CLAIMS

1. A process comprising:

(i) providing a gaseous stream including greater than 1 % by volume carbon dioxide;

(ii) providing water;

(iii) converting the carbon dioxide and the water to an organic intermediate and oxygen gas in the presence of light and photosynthetic microorganisms;

(iv) separating the oxygen gas from the organic intermediate; and

(v) converting, via a microorganism, the organic intermediate to ethylene and carbon dioxide after said step (iv) of separating the oxygen gas from the organic intermediate.

2. The process of claim 1, where said step (v) of converting the organic intermediate to ethylene and carbon dioxide takes place in the presence of excess water from said step (iii) of converting carbon dioxide and water to an organic intermediate, and where said step (v) of converting, via a microorganism, the organic intermediate to ethylene and carbon dioxide consumes only a portion of the organic intermediate formed in said step (iii) of converting carbon dioxide and water to an organic intermediate and oxygen gas, and further comprising the step of routing the excess water and organic intermediate from said step (v) of converting the organic intermediate to ethylene and carbon dioxide back to said step (iii) of converting the carbon dioxide and water to an organic intermediate.

3. The process of claim 1, where said step (iii) of converting carbon dioxide and water to an organic intermediate and oxygen gas takes place within a first bioreactor that contains the photosynthetic microorganisms, wherein the photosynthetic microorganisms are a microorganism that produces an organic intermediate and oxygen gas from the carbon dioxide in the presence of light energy.

4. The process of any of the preceding claims, where said gaseous stream includes greater than 3 % by volume carbon dioxide.

5. The process of any of the preceding claims, further comprising the step of compressing a flue gas stream from a combustion step to form the gaseous stream containing carbon dioxide.

6. The process of any of the preceding claims, where said step (iv) of separating oxygen from the organic intermediate produces an organic intermediate-rich stream that is introduced to said step (v) of converting, via a microorganism, the organic intermediate to ethylene and carbon dioxide.

7. The process of claim 6, where the organic intermediate-rich stream includes less than 30 ppm oxygen.

8. The process of claim 3, where said step (iv) of separating oxygen gas includes venting oxygen gas from the first bioreactor.

9. The process of any of the preceding claims, where said step (v) of converting, via a microorganism, the organic intermediate to ethylene and carbon dioxide takes place within a second bioreactor that contains the microorganism which produces an enzyme for converting the organic intermediate to ethylene and carbon dioxide.

10. The process of any of the preceding claims, where said step (v) of converting, via a microorganism, the organic intermediate to ethylene and carbon dioxide takes place in the substantial absence of light energy.

11. The process of any of the preceding claims, where the ethylene and the carbon dioxide formed in said step (v) of converting, via a microorganism, the organic intermediate to ethylene and carbon dioxide form a product stream.

12. The process of claim 11, further comprising the step of converting oxygen gas within the product stream to carbon dioxide.

13. The process of claim 11 or 12, further comprising the step of removing water from the product stream.

14. The process of any of claims 11-13, further comprising the step of separating carbon dioxide from the product stream.

15. The process of claim 14, where said step of separating carbon dioxide from the product stream produces an ethylene-rich stream.

16. The process of claim 14 or 15, where said step of separating the carbon dioxide from the product stream produces a carbon dioxide stream, and where the carbon dioxide stream is introduced to the step (iii) of converting the carbon dioxide and water to an organic intermediate and oxygen gas.

17. The process of any of the preceding claims, where said step (iii) of converting carbon dioxide and water to an organic intermediate and oxygen gas takes place within a first bioreactor.

18. The process of any of the preceding claims, where said step (iv) of separating the oxygen gas from the organic intermediate includes venting the oxygen gas from an aqueous medium in which the organic intermediate is contained.

19. The process of any of the preceding claims, where said step (v) of converting, via a microorganism, the organic intermediate to ethylene and carbon dioxide after said step (iv) of separating the oxygen gas from the organic intermediate takes place within a second bioreactor.

20. A system for producing ethylene, the system comprising:

(i) a first bioreactor including photosynthetic microorganisms that convert carbon dioxide to an organic intermediate and a by-product oxygen gas, said first bioreactor having a carbon dioxide inlet, a first outlet for the organic intermediate, and a second outlet for the by-product oxygen gas; and

(ii) a second bioreactor in fluid communication with the first bioreactor and including microorganisms that convert the organic intermediate produced in the first bioreactor to ethylene, said second bioreactor having an outlet for gaseous materials including ethylene, and said second bioreactor having an outlet for fluid materials including unreacted organic intermediate.

21. The system of claim 20, where the outlet for fluid materials of said second bioreactor is in fluid communication with said first bioreactor.

22. The system of claim 20, where the outlet for gaseous materials of said second bioreactor is in fluid communication with a carbon dioxide separator.

23. The system of claim 22, where the carbon dioxide separator includes an outlet for purified carbon dioxide, and where said outlet for purified carbon dioxide is in fluid communication with the first bioreactor.