Free Oxygen [O_2] Chemistry

Photosynthesis

With the aid of plants, Solar photon energy splits water molecules into free oxygen, protons (hydrogen ions) and energetic electrons.

$$H_2O + h\upsilon \rightarrow O_2 + 4H^+ + 4e^-$$

On the dark side, the Calvin reaction adds CO2 to create carbohydrate based molecules with entrapped energy. The electrons are transported by a special molecule: NADPH.

$$CO_2 + 4H^+ + 4e^- \rightarrow \left| CH_20 \right| + H_2O$$

Finally it's O_2 added to the air and carbohydrate molecules in a plant.
The earth's atmosphere is 21% O_2 from past and current photosynthesis.
Today O_2 delivers energy for biological and industrial human needs.

Respiration

Animals, and plants respire; their cells act to react O_2 with carbohydrate molecules (food) to release the energy needed to function. Humans breathe with lungs to capture O_2 into blood streams.

Glucose (sugar): [carbohydrate]

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 2880 \text{ kJ/mol}$$

Combustion

Photosynthesis molecules end up as complex organic matter like wood and methane. Over the ages, plant organic matter degenerates into fossil fuels. Oxidation releases some electron binding energy as heat.

Coal: [just carbon]

$$C + O_2 \rightarrow CO_2 + 395 \text{ kJ/mol}$$

Methane (natural gas): [hydrocarbon]

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + 890 \text{ kJ/mol}$$

Propane (heating gas): [hydrocarbon]

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O + 2204 \text{ kJ/mol}$$

Octane (gasoline): [hydrocarbon]

$$C_8H_{18} + 12.5O_2 \rightarrow 8CO_2 + 9H_2O + 5452 \text{ kJ/mol}$$

Note:For hydrocarbons, combustion heat is ~ 440 kJ/mol per O_2 mole.
1calorie = 4.18 joules, 1mol = 6.02 x 10^{23} molecules