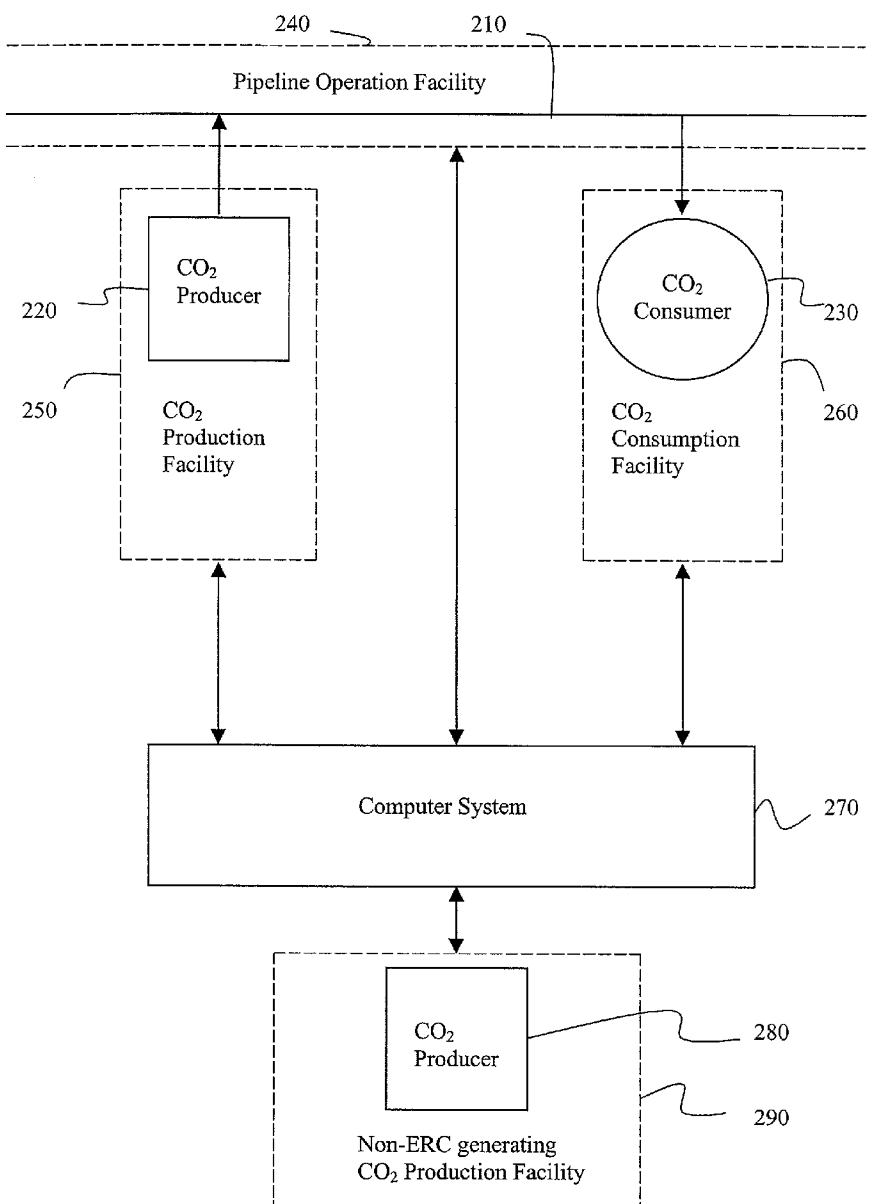
(57) **ABSTRACT**

Carbon dioxide emissions into the atmosphere are reduced and activities requiring CO_2, such as enhanced oil field recovery, are promoted, by collecting CO_2 in a pipeline from at least two different CO_2 production facilities and delivering the CO_2 through the pipeline to one or more CO_2 consumption facilities. Carbon dioxide emission reduction credit associated with the transfer of CO_2 through the pipeline is tracked.



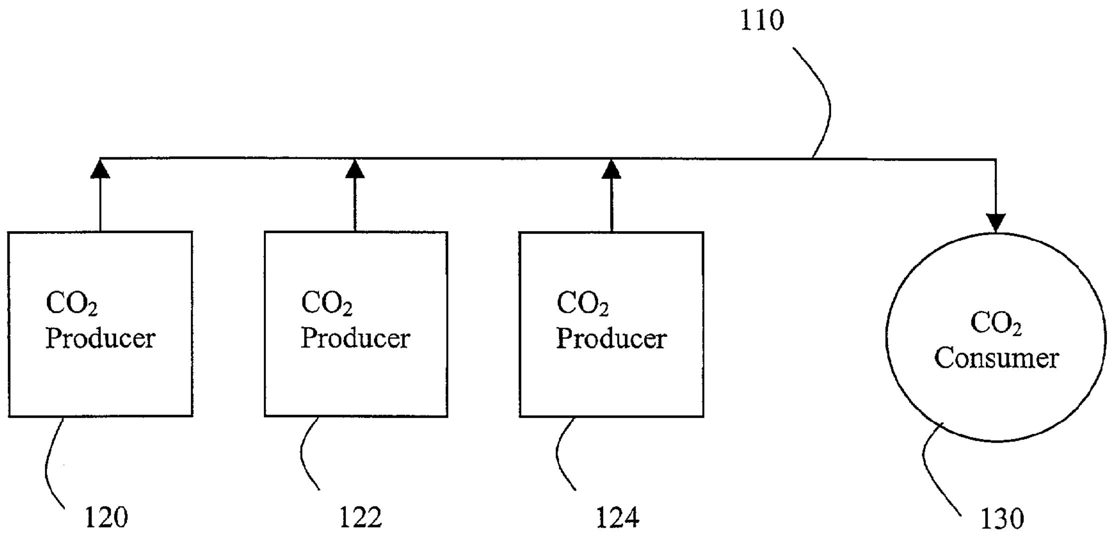

110
CO_2 Producer
CO_2 Producer
CO_2 Producer
CO_2 Consumer
120
122
124
130

FIG. 1

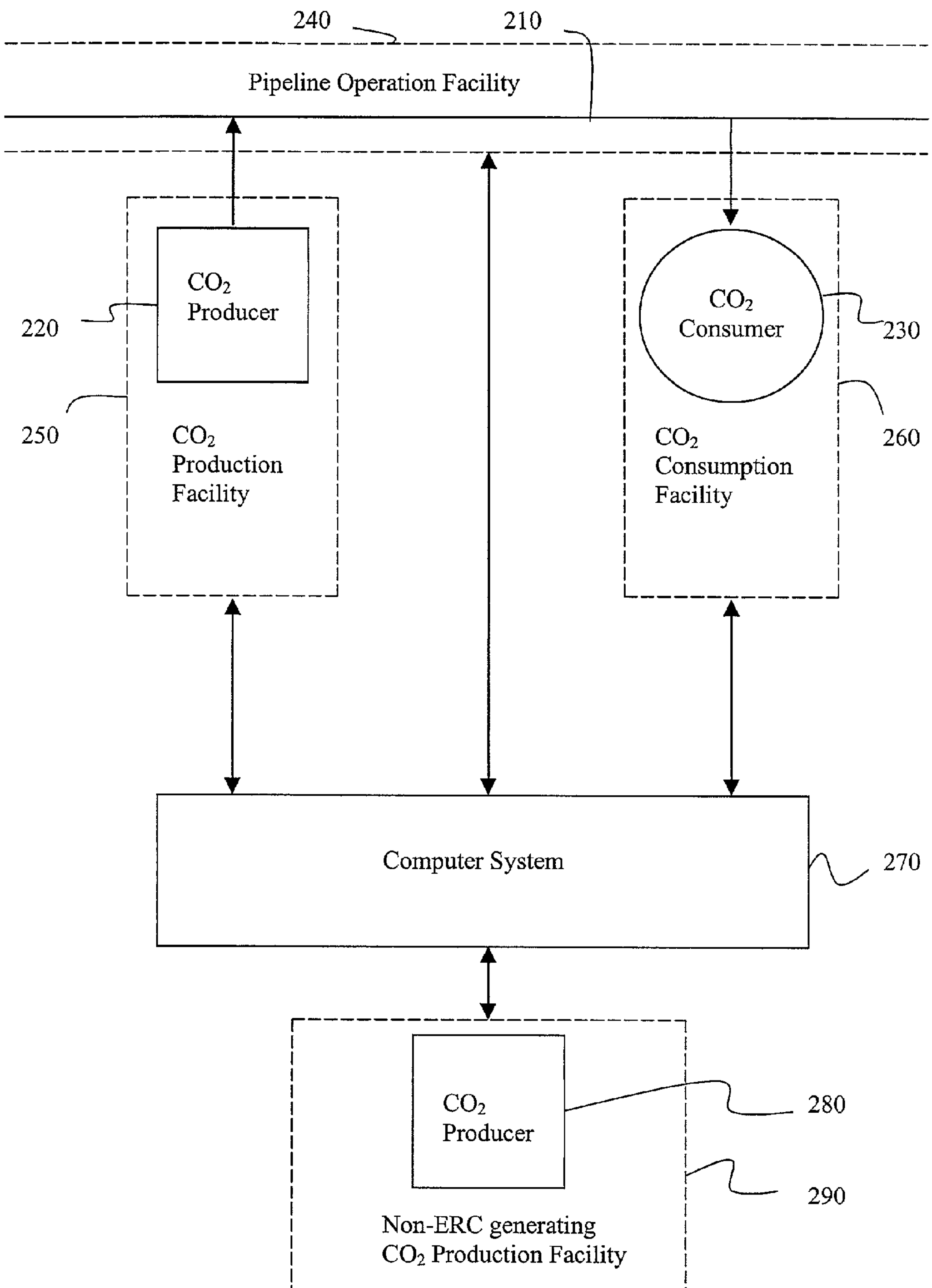

240
210
Pipeline Operation Facility
CO2
Producer
220
250
CO2
Production
Facility
CO2
Consumer
230
260
CO2
Consumption
Facility
Computer System
270
CO2
Producer
280
290
Non-ERC generating
CO2 Production Facility

FIG. 2

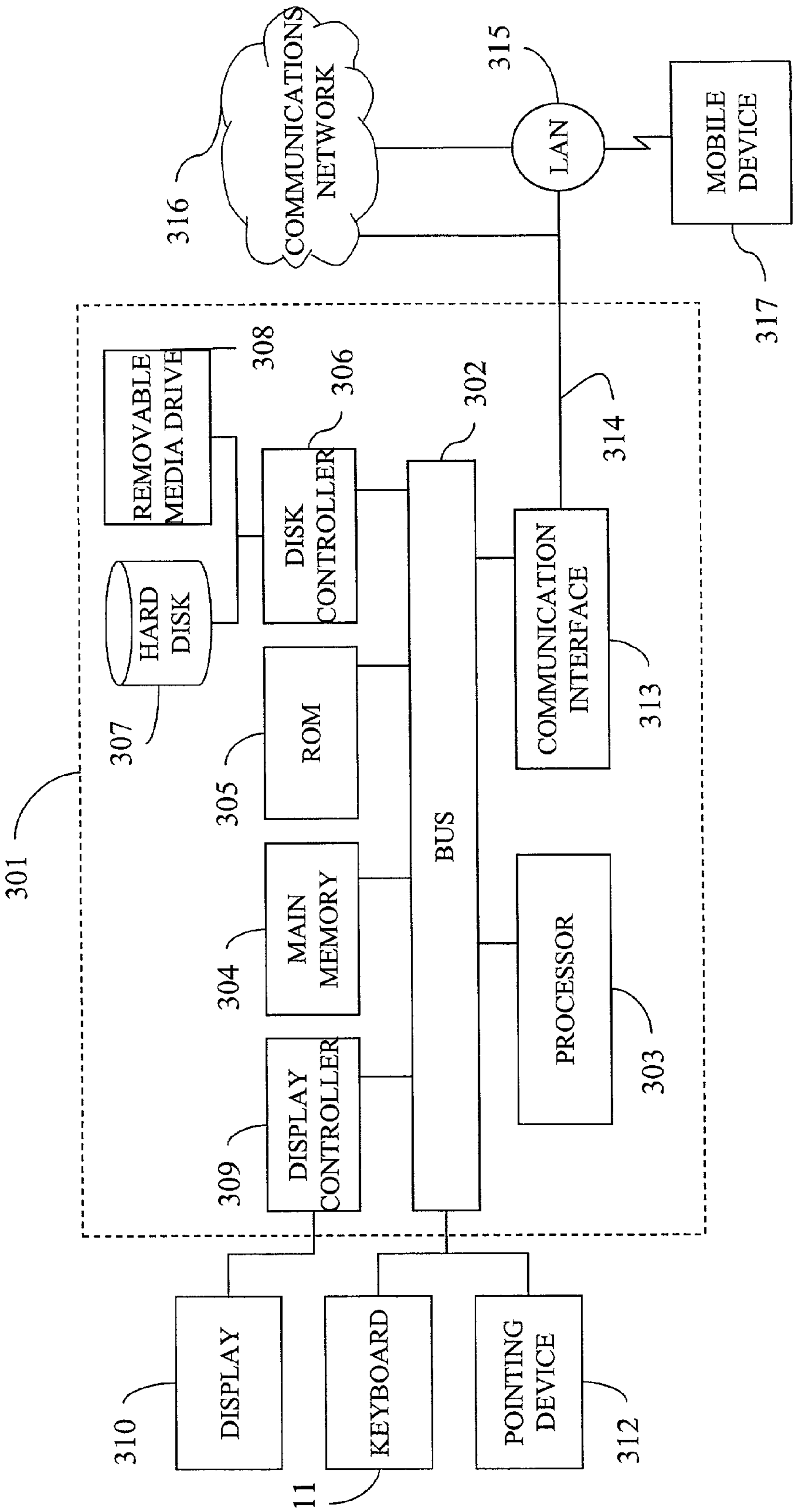

COMMUNICATIONS NETWORK
316
LAN
315
MOBILE DEVICE
317
REMOVABLE MEDIA DRIVE
308
DISK CONTROLLER
306
302
314
HARD DISK
307
ROM
305
COMMUNICATION INTERFACE
313
301
BUS
MAIN MEMORY
304
PROCESSOR
303
DISPLAY CONTROLLER
309
DISPLAY
310
KEYBOARD
311
POINTING DEVICE
312

FIG. 3

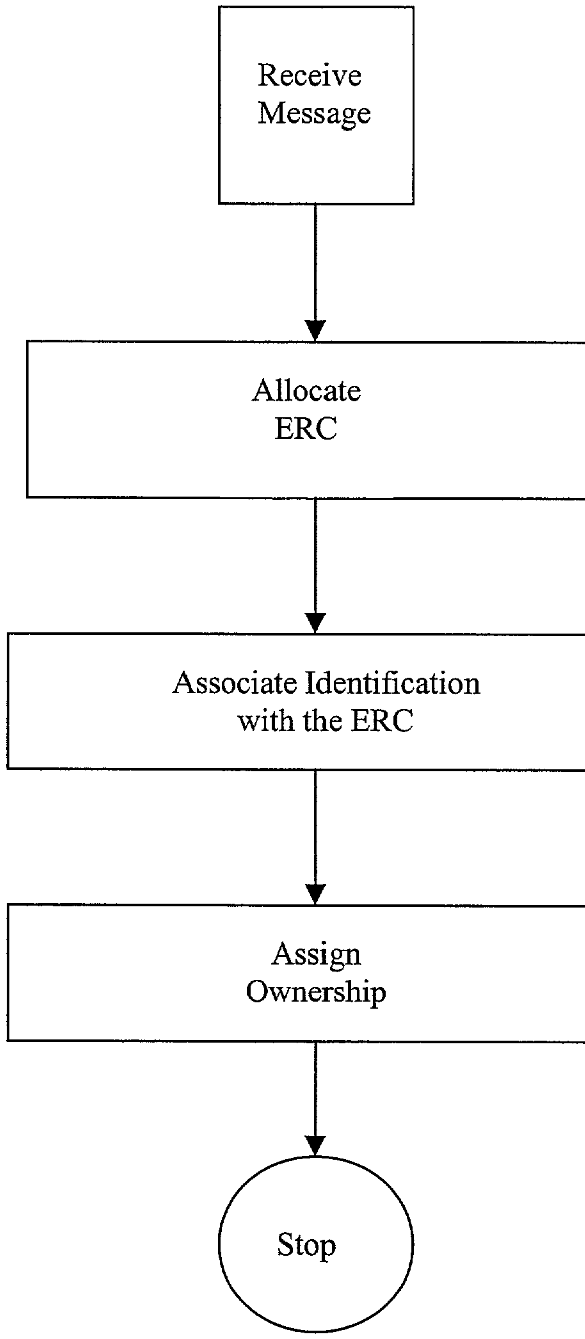

Receive Message
Allocate ERC
Associate Identification with the ERC
Assign Ownership
Stop

FIG. 4

CARBON DIOXIDE PIPELINE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] This invention relates to methods and systems for reducing the release of CO_2 into the atmosphere. In particular, this invention relates to methods and systems for collecting CO_2 in a pipeline from natural and man-made CO_2 producers and delivering the collected CO_2 to one or more CO_2 consumers.

[0003] 2. Discussion of the Background

[0004] Carbon dioxide is introduced into the atmosphere from many natural and man-made sources. Natural sources of CO_2 include respiration, fermentation and underground gas deposits. Man-made sources of CO_2 include hydrocarbon combustion, calcination of calcium carbonate, and a wide variety of chemical reduction processes relying upon the oxidation of carbon, carbon monoxide and other carbon based compounds.

[0005] A correlation has been established between an increase in CO_2 in the atmosphere over the past century and an increase in global temperature. If both trends continue, then the resulting global warming is predicted to have severe environmental consequences. To stop the global warming, governments are considering regulations to limit the introduction of CO_2 into the atmosphere. Among proposed incentives to reduce CO_2 emissions are various forms of CO_2 Emission Reduction Credit ("ERC") to be generated by reductions of CO_2 emissions into the atmosphere and designed to reflect the monetary benefit to society of such reductions. To reduce the economic impact of the regulations, facilities unwilling or unable to reduce CO_2 emissions are expected to be able to satisfy regulatory requirements by purchasing ERC on the open market from facilities generating ERC by reducing atmospheric CO_2 emissions. The proposed regulatory efforts highlight an urgent need to reduce the amount of CO_2 being introduced into the atmosphere.

[0006] Oil provides the modem world with energy and raw materials for a wide variety of applications. However, worldwide oil production appears to be leveling off and is predicted to begin declining over the next decade as oil reserves are depleted. Because oil is a non-renewable resource and oil supplies will eventually be exhausted, considerable efforts are being directed towards developing alternatives to oil. To provide time to convert from oil to oil alternatives, and to minimize the economic and social upheaval associated with the conversion, there is an urgent need to maintain oil production from mature fields for as long as possible.

[0007] Carbon dioxide flooding is a proven technology for enhancing oil recovery from depleted oil fields. When supercritical CO_2 is injected into a field above its minimum miscibility pressure, the supercritical liquid acts as a solvent with the C_5-C_{12} fraction of the oil in rock pores, swelling and expanding the oil and lowering its viscosity greatly. The CO_2 is typically injected into a pattern of single injection wells surrounded by multiple producing wells. The CO_2 miscible zone spreads outwards pushing an oil zone ahead of it. To prevent the lower viscosity miscible zone from "breaking out", water injection is often alternated with CO_2 for a less permeable barrier to CO_2 shortcut.

[0008] When oil begins to flow, some weeks or months later, some of the injected CO_2 returns to the surface dissolved in the oil. This CO_2 retains its value, and can be separated and re-injected. Eventually, some fields reach a self-sustaining inventory of CO_2, and at that point can recover all the recoverable oil without additional CO_2 purchases. When a field reaches its economic end, the wells are pumped solid with concrete, sealing a measured inventory of CO_2 into the formation for periods of geologic time.

[0009] However, CO_2 flooding has not been extensively adopted. One problem with CO_2 flooding has been the high costs associated with pipelines carrying CO_2. A CO_2 pipeline operates at ambient temperature but at very high pressure (2000 psi) in order to maintain the CO_2 in its dense supercritical phase. Another problem with CO_2 flooding has been finding supplies of CO_2 sufficient to support CO_2 flooding.

[0010] U.S. Pat. No. 4,261,420 discloses enhanced recovery of crude oil from oil fields using carbon dioxide obtained in connection with a process of making single cell protein. The '420 patent discloses that the most important problem in enhanced oil recovery is finding an economical CO_2 source, and that highly desirable are sources of substantially pure CO_2 that are available for direct use in an oil field.

[0011] U.S. Pat. No. 4,899,544 discloses a process using a hydrocarbon fuel to drive an electric generator and recovering CO_2 from an exhaust stream. The '544 patent discloses that carbon dioxide in quantities sufficiently large enough for commercial exploitation generally has come from naturally occurring underground supplies, as by-products of the operation of a primary process, such as the manufacture of ammonia or a hydrogen reformer, and in the exhaust gases from burning various hydrocarbon fuels. The '544 patent discloses that one of the largest problems faced by carbon dioxide users is the problem of transportation from the place of production to the place of use.

[0012] In the past, each oil field needing CO_2 for enhanced oil recovery has obtained the CO_2 either from a single dedicated CO_2 producing facility constructed at the oil field or from a single underground CO_2 deposit via a dedicated pipeline. However, the costs associated with building a different CO_2 producing facility or CO_2 pipeline for each oil field are prohibitive.

[0013] There is an urgent need for new methods of economically enhancing recovery from oil fields and of minimizing CO_2 emissions to the atmosphere.

SUMMARY OF THE INVENTION

[0014] The present invention provides methods of reducing CO_2 emissions to the atmosphere by using a pipeline to collect CO_2 from at least two different CO_2 production facilities and then delivering the collected CO_2 through the pipeline to one or more CO_2 consumption facilities where the CO_2 is needed. In embodiments the CO_2 from the pipeline is injected underground into one or more oil fields for use in enhanced oil recovery.

[0015] The present invention also provides methods and systems of tracking CO_2 emission reduction credit (ERC) generated when CO_2 emissions from at least two different CO_2 production facilities are collected in a pipeline and delivered to one or more CO_2 consumption facilities. The ERC can be sold to CO_2 production facilities that are unwilling or unable to reduce CO_2 emissions to the atmosphere as a way of satisfying government emission regulations.

[0016] By collecting the CO_2 produced by a number of different facilities into a single pipeline for delivery, the present invention provides CO_2 consumption facilities with a readily available and economical source of CO_2. The present invention reduces the total amount of CO_2 introduced into the atmosphere by efficiently putting CO_2 collected in the pipeline to beneficial use in, e.g., enhanced oil field recovery. The present invention also provides a mechanism for tracking and redistributing ERC that can aid in reducing the regulatory burden associated with reducing total CO_2 emissions into the atmosphere.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The preferred embodiments of this invention will be described in detail with reference to the following figures.

[0018] **FIG. 1** illustrates a CO_2 pipeline running between three different CO_2 production facilities and one CO_2 consumption facility.

[0019] **FIG. 2** illustrates a system/method for tracking CO_2 emission reduction credits.

[0020] **FIG. 3** illustrates a computer system upon which embodiments of the invention can be implemented.

[0021] **FIG. 4** is a flow chart illustrating a method of tracking CO_2 emission reduction credits.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0022] The present invention uses a pipeline to transfer CO_2 from at least two different CO_2 production facilities to at least one CO_2 consumption facility.

[0023] The CO_2 production facilities each include a CO_2 producer (i.e., a source of CO_2), which can be natural or man-made.

[0024] One natural CO_2 producer is a natural underground CO_2 deposit. Carbon dioxide deposits have been found in natural springs or wells. Naturally occurring underground supplies of CO_2 have been found in Colorado, Wyoming and Mississippi.

[0025] Man-made CO_2 producers include coal gasification facilities. A coal gasification facility converts coal, coke or char to gaseous products by reaction with air, hydrogen, oxygen, steam, or a mixture thereof. Products include carbon dioxide, carbon monoxide, hydrogen, methane, and some other chemicals in a ratio dependent upon the particular reactants employed and the temperatures and pressures within the reactors, as well as upon the type of treatment which the gases from the gasifier undergo subsequent to their leaving the gasifier.

[0026] Another man-made source of CO_2 is a facility for generating power by combusting coal or hydrocarbons. Combustion is an exothermic oxidation reaction. In the presence of sufficient oxygen, coal, which is primarily carbon, is oxidized to CO_2 (i.e., $C+O_2 \rightarrow CO_2$) Hydrocarbons, for example carbohydrates, are oxidized to CO_2 and water (i.e., $C_6H_{12}O_6 \rightarrow 6CO_2+6H_2O$).

[0027] Still another man-made CO_2 producer is a facility for calcining carbonates. Preferably, the carbonates that are to be calcined include one or more of magnesium and calcium. Thermal decomposition of, e.g., magnesite ($MgCO_3$) produces magnesium oxide and releases CO_2 (i.e., $MgCO_3 \rightarrow MgO+CO_2$). Thermal decomposition of limestone ($CaCO_3$) produces calcium oxide (CaO, lime) and releases CO_2 (i.e., $CaCO_3 \rightarrow CaO+CO_2$). Thermal decomposition of dolomite ($CaMg(CO_3)_2$) produces calcium oxide, magnesium oxide and CO_2 (i.e., $CaMg(CO_3)_2 \rightarrow CaO+MgO+2CO_2$). A facility for calcining such carbonates can be used to produce various cements in addition to CO_2.

[0028] Many industrial processes rely upon the "shift reaction" (i.e., $CO+H_2O \rightarrow H_2+CO_2$) to form hydrogen, with CO_2 released as an unwanted by-product. A facility for producing hydrogen via the shift reaction thus forms large amounts of waste CO_2.

[0029] The shift reaction can be used in facilities for reducing a metal-containing compound to form a metal. For example, smelting facilities can isolate various metals (M), preferably transition metals, more preferably iron, from metal-containing compounds in ore by reducing the metal-containing compounds with hydrogen from the shift reaction. Preferably, the metal-containing compounds are metal oxides, and the metal oxides are reduced by the hydrogen to form the metal, with water as a by-product (e.g., $MO_x+xH_2 \rightarrow M+xH_2O$). To avoid transporting highly combustible hydrogen gas over large distances, the hydrogen used in the smelting is produced by the shift reaction at the smelting site and CO_2 is released as a by-product. In an alternative process, metal oxide in ore can be reduced with carbon monoxide to produce metal, with CO_2 as a by-product (i.e., $MO_x+xCO \rightarrow M+xCO_2$).

[0030] Hydrogen from the shift reaction is also used to produce ammonia (e.g., $3H_2+N_2 \rightarrow 2NH_3$). Facilities for synthesizing ammonia typically produce the hydrogen on-site and release the CO_2 by-product of the shift reaction into the atmosphere.

[0031] Still another man-made source of CO_2 is a facility for fermenting sugar or starch into alcohol (e.g., $C_6H_{12}O_6 \rightarrow 2C_2H_5OH+2CO_2$). Fermentation is a chemical change induced by a living organism or enzyme, specifically bacteria or the microorganisms occurring in unicellular plants such as yeast, molds, of fungi. Carbon dioxide production facilities relying upon fermentation include gasohol production facilities and breweries.

[0032] Other CO_2 production facilities include petroleum cracking facilities, where CO_2 can be released as a result of the partial combustion of hydrocarbons with air.

[0033] According to the present invention a pipeline is used to collect CO_2 from at least two different CO_2 production facilities and to deliver the collected CO_2 through the pipeline to one or more CO_2 consumption facilities. Preferably, the at least two different CO_2 production facilities have different methods of CO_2 production. For example, preferably the at least two different CO_2 production facilities produce CO_2 as a by-product of different industrial processes each relying upon a different combination of chemical reactions. In embodiments, the at least two different CO_2 production facilities can be at least three CO_2 production facilities. In other embodiments, the one or more CO_2 consumption facilities can be two or more CO_2 consumption facilities.

[0034] The pipeline carries CO_2 with minimal or no leakage. Preferably, the pipeline carries CO_2 as a supercritical fluid. The pipeline can be constructed using techniques known in the art.

[0035] The CO_2 consumption facilities each include a CO_2 consumer (i.e., a "sink" for CO_2). The CO_2 consumer can be, for example, a facility for carbonating beverages or a facility for filling CO_2 into high pressure gas cylinders. Preferably, the CO_2 consumer includes at least one oil field, and CO_2 from the pipeline is injected into the at least one oil field to enhance the recovery of oil from the oil field by methods known in the art. In embodiments, oil and CO_2 are pumped from an oil field, the CO_2 is separated from the oil, and the separated CO_2 is recycled by injection back into the oil field to promote additional oil recovery.

[0036] In contrast to a conventional CO_2 pipeline, which either connects a single CO_2 production facility to an on-site oil field or connects a natural underground CO_2 deposit to an oil field, the CO_2 pipeline of the present invention connects at least two different CO_2 production facilities to at least one CO_2 consumption facility over large distances. In embodiments, the at least two CO_2 production facilities can each be separated by 0.5 or more, 1 or more, 2 or more, or 10 or more miles. In other embodiments, the at least two CO_2 production facilities and the at least one CO_2 consumption facility can each be separated by 0.5 or more, 1 or more, 2 or more, or 10 or more miles. In still other embodiments, each of the at least two CO_2 production facilities can be separated by 5 or more, 10 or more, 25 or more, or 100 or more miles from each of the at least one CO_2 consumption facility.

[0037] **FIG. 1** shows an embodiment of the invention in which a CO_2 pipeline **110** connects CO_2 producers **120**, **122** and **124** with CO_2 consumer **130**.

[0038] The collection of CO_2 in a pipeline from at least two CO_2 production facilities and the delivery of the CO_2 through the pipeline to one or more CO_2 consumption facilities results in a reduction in CO_2 emissions into the atmosphere. To limit global warming, governments worldwide are discussing regulations limiting total CO_2 emissions into the atmosphere. Governments are also considering the use of CO_2 emission reductions credit, which can be bought and sold on the open market, as an incentive to CO_2 producers to limit atmospheric CO_2 emissions, preferably to zero.

[0039] In embodiments, the present invention provides systems and methods of tracking CO_2 emission reduction credit generated when CO_2 is collected in a pipeline from at least two different CO_2 production facilities and the CO_2 is then delivered through the pipeline to one or more CO_2 consumption facilities.

[0040] **FIG. 2** illustrates embodiments of the inventive systems and methods for tracking CO_2 emission reduction credits. A pipeline **210** connects CO_2 producer **220** with CO_2 consumer **230**. The pipeline **210** is part of a pipeline operation facility **240**, which operates the pipeline **210**. The CO_2 producer **220** is part of a CO_2 production facility **250**, which operates the CO_2 producer **220**. The CO_2 consumer **230** is part of a CO_2 consumption facility **260**, which operates the CO_2 consumer **230**.

[0041] Preferably, the CO_2 producer **220** is a facility for gasifying coal, a facility for combusting coal or hydrocarbons to generate power, a facility for calcining calcium carbonate, a facility for reducing a metal-containing compound to form a metal, or a facility for synthesizing ammonia.

[0042] Preferably, the CO_2 consumer **230** includes at least one oil field.

[0043] The flow of CO_2 from the CO_2 production facility **250** through the pipeline **210** to the CO_2 consumer **230** in the CO_2 consumption facility **260** generates CO_2 emission reduction credit by preventing the CO_2 from CO_2 producer **220** from entering the atmosphere.

[0044] The pipeline **210**, the CO_2 production facility **250**, and the CO_2 consumption facility **260** are all connected to a computer system **270** (shown in more detail in **FIG. 3**).

[0045] Also connected to computer system **270** is a non-ERC generating CO_2 production facility **290** including a CO_2 producer **280**. The CO_2 producer **280** emits CO_2 into the atmosphere. As a result, to meet regulatory requirements the non-ERC generating CO_2 production facility **290** needs ERCs to offset the atmospheric CO_2 emissions of CO_2 producer **280**.

[0046] The computer system **270** tracks the ERC generated by the flow of CO_2 through the pipeline **210** and transfers ownership of the ERC to the non-ERC generating CO_2 production facility **290** in exchange for predetermined assets, such as money, from the non-ERC generating CO_2 production facility **290**. The vertical lines with arrows on both ends in **FIG. 2** represent flows of information regarding, e.g., ownership of ERCs and money between the computer system **270** and the pipeline operation facility **240**, the CO_2 production facility **250**, the CO_2 consumption facility **260** and the non-ERC generating CO_2 production facility **290**, respectively.

[0047] Embodiments of the present invention providing a system for tracking CO_2 emission reduction credit are illustrated in **FIG. 2**. The system includes the computer system **270** including a processor having a communications interface (as will be shown in **FIG. 3**); and a memory configured to hold computer executable instructions that, when executed by the processor, implement a message reception mechanism configured to receive a message from CO_2 production facility **250** and a pipeline operation facility **240** regarding an amount of CO_2 introduced by the CO_2 production facility **250** into the pipeline **210** operated by the pipeline operation facility **240**, an account recording mechanism configured to allocate a predetermined amount of CO_2 emission reduction credit to one or more of the CO_2 production facility **250** and the pipeline operation facility **240** for the CO_2 introduced into the pipeline **210**, a labeling mechanism configured to assign an identification to the amount of CO_2 emission reduction credit allocated for CO_2 delivered, and an exchange mechanism configured to assign ownership of the amount of the CO_2 emission reduction credit to another entity (e.g, non-ERC generating CO_2 production facility **290**) in exchange for the another entity providing a predetermined asset to one or more of the CO_2

production facility **250** and the pipeline operation facility **240**. In embodiments, the message reception mechanism can be configured to receive another message from the CO_2 consumption facility **260** regarding an amount of the CO_2 withdrawn from the pipeline **210** by the CO_2 consumption facility **260**; and the account recording mechanism implemented in the computer system **270** can be configured to allocate another predetermined amount of CO_2 emission reduction credit to the CO_2 consumption facility **260** for the amount of CO_2 withdrawn from the pipeline **210**. In further embodiments, the exchange mechanism can be configured to assign ownership of the another predetermined amount of CO_2 emission reduction credit to the another entity (e.g., non-ERC generating CO_2 production facility **290**) in exchange for the another entity providing another predetermined asset to the CO_2 consumption facility.

[**0048**] **FIG. 2** also illustrates embodiments of the present invention that provide a computer implemented method for tracking emission reduction credits. The inventive method includes steps of receiving a message at a controller **270** from one or more of CO_2 production facility **250** and pipeline operation facility **240** regarding an amount of CO_2 introduced by the CO_2 production facility **250** into a pipeline **210** operated by the pipeline operation facility **240**; allocating a predetermined amount of CO_2 emission reduction credit to one or more of the CO_2 production facility **250** and the pipeline operation facility **240** for the CO_2 introduced into the pipeline **210**; associating an identification to the amount of CO_2 emission reduction credit allocated for CO_2 delivered; and assigning ownership of the amount of CO_2 emission reduction credit to another entity (e.g., non-ERC generating CO_2 production facility **290**) in exchange for the another entity providing a predetermined asset to one or more of the CO_2 production facility **250** and the pipeline operation facility **240**. In embodiments, the method includes additional steps of receiving another message from the CO_2 consumption facility **260** regarding an amount of CO_2 withdrawn from the pipeline **210** into the CO_2 consumption facility **260**; and allocating another predetermined amount of CO_2 emission reduction credit to the CO_2 consumption facility **260** for the amount of CO_2 withdrawn from the pipeline **210**. In other embodiments, the method can further include a step of assigning ownership of the another predetermined amount of CO_2 emission reduction credit to the another entity (e.g., non-ERC generating CO_2 production facility **290**) in exchange for the another entity providing another predetermined asset to the CO_2 consumption facility **260**.

[**0049**] **FIG. 3** illustrates a computer system **301**, that shows sub-components of the computer system **270** of **FIG. 2**, upon which embodiments of the present invention can be implemented. In particular, the message reception mechanism, the account recording mechanism, the labeling mechanism, and the exchanging mechanism discussed above are implemented in computer system **301**. The computer system **301** includes a bus **302** or other communication mechanism for communicating information, and a processor **303** coupled with the bus **302** for processing the information. The computer system **301** also includes a main memory **304**, such as a random access memory (RAM) or other dynamic storage device (e.g., dynamic RAM (DRAM), static RAM (SRAM), and synchronous DRAM (SDRAM)), coupled to the bus **302** for storing information and instructions to be executed by processor **303**. In addition, the main memory **304** may be used for storing temporary variables or other intermediate information during the execution of instructions by the processor **303**. The computer system **301** further includes a read only memory (ROM) **305** or other static storage device (e.g., programmable ROM (PROM), erasable PROM (EPROM), and electrically erasable PROM (EEPROM)) coupled to the bus **302** for storing static information and instructions for the processor **303**.

[**0050**] The computer system **301** also includes a disk controller **306** coupled to the bus **302** to control one or more storage devices for storing information and instructions, such as a magnetic hard disk **307**, and a removable media drive **308** (e.g., floppy disk drive, read-only compact disc drive, read/write compact disc drive, compact disc jukebox, tape drive, and removable magneto-optical drive). The storage devices may be added to the computer system **301** using an appropriate device interface (e.g., small computer system interface (SCSI), integrated device electronics (IDE), enhanced-IDE (E-IDE), direct memory access (DMA), or ultra-DMA).

[**0051**] The computer system **301** may also include special purpose logic devices (e.g., application specific integrated circuits (ASICs)) or configurable logic devices (e.g., simple programmable logic devices (SPLDs), complex programmable logic devices (CPLDs), and field programmable gate arrays (FPGAs)).

[**0052**] The computer system **301** may also include a display controller **309** coupled to the bus **302** to control a display **310**, such as a cathode ray tube (CRT), for displaying information to a computer user. The computer system includes input devices, such as a keyboard **311** and a pointing device **312**, for interacting with a computer user and providing information to the processor **303**. The pointing device **312**, for example, may be a mouse, a trackball, or a pointing stick for communicating direction information and command selections to the processor **303** and for controlling cursor movement on the display **310**. In addition, a printer may provide printed listings of data stored and/or generated by the computer system **301**.

[**0053**] The computer system **301** performs a portion or all of the processing steps of the invention in response to the processor **303** executing one or more sequences of one or more instructions contained in a memory, such as the main memory **304**. Such instructions may be read into the main memory **304** from another computer readable medium, such as a hard disk **307** or a removable media drive **308**. One or more processors in a multi-processing arrangement may also be employed to execute the sequences of instructions contained in main memory **304**. In alternative embodiments, hard-wired circuitry may be used in place of or in combination with software instructions. Thus, embodiments are not limited to any specific combination of hardware circuitry and software.

[**0054**] As stated above, the computer system **301** includes at least one computer readable medium or memory for holding instructions programmed according to the teachings of the invention and for containing data structures, tables, records, or other data described herein. Examples of computer readable media are compact discs, hard disks, floppy disks, tape, magneto-optical disks, PROMs (EPROM, EEPROM, flash EPROM), DRAM, SRAM, SDRAM, or any other magnetic medium, compact discs (e.g., CD-

ROM), or any other optical medium, punch cards, paper tape, or other physical medium with patterns of holes, a carrier wave (described below), or any other medium from which a computer can read.

[0055] Stored on any one or on a combination of computer readable media, the present invention includes software for controlling the computer system **301**, for driving a device or devices for implementing the invention, and for enabling the computer system **301** to interact with a human user (e.g., print production personnel). Such software may include, but is not limited to, device drivers, operating systems, development tools, and applications software. Such computer readable media further includes the computer program product of the present invention for performing all or a portion (if processing is distributed) of the processing performed in implementing the invention.

[0056] The computer code devices of the present invention may be any interpretable or executable code mechanism, including but not limited to scripts, interpretable programs, dynamic link libraries (DLLs), Java classes, and complete executable programs. Moreover, parts of the processing of the present invention may be distributed for better performance, reliability, and/or cost.

[0057] The term "computer readable medium" as used herein refers to any medium that participates in providing instructions to the processor **303** for execution. A computer readable medium may take many forms, including but not limited to, non-volatile media, volatile media, and transmission media. Non-volatile media includes, for example, optical, magnetic disks, and magneto-optical disks, such as the hard disk **307** or the removable media drive **308**. Volatile media includes dynamic memory, such as the main memory **304**. Transmission media includes coaxial cables, copper wire and fiber optics, including the wires that make up the bus **302**. Transmission media also may also take the form of acoustic or light waves, such as those generated during radio wave and infrared data communications.

[0058] Various forms of computer readable media may be involved in carrying out one or more sequences of one or more instructions to processor **303** for execution. For example, the instructions may initially be carried on a magnetic disk of a remote computer. The remote computer can load the instructions for implementing all or a portion of the present invention remotely into a dynamic memory and send the instructions over a telephone line using a modem. A modem local to the computer system **301** may receive the data on the telephone line and use an infrared transmitter to convert the data to an infrared signal. An infrared detector coupled to the bus **302** can receive the data carried in the infrared signal and place the data on the bus **302**. The bus **302** carries the data to the main memory **304**, from which the processor **303** retrieves and executes the instructions. The instructions received by the main memory **304** may optionally be stored on storage device **307** or **308** either before or after execution by processor **303**.

[0059] The computer system **301** also includes a communication interface **313** coupled to the bus **302**. The communication interface **313** provides a two-way data communication coupling to a network link **314** that is connected to, for example, a local area network (LAN) **315**, or to another communications network **316** such as the Internet. For example, the communication interface **313** may be a network interface card to attach to any packet switched LAN. As another example, the communication interface **313** may be an asymmetrical digital subscriber line (ADSL) card, an integrated services digital network (ISDN) card or a modem to provide a data communication connection to a corresponding type of communications line. Wireless links may also be implemented. In any such implementation, the communication interface **313** sends and receives electrical, electromagnetic or optical signals that carry digital data streams representing various types of information.

[0060] The network link **314** typically provides data communication through one or more networks to other data devices. For example, the network link **314** may provide a connection to another computer through a local network **315** (e.g., a LAN) or through equipment operated by a service provider, which provides communication services through a communications network **316**. The local network **314** and the communications network **316** use, for example, electrical, electromagnetic, or optical signals that carry digital data streams, and the associated physical layer (e.g., CAT 5 cable, coaxial cable, optical fiber, etc). The signals through the various networks and the signals on the network link **314** and through the communication interface **313**, which carry the digital data to and from the computer system **301** maybe implemented in baseband signals, or carrier wave based signals. The baseband signals convey the digital data as unmodulated electrical pulses that are descriptive of a stream of digital data bits, where the term "bits" is to be construed broadly to mean symbol, where each symbol conveys at least one or more information bits. The digital data may also be used to modulate a carrier wave, such as with amplitude, phase and/or frequency shift keyed signals that are propagated over a conductive media, or transmitted as electromagnetic waves through a propagation medium. Thus, the digital data may be sent as unmodulated baseband data through a "wired" communication channel and/or sent within a predetermined frequency band, different than baseband, by modulating a carrier wave. The computer system **301** can transmit and receive data, including program code, through the network(s) **315** and **316**, the network link **314** and the communication interface **313**. Moreover, the network link **314** may provide a connection through a LAN **315** to a mobile device **317** such as a personal digital assistant (PDA) laptop computer, or cellular telephone.

[0061] **FIG. 4** is a flow chart illustrating a method of tracking CO_2 emission reduction credits. Upon receiving a message from one or more of at least two different CO_2 production facilities, a pipeline operation facility, and a CO_2 consumption facility that CO_2 has been diverted from entering the atmosphere, a computer system (such as computer system **270** in **FIG. 2**) allocates ERC based on the amount of diverted CO_2; associates an identification with the allocated ERC; and assigns ownership to the ERC.

[0062] While the present invention has been described with respect to specific embodiments, it is not confined to the specific details set forth, but includes various changes and modifications that may suggest themselves to those skilled in the art, all falling within the scope of the invention as defined by the following claims.

What is claimed is:

1. A method of reducing CO_2 emissions to the atmosphere, the method comprising

collecting in a pipeline CO_2 from at least two CO_2 production facilities having different methods of CO_2 production; and

delivering the CO_2 through the pipeline to at least one CO_2 consumption facility, wherein

the pipeline extends between the at least two CO_2 production facilities and the at least one CO_2 consumption facility.

2. The method according to claim 1, wherein the at least two CO_2 production facilities are differently selected from the group consisting of

a natural underground CO_2 deposit,

a facility for gasifying coal,

a facility for combusting coal or hydrocarbons to generate power,

a facility for calcining a carbonate including at least one element selected from the group consisting of magnesium and calcium,

a facility for producing hydrogen,

a facility for reducing a metal-containing compound to form a metal,

a facility for synthesizing ammonia, and

a facility for fermenting sugar or starch.

3. The method according to claim 2, wherein the at least two CO_2 production facilities are differently selected from the group consisting of

a facility for gasifying coal,

a facility for combusting coal or hydrocarbons to generate power,

a facility for calcining a carbonate including at least one element selected from the group consisting of magnesium and calcium,

a facility for producing hydrogen,

a facility for reducing a metal-containing compound to form a metal, and

a facility for synthesizing ammonia.

4. The method according to claim 2, wherein the metal-containing compound is a metal-bearing ore.

5. The method according to claim 2, wherein the metal comprises at least one selected from the group consisting of transition metals.

6. The method according to claim 2, wherein the metal comprises iron.

7. The method according to claim 1, wherein the at least two CO_2 production facilities are at least three CO_2 production facilities.

8. The method according to claim 1, wherein the at least one CO_2 consumption facility is at least two CO_2 consumption facilities.

9. The method according to claim 1, wherein the at least one CO_2 consumption facility includes at least one oil field.

10. The method according to claim 9, further comprising injecting the CO_2 delivered through the pipeline into the at least one oil field.

11. The method according to claim 10, further comprising

pumping oil and CO_2 from the at least one oilfield; and

recycling the CO_2 pumped from the at least one oilfield back into the at least one oilfield.

12. A method of reducing CO_2 emissions to the atmosphere, the method comprising

collecting in a pipeline CO_2 from at least two CO_2 production facilities each separated by 0.5 or more miles; and

delivering the CO_2 through the pipeline to at least one CO_2 consumption facility, wherein

the pipeline extends between the at least two CO_2 production facilities and the at least one CO_2 consumption facility.

13. The method according to claim 12, wherein the at least two CO_2 production facilities and the at least one CO_2 consumption facility are each separated by 0.5 or more miles.

14. The method according to claim 12, wherein each of the at least two CO_2 production facilities is separated by 5 or more miles from each of the at least one CO_2 consumption facility.

15. The method according to claim 12, wherein the at least two CO_2 production facilities are differently selected from the group consisting of

a facility for gasifying coal,

a facility for combusting coal or hydrocarbons to generate power,

a facility for calcining a carbonate including at least one element selected from the group consisting of magnesium and calcium,

a facility for producing hydrogen,

a facility for reducing a metal-containing compound to form a metal, and

a facility for synthesizing ammonia.

16. A system for tracking CO_2 emission reduction credit, the system comprising

a processor having a communications interface; and

a memory configured to hold therein computer executable instructions that, when executed by the processor, implement

a message reception mechanism configured to receive a message from one or more of at least two CO_2 production facilities and a pipeline operation facility regarding an amount of CO_2 introduced by the at least two CO_2 production facilities into a pipeline operated by the pipeline operation facility,

an account recording mechanism configured to allocate a predetermined amount of CO_2 emission reduction credit to one or more of the at least two CO_2 production facilities and the pipeline operation facility for the CO_2 introduced into the pipeline, a labeling mechanism configured to assign an identification to the amount of CO_2 emission reduction credit, and

an exchange mechanism configured to assign ownership of the amount of the CO_2 emission reduction credit to another entity in exchange for the another entity providing a predetermined asset to one or more of the at least two CO_2 production facilities and the pipeline operation facility.

17. The system according to claim 16, wherein the at least two CO_2 production facilities have different methods of CO_2 production.

18. The system according to claim 16, wherein the at least two CO_2 production facilities are differently selected from the group consisting of

a facility for gasifying coal,

a facility for combusting coal or hydrocarbons to generate power,

a facility for calcining a carbonate including at least one element selected from the group consisting of magnesium and calcium,

a facility for producing hydrogen,

a facility for reducing a metal-containing compound to form a metal, and

a facility for synthesizing ammonia.

19. The system according to claim 16, wherein the predetermined asset is an amount of money.

20. The system according to claim 16, wherein

the message reception mechanism is configured to receive another message from a CO_2 consumption facility regarding an amount of the CO_2 withdrawn from the pipeline by the CO_2 consumption facility; and

the account recording mechanism is configured to allocate another predetermined amount of CO_2 emission reduction credit to the CO_2 consumption facility for the amount of CO_2 withdrawn from the pipeline.

21. The system according to claim 20, wherein the exchange mechanism is configured to assign ownership of the another predetermined amount of CO_2 emission reduction credit to the another entity in exchange for the another entity providing another predetermined asset to the CO_2 consumption facility.

22. The system according to claim 21, wherein the another predetermined asset is an amount of money.

23. The system according to claim 20, wherein the CO_2 consumption facility includes at least one oil field.

24. A computer implemented method for tracking emission reduction credits, the method comprising steps of

receiving a message at a controller from one or more of at least two CO_2 production facilities and a pipeline operation facility regarding an amount of CO_2 introduced by the at least two CO_2 production facilities into a pipeline operated by the pipeline operation facility;

allocating a predetermined amount of CO_2 emission reduction credit to one or more of the at least two CO_2 production facilities and the pipeline operation facility for the CO_2 introduced into the pipeline;

associating an identification to the amount of CO_2 emission reduction credit; and

assigning ownership of the amount of CO_2 emission reduction credit to another entity in exchange for the another entity providing a predetermined asset to one or more of the at least two CO_2 production facilities and the pipeline operation facility.

25. The method according to claim 24, wherein the at least two CO_2 production facilities have different methods of CO_2 production.

26. The method according to claim 24, wherein the at least two CO_2 production facilities are differently selected from the group consisting of

a facility for gasifying coal,

a facility for combusting coal or hydrocarbons to generate power,

a facility for calcining a carbonate including at least one element selected from the group consisting of magnesium and calcium,

a facility for producing hydrogen,

a facility for reducing a metal-containing compound to form a metal, and

a facility for synthesizing ammonia.

27. The method according to claim 24, wherein the predetermined asset is an amount of money.

28. The method according to claim 24, further comprising steps of

receiving another message from a CO_2 consumption facility regarding an amount of CO_2 withdrawn from the pipeline into the CO_2 consumption facility; and

allocating another predetermined amount of CO_2 emission reduction credit to the CO_2 consumption facility for the amount of CO_2 withdrawn from the pipeline.

29. The method according to claim 28, further comprising a step of assigning ownership of the another predetermined amount of CO_2 emission reduction credit to the another entity in exchange for the another entity providing another predetermined asset to the CO_2 consumption facility.

30. The method according to claim 29, wherein the another predetermined asset is an amount of money.

31. The method according to claim 28, wherein the CO_2 consumption facility includes at least one oil field.

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