CO_2 ACTIVATION OF ABANDONED OIL WELLS

Oil is removed in three phases. The first phase is simplest. The first phase is the primary phase where the oil is simply pumped from the well. After the oil production reaches exhaustion the secondary phase is initiated to extract additional oil by injecting water. Again, after the oil production reaches exhaustion the tertiary phase is initiated to extract the remaining oil that is extremely viscous so that CO_2 or N_2 gases are injected to reduce the viscosity.

Oil viscosity is reduced dramatically with dissolving CO_2 in oil. The overall reduction of viscosity depends on the initial viscosity, where there is greater reduction for higher viscous crudes. Reducing oil viscosity increases relative permeability of oil and reduces residual oil saturation. Oil permeability is higher in CO_2 injection compared to N_2 injection. Interfacial tension and viscosity reduction, and oil swelling are mechanisms that account for oil relative permeability improvement. These cause the recovery factor of CO_2 injection to become higher than N_2 injection. Recovery factor in CO_2 injection is higher due to swelling effect of CO_2 and lower interfacial tension result in lower residual oil saturation.

Figure 1 shows a commercial CO_2 gas injection into an abandoned oil well (Tertiary Phase). Figure 2 shows the three phases of the oil well activities. The tertiary phase wherein CO_2 is injected produces oil that would have been left behind in an oil well considered abandoned. Therefore, the tertiary phase oil production is called, Enhanced Oil Recovery (EOR).

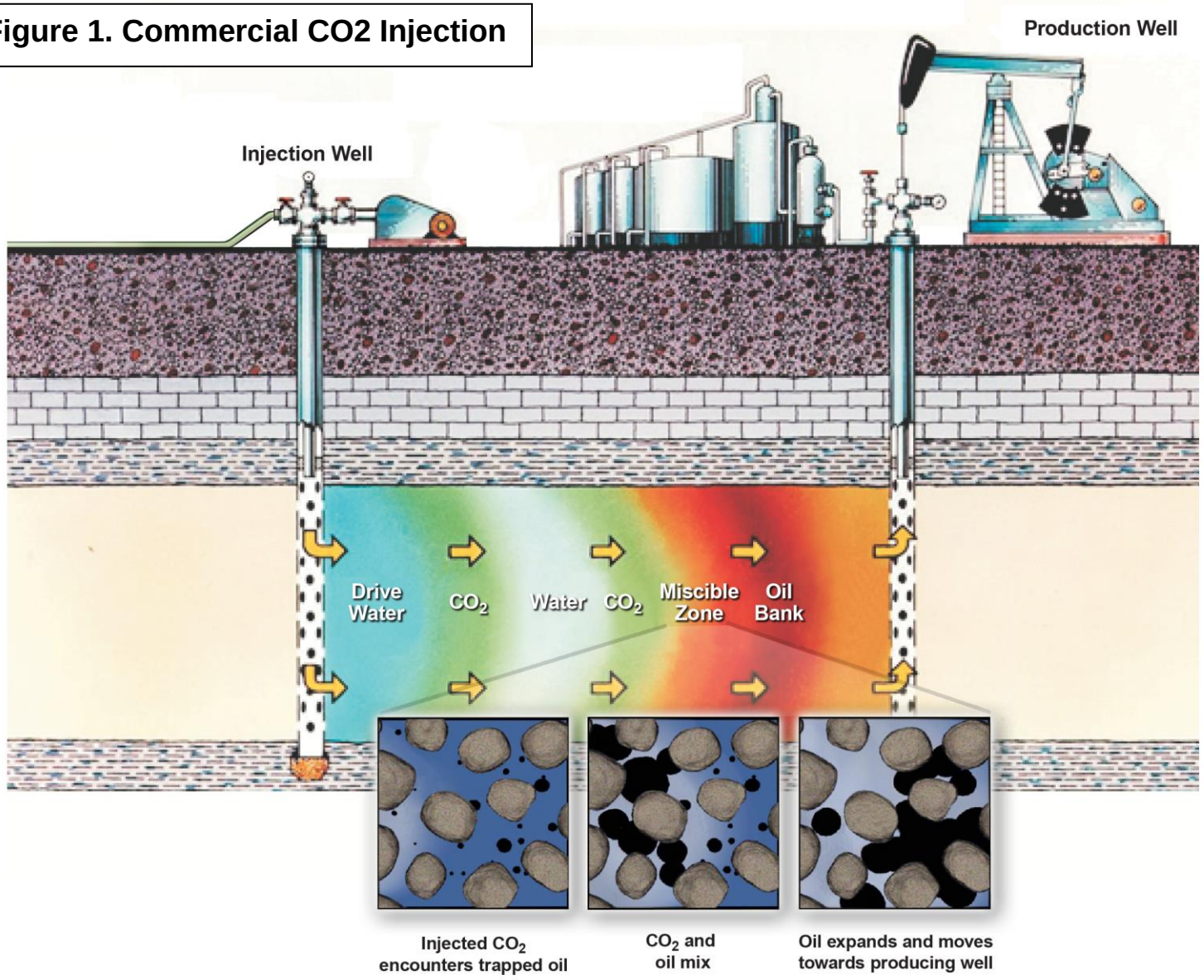
In the EEG LLC version of EOR CO_2 blocks are dropped down the existing injection borehole pipes so that the cold dry blocks of CO_2 impinge on the warm oil pool (Figure 3). The vaporizing CO_2 solid cylinders throw off vapor and propel the smaller and smaller solid cylinders through the viscous oil pool. The CO_2 gas mixes with the oil and reduces the oil viscosity so that it can be pumped again.

Figure 4 shows how this EOR process fits in with the patented suite of EEG LLC processes.

Figure 5 shows the state of development of the EEG LLC E.O.R. system. The reason for the rating is the degree of difficulty in obtaining a site for a Demonstration Test.

Figure 6 shows the ratings based upon the same difficulty…obtain a site for a Demonstration Test. In order to increase the possibility for obtaining access to an existing site we need a site where the dry ice cylinders can be easily dropped down the injection hole. The results at the production hole will then become evident.

Figure 1. Commercial CO2 Injection



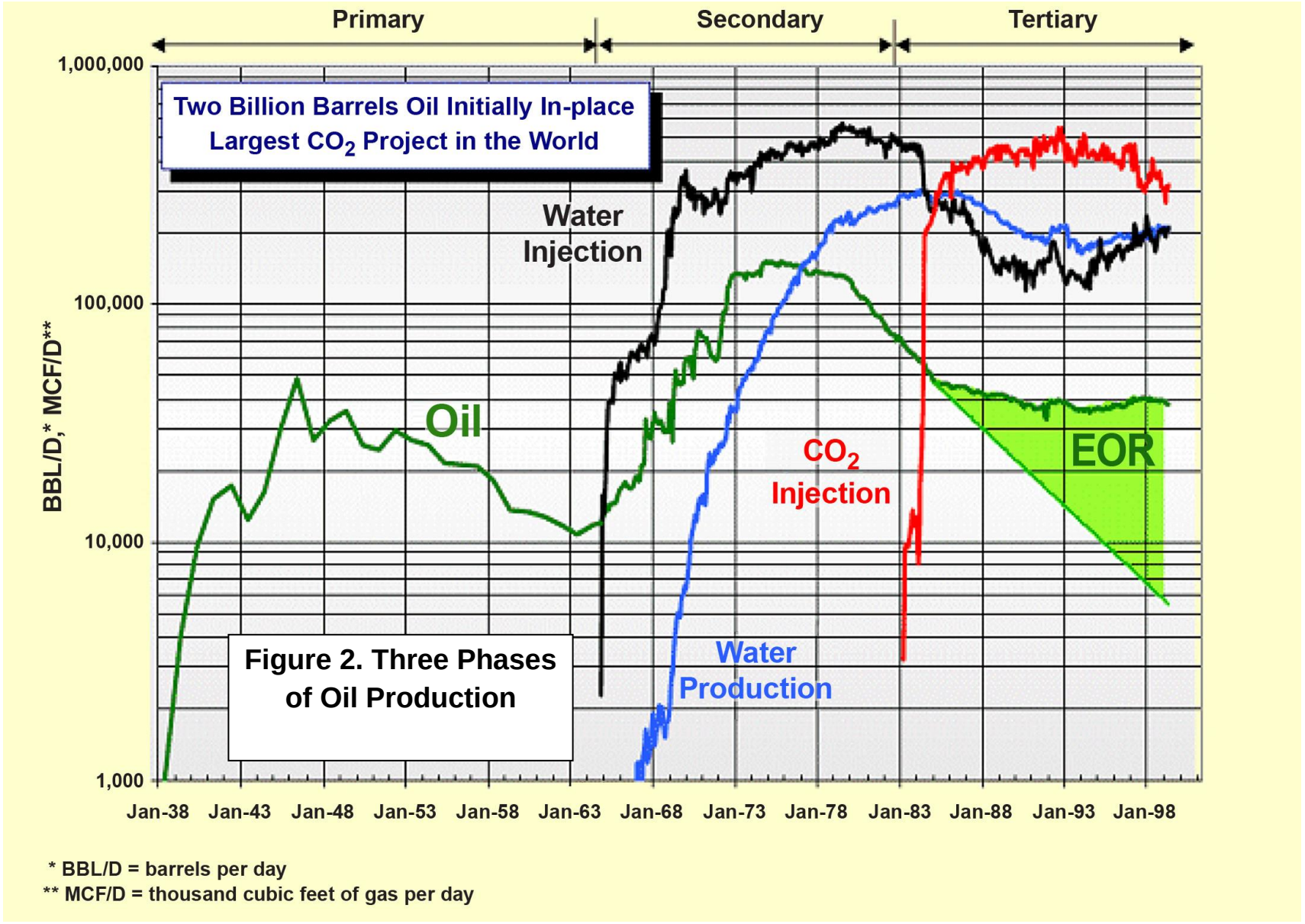


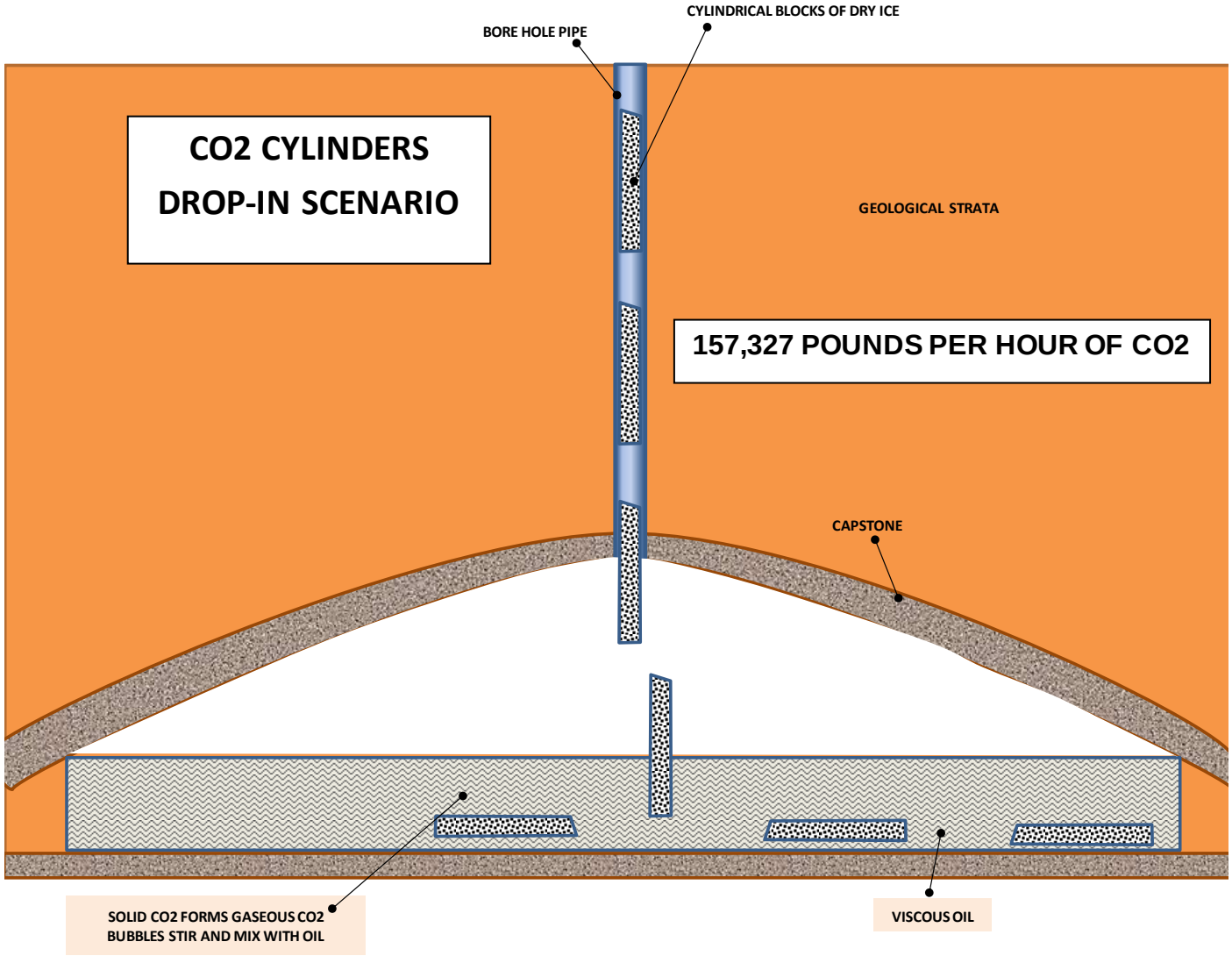
Figure 2. Three Phases of Oil Production

* BBL/D = barrels per day

** MCF/D = thousand cubic feet of gas per day

Figure 3. EEG LLC Tertiary Stage Procedure

CONTINUOUS DROP IN OF CO2 CYLINDERS
|DENSE CYLINDERS SINK TO BOTTOM OF MATURE OIL POOL
RAPID WARMING OF SOLID CO2 RESULTS IN VIGOROUS RELEASE OF CO2 BUBBLES
CO2 RAPIDLY AND FORCIBLY MIGRATES THROUGHOUT OIL POOL



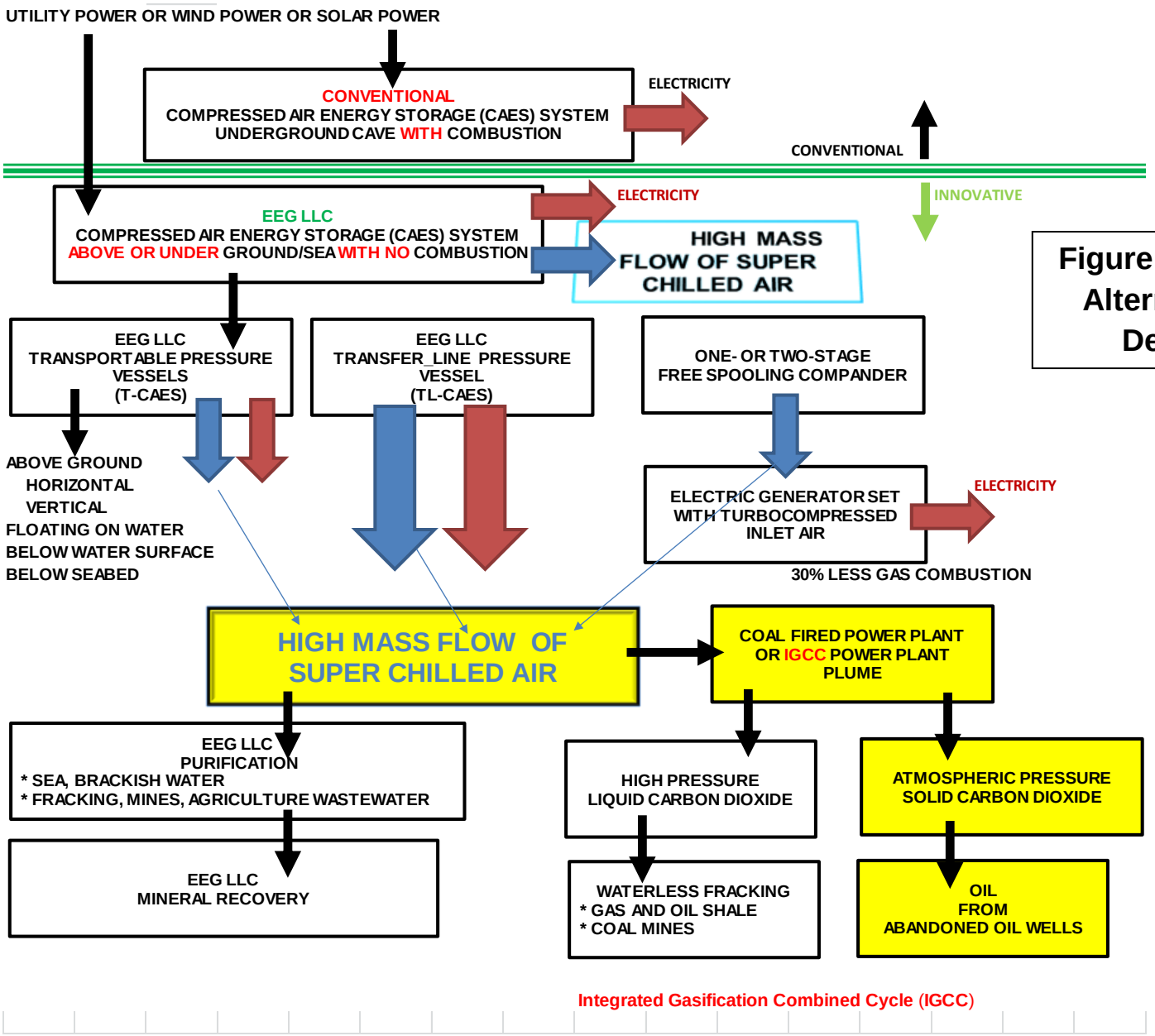


Figure 4. Sequence of Alternate Energies Development

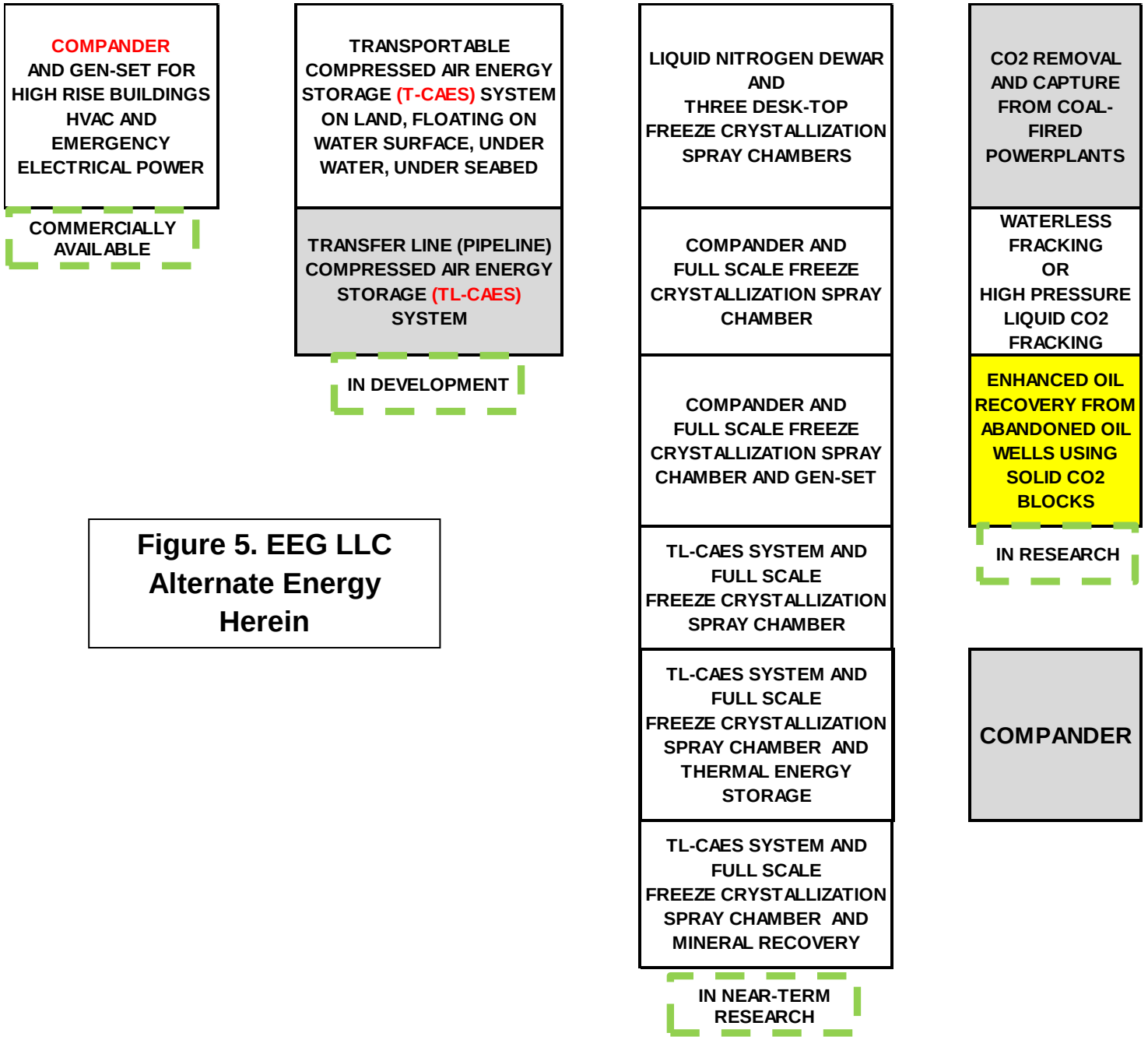


Figure 5. EEG LLC Alternate Energy Herein

SEE PATENT TITLE ON LIST OF PATENT NUMBERS	APPLICATION	STAGE OF DEVELOPMENT	INITIAL INVESTMENT	TIME SCALE	NUMBER OF SITES	MAGNITUDE OF RETURN PER SITE
12	COMPANDER AND GEN-SET FOR HIGH RISE BUILDINGS HVAC AND EMERGENCY ELECTRICAL POWER	EACH COMPONENT IS AVAILABLE OFF-THE SHELF EXCEPT FOR CENTRIFUGE DOUBLE-ELBOW-DUCT	VERY SMALL	PRESENT	VERY LARGE	EXTREMELY LARG
1, 3, 4, 11, 13, 16, 17	TRANSPORTABLE COMPRESSED AIR ENERGY STORAGE (T-CAES) SYSTEM ON LAND, FLOATING ON WATER SURFACE, UNDER WATER, UNDER SEABED	EACH COMPONENT IS AVAILABLE OFF-THE SHELF	MEDIUM	PRESENT	LARGE	MEDIUM
2	TRANSFER LINE (PIPELINE) COMPRESSED AIR ENERGY STORAGE (TL-CAES) SYSTEM	EACH COMPONENT IS AVAILABLE OFF-THE SHELF	LARGE	PRESENT	MEDIUM	MEDIUM
18	LIQUID NITROGEN DEWAR AND THREE DESK-TOP FREEZE CRYSTALLIZATION SPRAY CHAMBERS	SIMPLE SOLUTES (HIGH CERTAINTY) COMPLEX SOLUTES (LESS CERTAIN) TOXIC SOLUTES (LEGAL ISSUES)	SMALL	MONTHS	MEDIUM	LARGE
18	COMPANDER AND FULL SCALE FREEZE CRYSTALLIZATION SPRAY CHAMBER	ISOLATION PERFORMANCE DEPENDENT ON 3 DESK-TOP CHAMBER TESTS	VERY SMALL	MONTHS	ONE	EXTREMELY LARGE
6 , 7	TL-CAES SYSTEM AND FULL SCALE FREEZE CRYSTALLIZATION SPRAY CHAMBER	VALIDATE SEPARATION EFFICIENCY OF WASTEWATER DROPLETS OVER SHORT RESIDENCE TIME AND WITH EXTREME TEMPERATURE DIFFERENCES	LARGE	MONTHS	ONE	EXTREMELY LARGE
5, 7	TL-CAES SYSTEM AND FULL SCALE FREEZE CRYSTALLIZATION SPRAY CHAMBER AND THERMAL ENERGY STORAGE	SITE WHERE THERMAL ENERGY STORAGE WATER TANKS ALREADY IN USE	LARGE	MONTHS	VERY LARGE	MEDIUM
8	TL-CAES SYSTEM AND FULL SCALE FREEZE CRYSTALLIZATION SPRAY CHAMBER AND MINERAL RECOVERY	VALIDATE SEPARATION EFFICIENCY OF BULK WASTEWATER OVER SHORT RESIDENCE TIME AND WITH EXTREME TEMPERATURE DIFFERENCES	VERY LARGE	SEVERAL YEARS	LARGE	LARGE
9	CO2 REMOVAL AND CAPTURE FROM COAL-FIRED POWERPLANTS	CURRENT TECHNOLOGY OF HEAT EXCHANGERS	LARGE	MONTHS	MEDIUM	LARGE
10, 14	WATERLESS FRACKING OR HIGH PRESSURE LIQUID CO2 FRACKING	EXTEND SHALE/COAL STRATA LABORATORY DATA TO FIELD	VERY VERY LARGE	MANY YEARS	VERY LARGE	EXTREMELY LARGE
15	ENJANCED OIL RECOVERY FROM ABANDONED OIL WELLS USING SOLID CO2 BLOCKS	EXTEND LABORATORY DATA TO FIELD	VERY VERY LARGE	MANY MANY YEARS	MEDIUM	SMALL

Figure 6. Ratings of the EEG LLC Processes