# Chemistry and Energy Sustainability

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## ABSTRACT

A well-known book titled “Chemistry the Central Science” has been republished up to its 13th edition in 2014, indicating that the significance of chemistry is well recognized in the development of science and technology. For energy sustainability, the role of chemistry is crucial. The carbon energy creates human civilization, which is now threatened in return by carbon emission for its sustainability. The concept of green carbon science is then proposed as the scientific basis for the integration of highly efficient carbon resource processing and utilization, low carbon emission, and carbon chemical recycling. Green carbon science is defined as study and optimization of the transformation of carbon chemical bonding and the relevant processes involved in the entire carbon cycle from carbon resource processing, carbon energy utilization, CO2 fixation, and carbon recycling to minimize the carbon imbalance caused by over-consumption of carbon resources. The objective is clearly energy sustainability.

The chemistry basics for carbon energy, such as elements, bonds, and molecules are briefly introduced. The essence of chemistry for energy conversion lies in two main aspects: hydrogen involving chemistry and redox chemistry. The key role of hydrogen for green carbon science and energy sustainability is highly stressed. The redox chemistry, which is closely related to carbon energy and carbon recycle, can be interpreted as intrinsic chemistry of green carbon science. Chemistry for energy storage and chemical engineering approaches are also discussed.

Four Phases I, II, III and IV can be discriminated for different conversion reactions and related processes in the graphic expression of green carbon science, they are: low carbon fossil resource processing, biomass conversion, CO2 chemical recycling, and CO2 ecological/chemical recycling, respectively. The core part of the graphic expression is fuel and chemicals production, that is, the function of a refinery. If oil refinery is regarded as the first generation refinery, the second, third, fourth and fifth generation refineries will be constructed by sequentially introducing Phase I, II, III and IV processes.