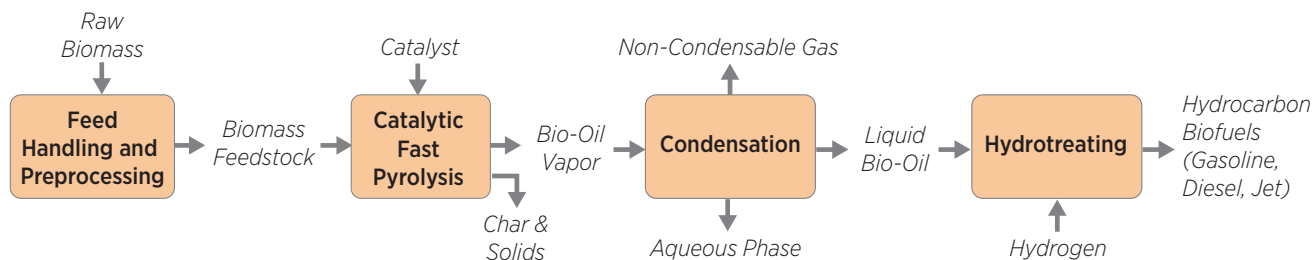


## In-Situ Catalytic Fast Pyrolysis

*In the in-situ catalytic fast pyrolysis pathway, biomass is rapidly heated in a fluidized bed reactor containing a catalyst to yield a partially stabilized and deoxygenated bio-oil vapor. The vapor is condensed into a liquid bio-oil and subsequently upgraded to produce hydrocarbon biofuel blendstocks.*

### Process Block Diagram



### Process Design Details

- Biomass containing 30 percent weight (wt%) water is dried to about 10 wt% moisture and size reduced to 2–6 millimeters to produce an acceptable biomass pyrolysis feedstock.
- The biomass feedstock is rapidly converted in the absence of oxygen in a reactor containing a catalyst (catalytic fast pyrolysis). As the biomass vaporizes due to heating (usually between 350°C–500°C), the catalyst acts to partially deoxygenate and stabilize the pyrolysis vapor. Common catalysts typically used to crack the vapor are zeolite, doped zeolite, superacid, solid acid, or other catalyst types. Catalysts can be recycled or regenerated in a circulating fluidized bed reactor.
- The stabilized bio-oil vapor exits the reactor, and solids are removed via cyclones.
- The resulting bio-oil vapor is condensed into a liquid and spontaneously phase separates into aqueous and organic phases
- The organic fraction of bio-oil is hydrotreated in one or more stages. The number of stages and severity will be dependent upon the level of oxygen and oxygenated species in the intermediate catalytic pyrolysis bio-oil. The severity of hydrotreating is expected to be lower than those used to upgrade conventional fast pyrolysis oils. Cobalt molybdenum is one hydrotreating catalyst that may be used in this process.
- Hydrotreated bio-oil is expected to be a wide-boiling range stream that can be distilled into appropriate blendstock ranges (e.g., naphtha and diesel). Hydrocracking may not be necessary depending on the extent of cracking that occurs during vapor phase upgrading.
- The aqueous phases resulting from catalytic fast pyrolysis and hydrotreating can contain up to 40% of the biogenic carbon; therefore, maximizing carbon efficiency throughout (for higher fuel product yields) is essential.

### Rationale for Selection

Conventional fast pyrolysis with vapor phase upgrading research and development (R&D)—which is the existing design case—as well as the R&D in the ex-situ pathway design case, will facilitate understanding of the upgrading step chemistry and optimum catalyst/operating conditions for in-situ. Therefore, it's a natural segue to move from fast pyrolysis, to ex-situ catalytic fast pyrolysis, and then to in-situ fast pyrolysis as a technology development pipeline.

### Next Steps

Techno-economic analysis models for the in-situ catalytic fast pyrolysis pathway will be developed in 2014. These analyses will be used to develop 2022 technical and cost targets.