
NINTH ANNUAL NH₃ FUEL CONFERENCE

Simple Molecules Strategy

An Approach to Integrating NH₃ Fuel into the Transportation Fuel Economy

October 1, 2012



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Starting Point: The Dual-Fuel Strategy

- The Dual-Fuel Strategy was developed by Professor Bill Ahlgren of Cal Poly University
 - A scheme for a fully sustainable, comprehensive global energy economy
 - Calls for a focus on two energy vectors: a “carbofuel (e.g., methanol)” and a “nitrofuel (e.g., ammonia)”
 - Concerned both with the ultimate state and with the process for getting there from here

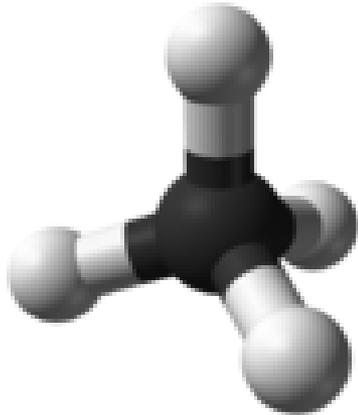
The Role of NH3 in the Strategy

- NH3 does the heavy lifting in the Dual-Fuel Strategy: “Nitrofuel will be most efficiently produced and at least cost; it will therefore be used whenever possible.”
- This is so because NH3 is the best bet when weighed against three criteria
 - Cost
 - Implementability
 - Ultimate scalability

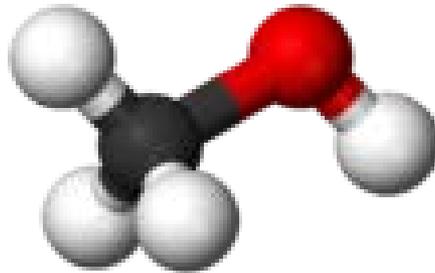
The Unique Circumstance

- Its performance against the key criteria derives in part from a circumstance that is unique to NH₃: it can be a part of three major future-oriented energy movements:
 - “Clean Fossil”
 - Biofuels
 - Smart Grid
- There is a play that can be made with NH₃ in each movement
 - Now, without any further ado
- The Simple Molecules Strategy speaks to the Biofuels play

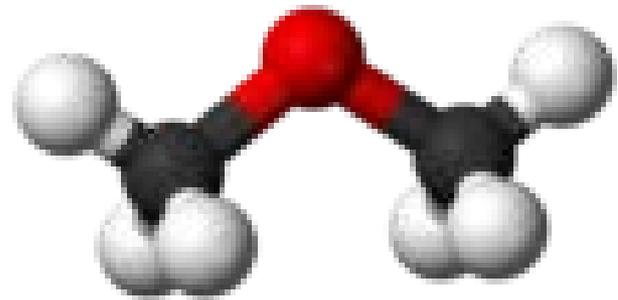
The Simple Molecules



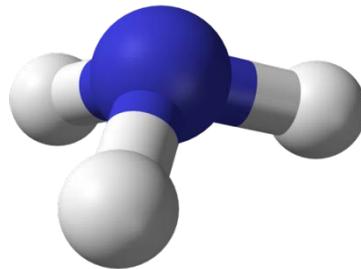
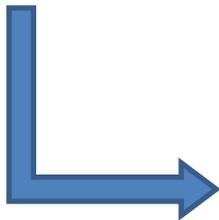
Methane



Methanol



Dimethyl Ether



Ammonia

The Simple Molecules Strategy

Vehicle Side

Fuel Side

Breaking the Alt Vehicle/Fuel Impasse

Vehicle Side

Fuel Side

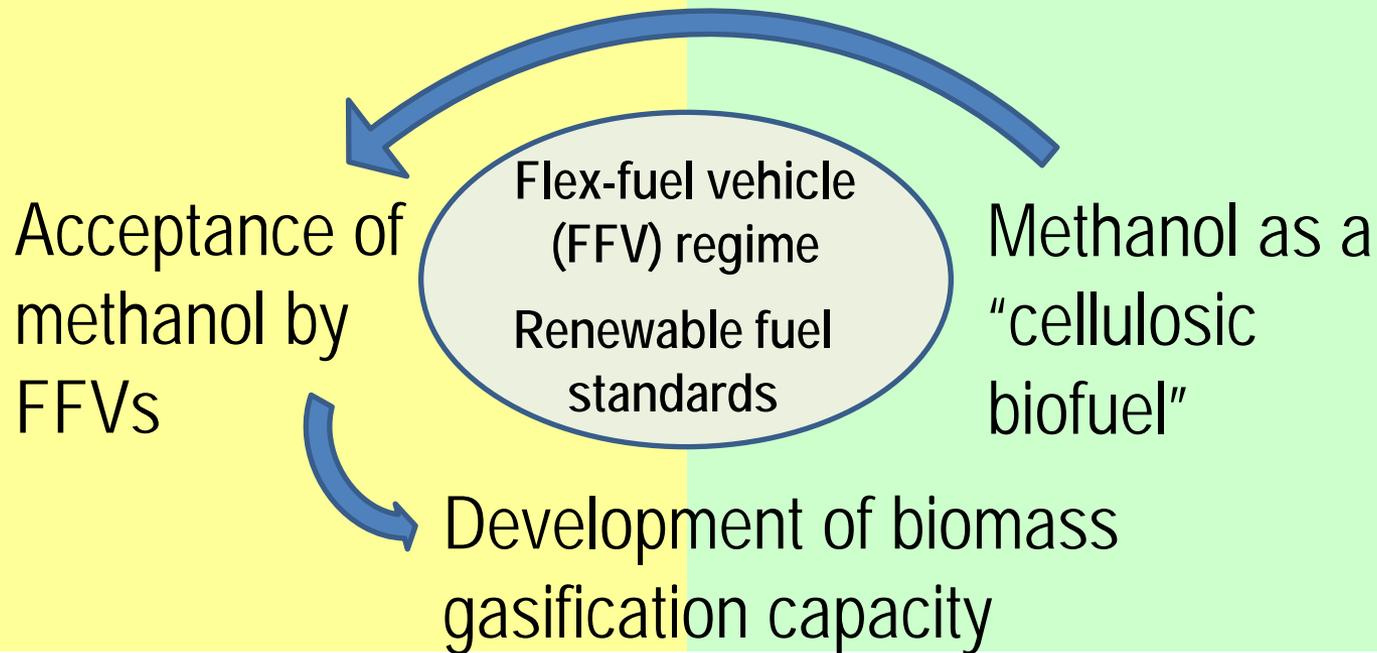
Flex-fuel vehicle
(FFV) regime

Renewable fuel
standards

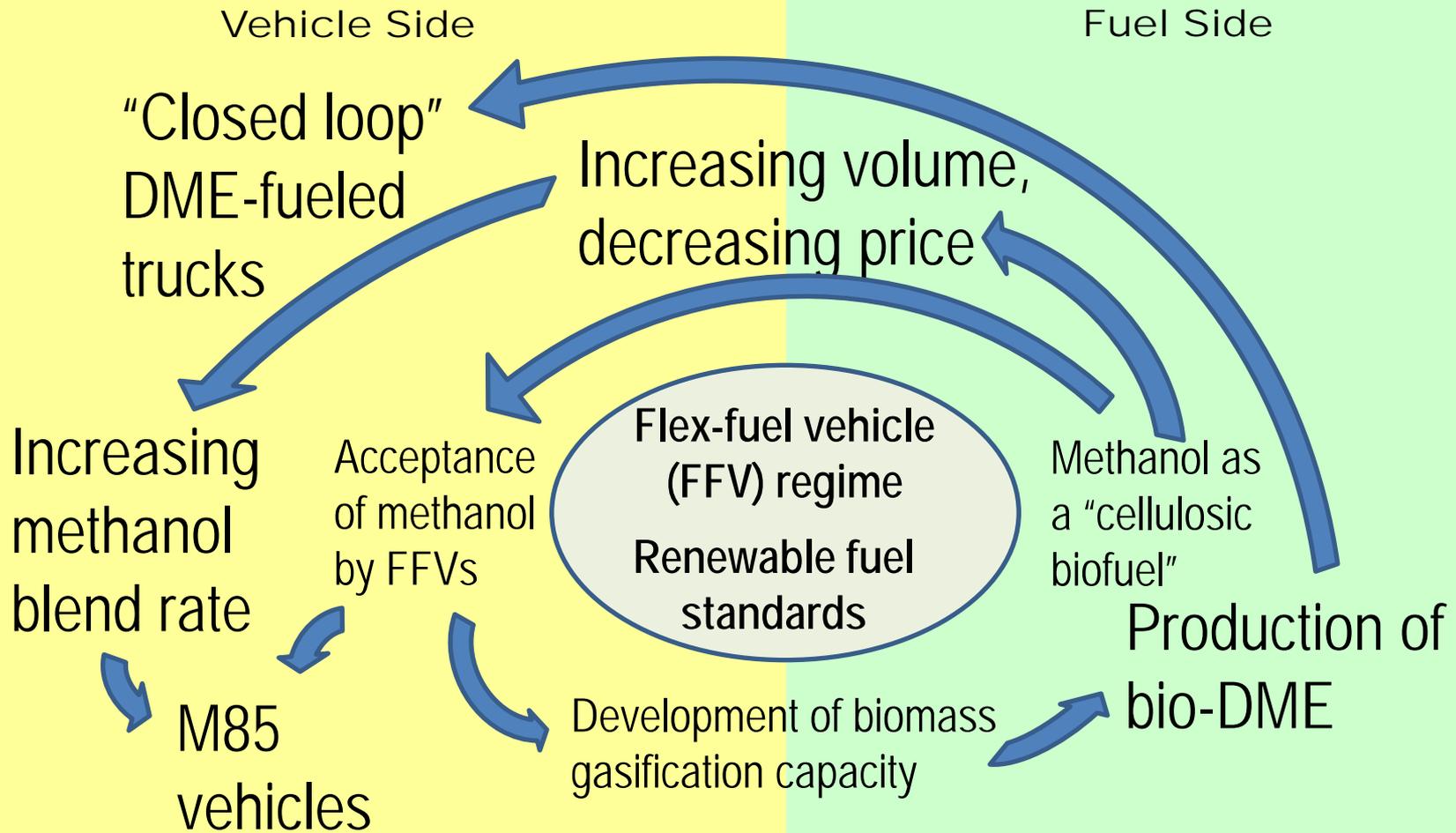
Breaking the Alt Vehicle/Fuel Impasse

Vehicle Side

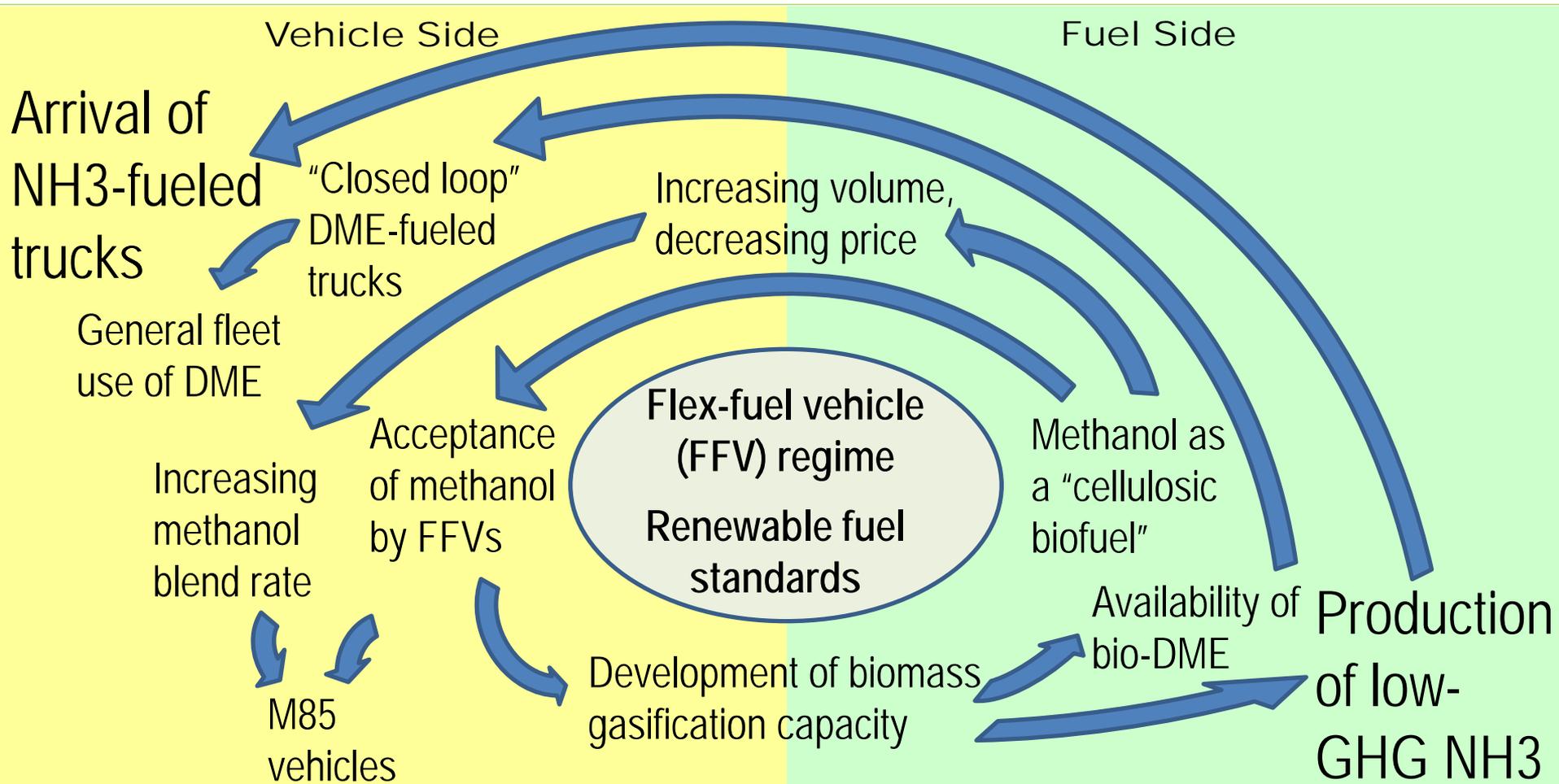
Fuel Side



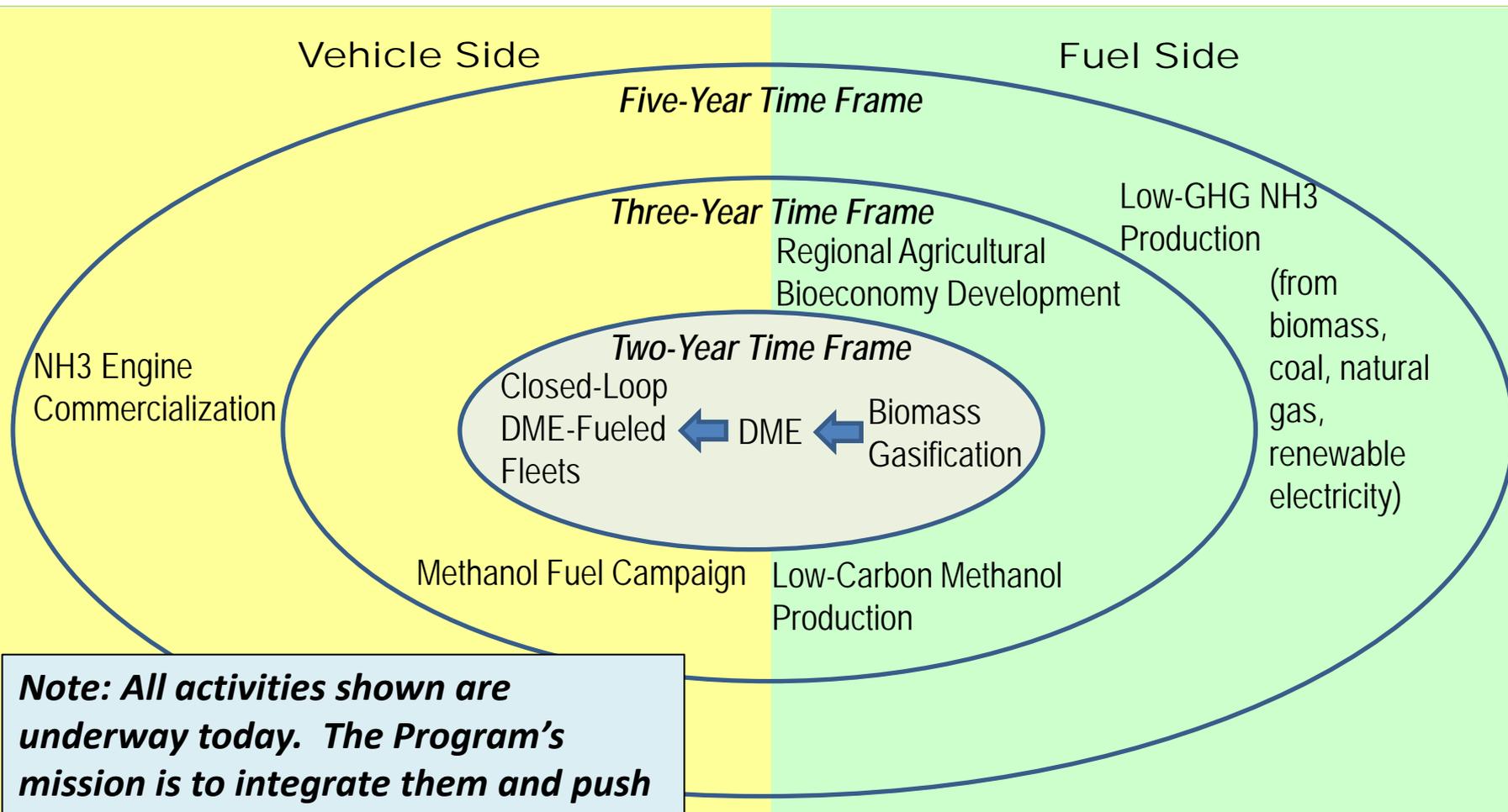
Breaking the Alt Vehicle/Fuel Impasse



Breaking the Alt Vehicle/Fuel Impasse



SIMPLE MOLECULES PROGRAM CONCEPT



Note: All activities shown are underway today. The Program's mission is to integrate them and push them forward with greater urgency

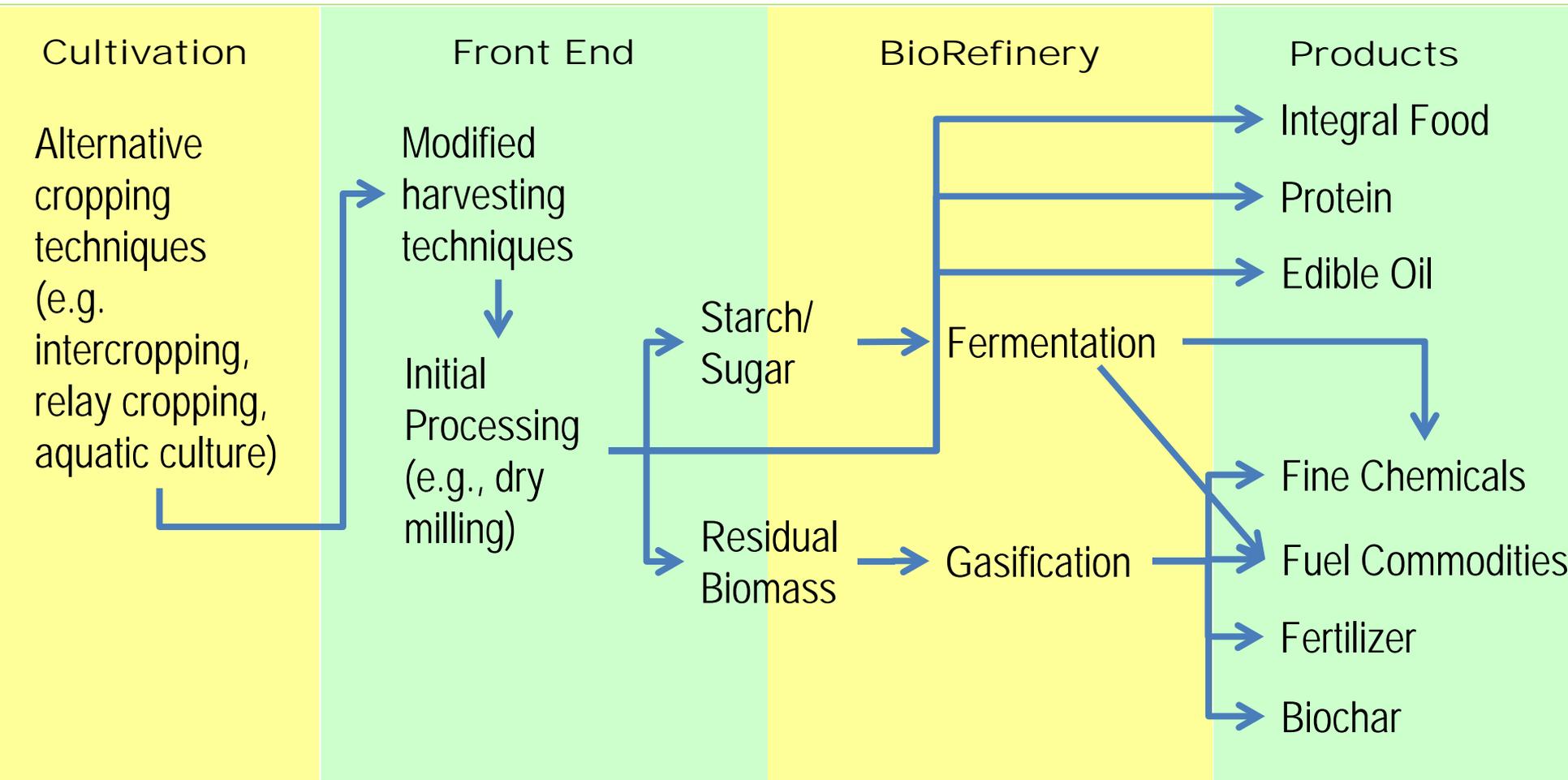
Strategy Implementation - 1

- California is an important front for all four Simple Molecules
 - Methane is a major focus of the CEC Alternative Fuels group
 - Methanol was the subject of a pioneering program in the 1990s
 - A “bottom-up” DME fuel initiative is gaining momentum
 - Best venue for establishing NH₃ as a transportation fuel, starting with demonstration projects both on the supply and demand sides of the market
 - Source of a new concept: tradable carbon credits from the use of green NH₃ as a fertilizer

Strategy Implementation - 2

- Now opening a new front of activity in Washington, working with various players to support the U.S. Renewable Fuel Standard
- We are there as an advocate for the larger questions
 1. Ultimate scalability: the authoritative USDOE/USDA study projects that biomass-derived fuels could meet one-third of our transportation needs
 2. Seamless transition: how can biofuels set the stage for other production methods of the simple molecules
 3. Level playing field: the system should give all comers the chance to compete and should let the best option will win

AGRICULTURAL BIOECONOMY

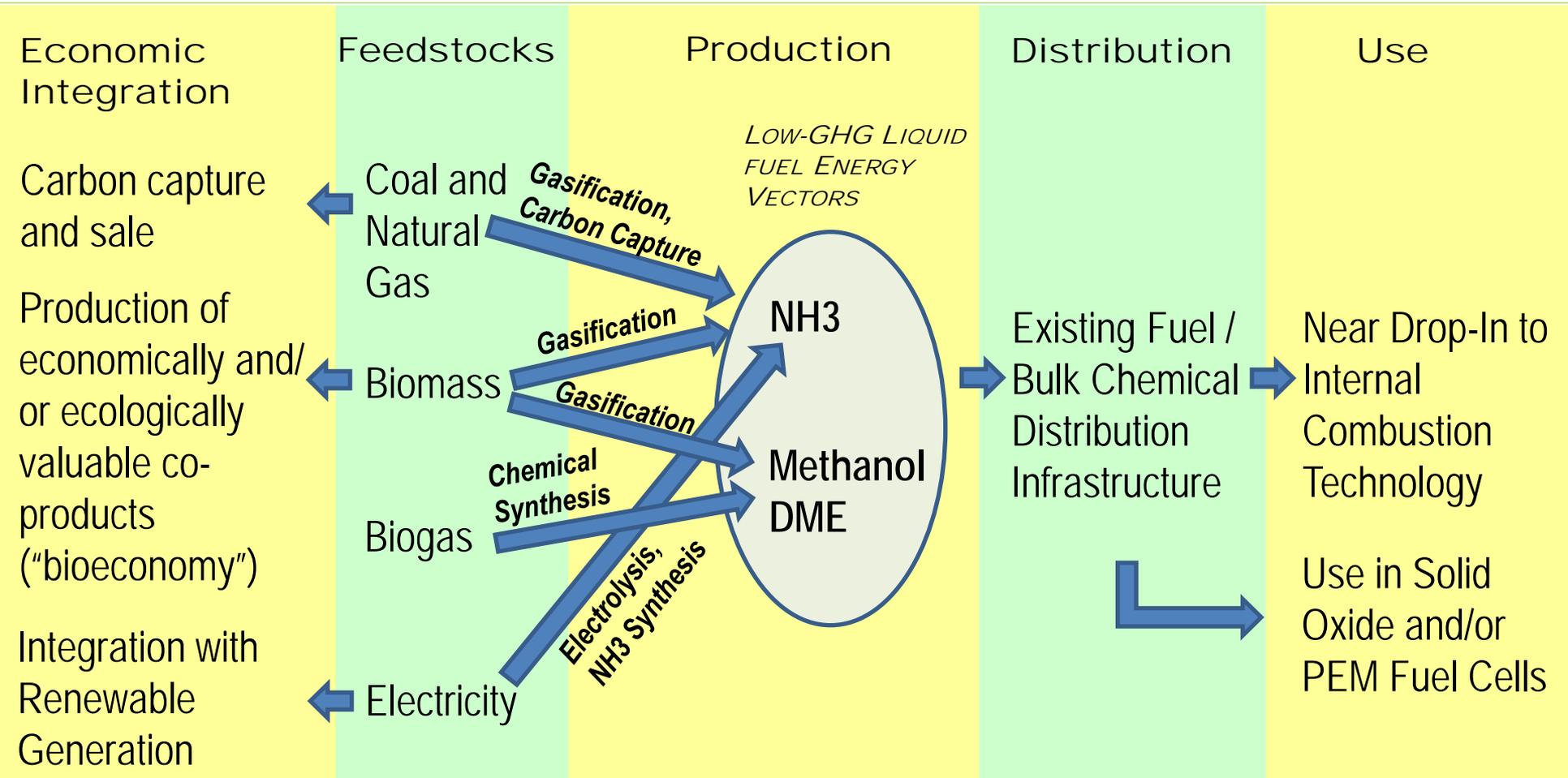


Based on Syngest's "Cornucopia" concept : <http://www.biofuelsdigest.com/bdigest/2010/06/16/transformation-technology-syngest-cornucopia-biorefinery/> . .



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MOST PROMISING ENERGY VECTORS



From Bill's IEEE Paper

- “The dual-fuel strategy is a plan to facilitate the transition from fossil to renewable sources by first replacing fossil with renewable fuels. It stipulates that all energy sources (fossil, renewable, and nuclear) will be most efficiently monetized by conversion to three primary energy vectors: electric power and two liquid renewable fuels, all compatible with existing infrastructure. One member of a dual-fuel pair is nitrogen-based, for example, ammonia, and the other is carbon-based, for example, methanol.”
 - “The Dual-Fuel Strategy: An Energy Transition Plan”, accepted for publication by the [Proceedings of the IEEE](#)