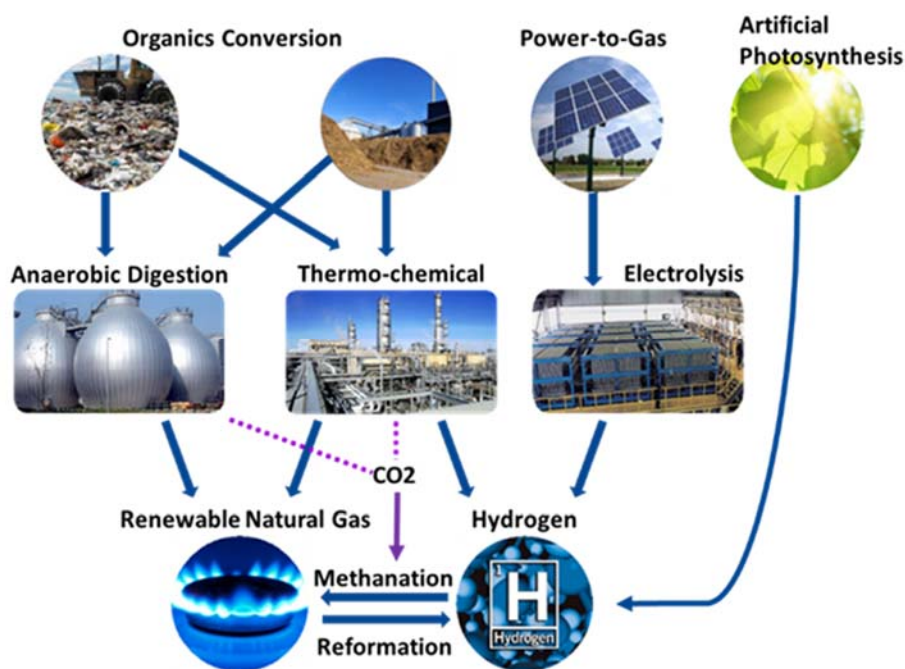




## Overview of Renewable Gaseous Fuel (Renewable Gas)

Renewable gas is a term used to describe gaseous fuels, specifically renewable methane and hydrogen, that introduce no net CO<sub>2</sub> into the atmosphere when they are combusted (such as in a power plant or burner) or oxidized without combustion (such as in a fuel cell). Although methane (CH<sub>4</sub>) obviously contains carbon, it can be climate neutral if the carbon comes from a so-called continuous or biogenic cycle – one in which carbon is removed from the air when the material is formed, for example, via photosynthesis as plants grow. It is this continuous carbon cycle that makes dairy biogas, landfill gas and gasified woody biomass material carbon-neutral.

Hydrogen is carbon-free but can have a carbon footprint if produced from fossil natural gas or electricity that has CO<sub>2</sub> emissions. The term renewable hydrogen is used to distinguish hydrogen that uses only renewable feedstock (organic material, renewable methane or renewable electricity) in its formation. Renewable hydrogen and renewable methane can be inter-converted through either reformation of renewable methane to produce hydrogen or methanation of renewable hydrogen (by reaction with CO<sub>2</sub>) to produce methane. Research is being undertaken to produce renewable gaseous fuel directly from sunlight via a process termed artificial photosynthesis. The various renewable hydrogen and methane pathways are shown in Figure 1 below.



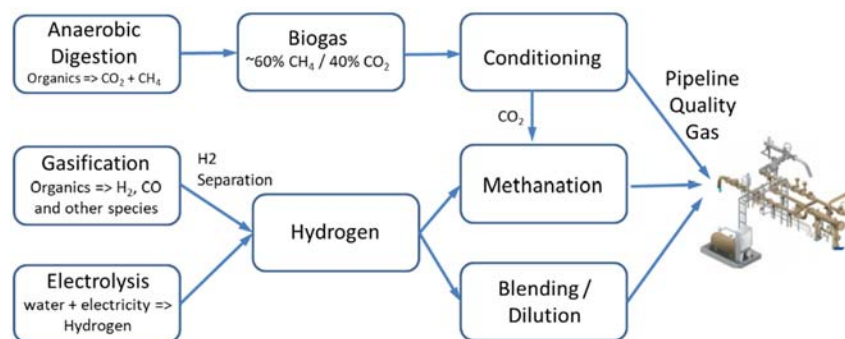
**Figure 1.** Renewable Gas Production Pathways

As yet, there is no universally agreed to terminology for the various types of renewable gas, but the table below reflects an evolving consensus on terminology.

Term	Definition / Usage
Biogas	Mixture of methane/ CO <sub>2</sub> (~ 60/40 by volume) and minor constituents derived from bio sources – cannot be introduced onto the common carrier natural gas system without cleanup
Biomethane	Biogas that has been conditioned (cleaned and purified) to meet pipeline standards comprised primarily of methane with small remaining amounts of CO <sub>2</sub>
Syngas	Hydrogen rich gas (with high fraction of carbon monoxide, CO) produced through gasification of biomass , from which (near) pure hydrogen or methane (with additional CO <sub>2</sub> ) can be synthesized
Synthetic methane / Renewable methane	Methane fmed by combining hydrogen (generally from electrolysis) with CO <sub>2</sub> – it is renewable if the CO <sub>2</sub> is biogenic or captured from the air, and the electricity is renewable
Renewable Natural Gas	While generally used interchangeably with biomethane, includes as well renewable electrolytic methane
Renewable or Green Hydrogen	Hydrogen derived through electrolysis or reformation of methane derived from renewable feedstocks (organics and renewable energy)
Renewable Gas	All of the above.

The use of the natural gas system to absorb, store, and transport renewable hydrogen and renewable methane is an important element of ensuring that the value of renewable gas can be fully realized by making the fuel available where and when needed. The California Public Utilities Commission (“Commission”) has already undertaken significant action to ensure that renewable methane sourced from bio resources (i.e., biomethane) can be stored and transported over the natural gas system through recent proceedings. There remain several issues yet to address. Figure 2 shows a variety of pathways for producing and conditioning (i.e., removing CO<sub>2</sub> and other constituents to bring the gas within the parameters required for safety and interchangeability on the common carrier gas system). Four key issues need to be addressed to support development of renewable gas resources:

- Heating value limit (this is well known to the Commission)
- Hydrogen blending limits (engineering literature indicates an acceptable range of 5% to 20% but there is no active Commission proceeding addressing this issue)
- Blending renewable gas with gas from the common carrier system can potentially address the gas quality issue but tariffs are not currently in place to “borrow” gas for blending
- Electrolytic hydrogen producers must currently pay retail rates for “surplus” (or otherwise curtailed) renewable energy



**Figure 2.** Renewable Gas to Pipeline Pathways