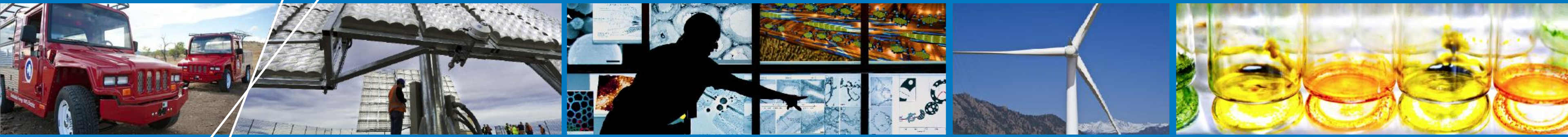
Applications of the Biomass Scenario Model



Brian W Bush

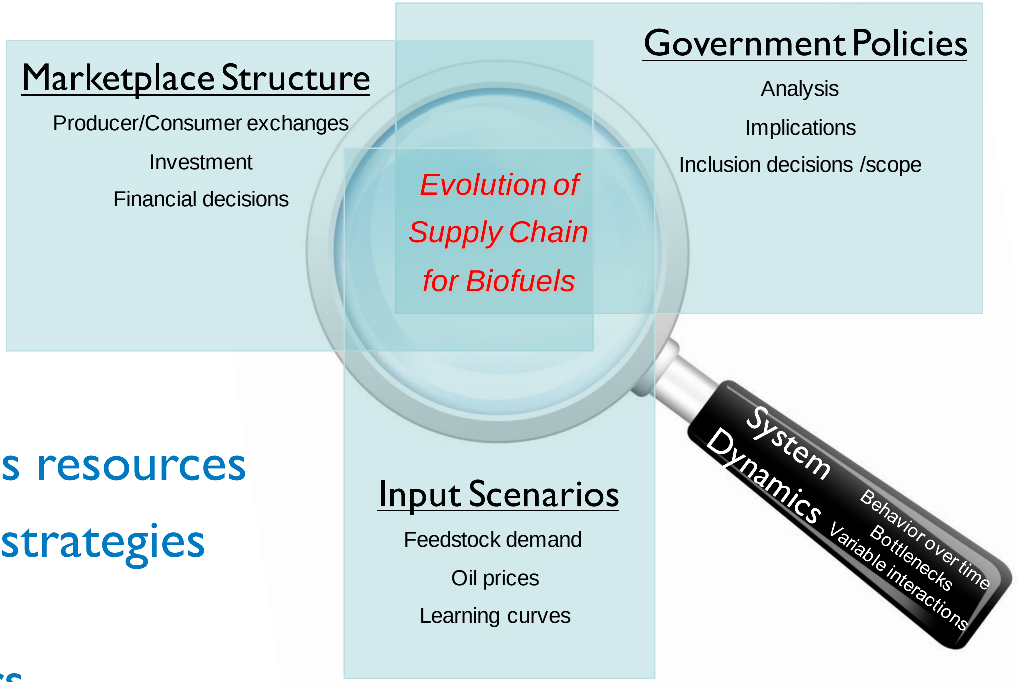
Presentation at EIA's "Biofuels in AEO2013 " Workshop

20 March 2013

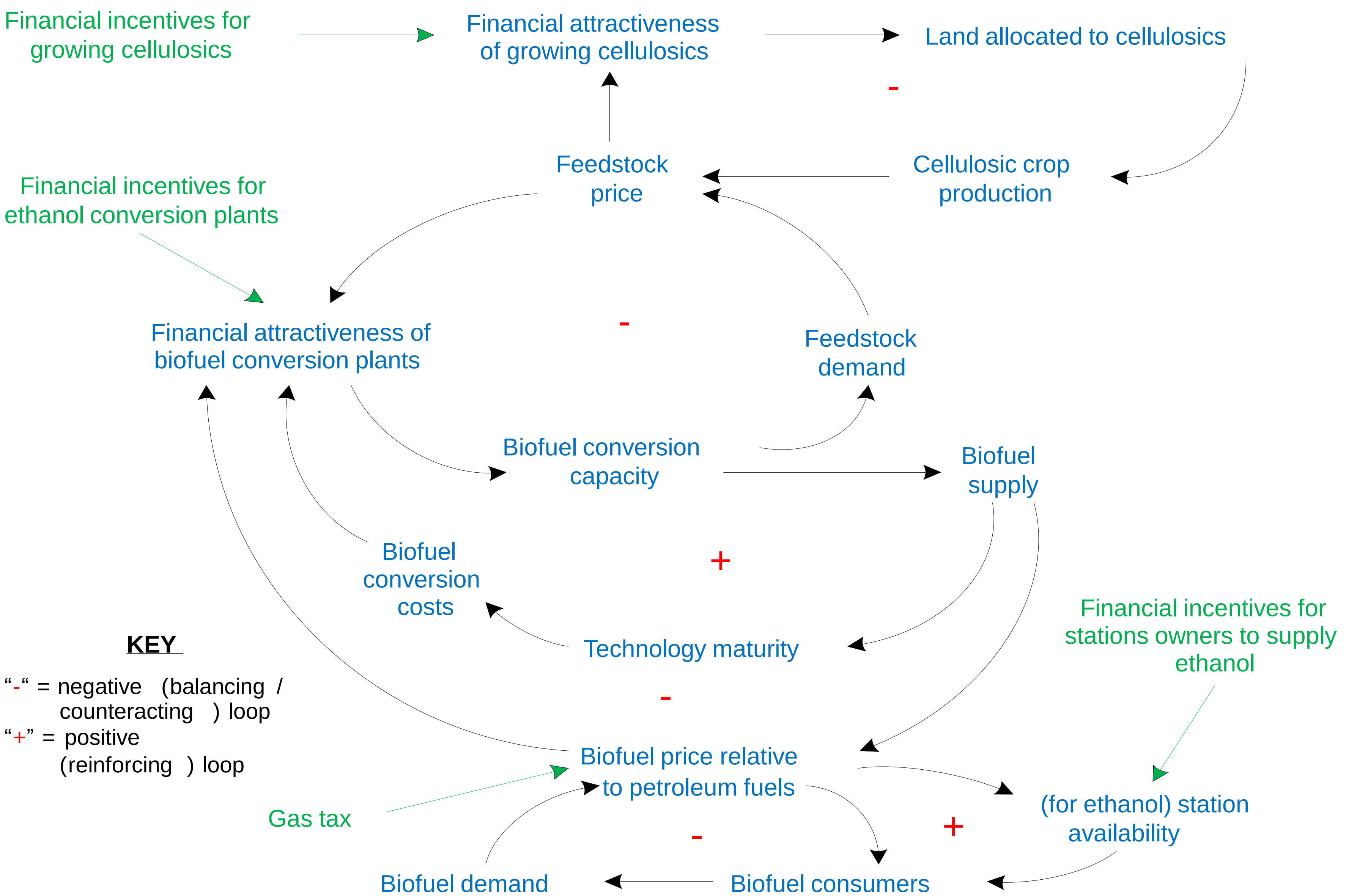
Focus of Biomass Supply-Chain Analysis

Deployment Analysis: exploring how rapidly biofuel technologies might be deployed to make a significant contribution to the country's transportation energy

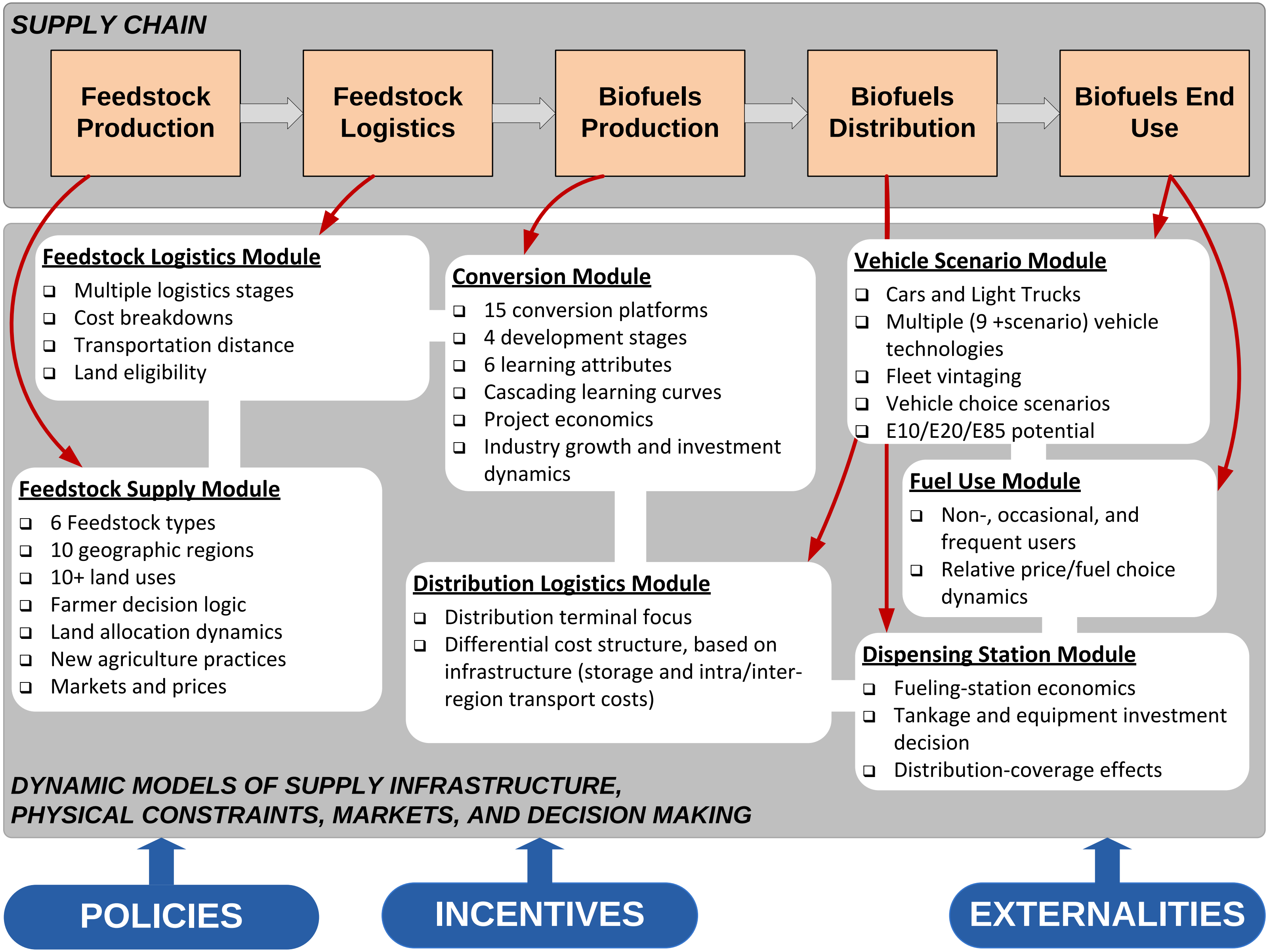
- Generate plausible scenarios
- Understand the transition dynamics
- Investigate potential market penetration scenarios
- Analyze prospective policies and incentives
- Identify high-impact drivers and bottlenecks
- Study competition for biomass resources
- Assess R&D and deployment strategies
- Enable and facilitate focused discussion among stakeholders



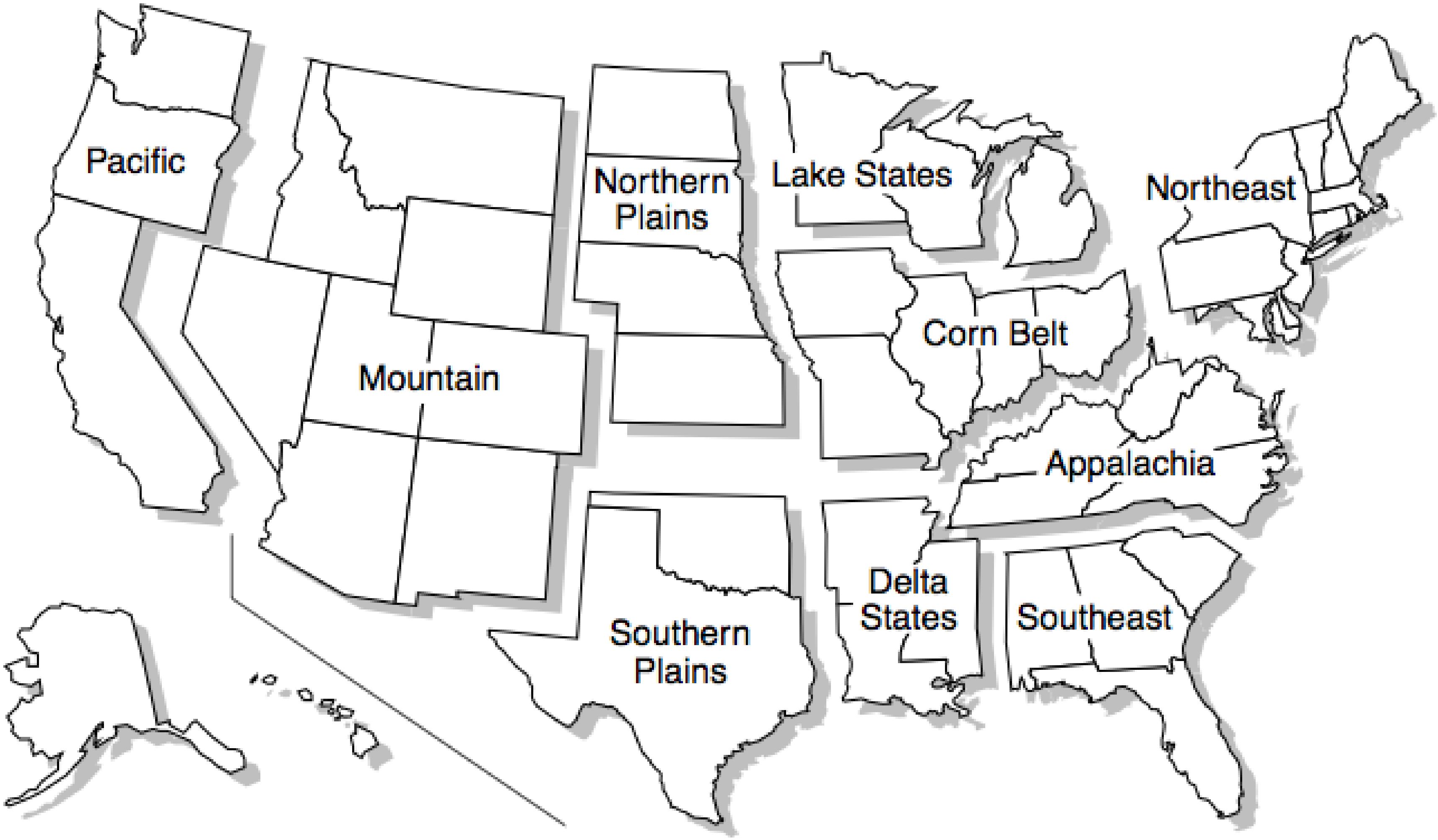
Example of Influences/Feedbacks



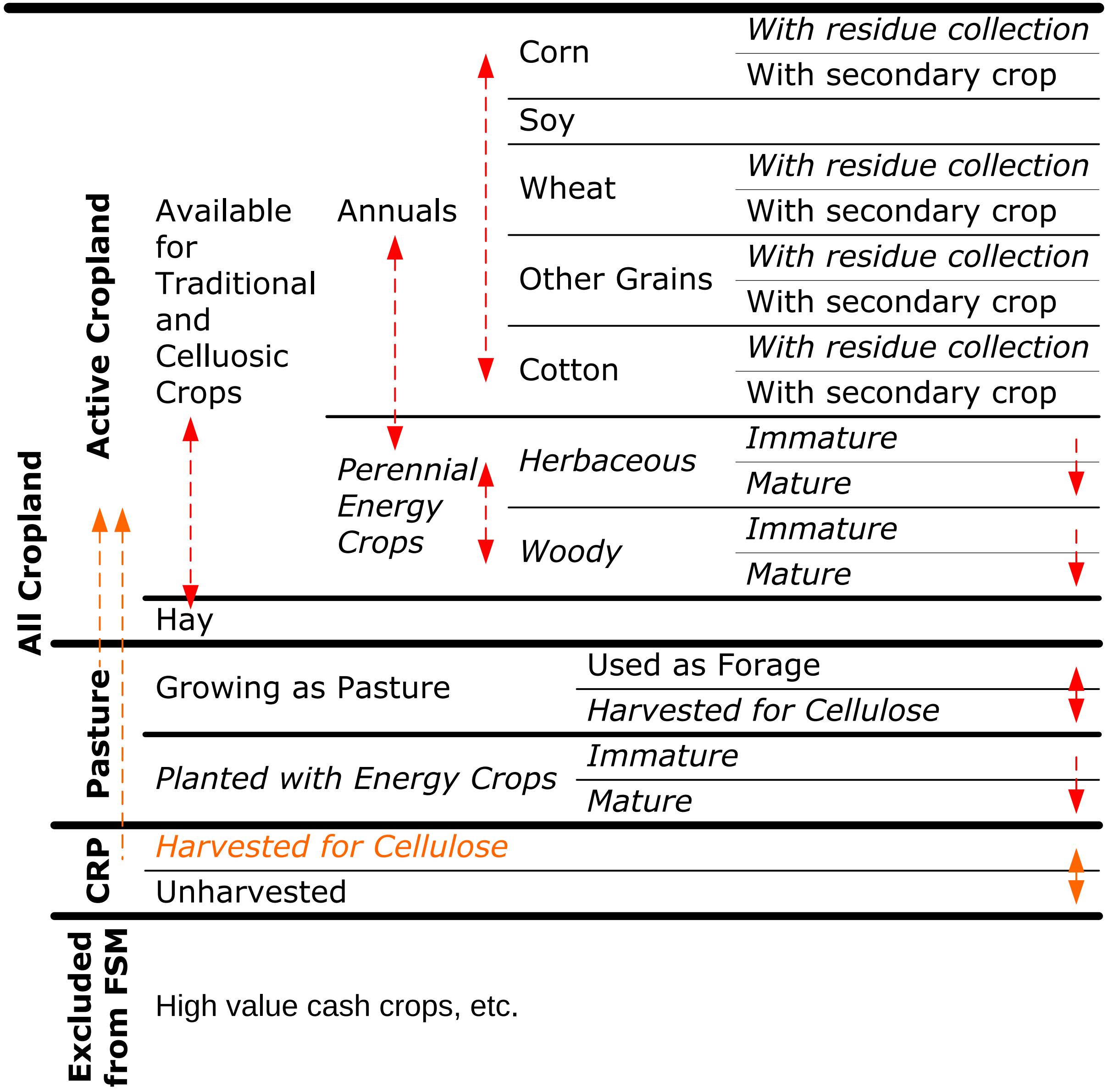
Key Characteristics of BSM Modules



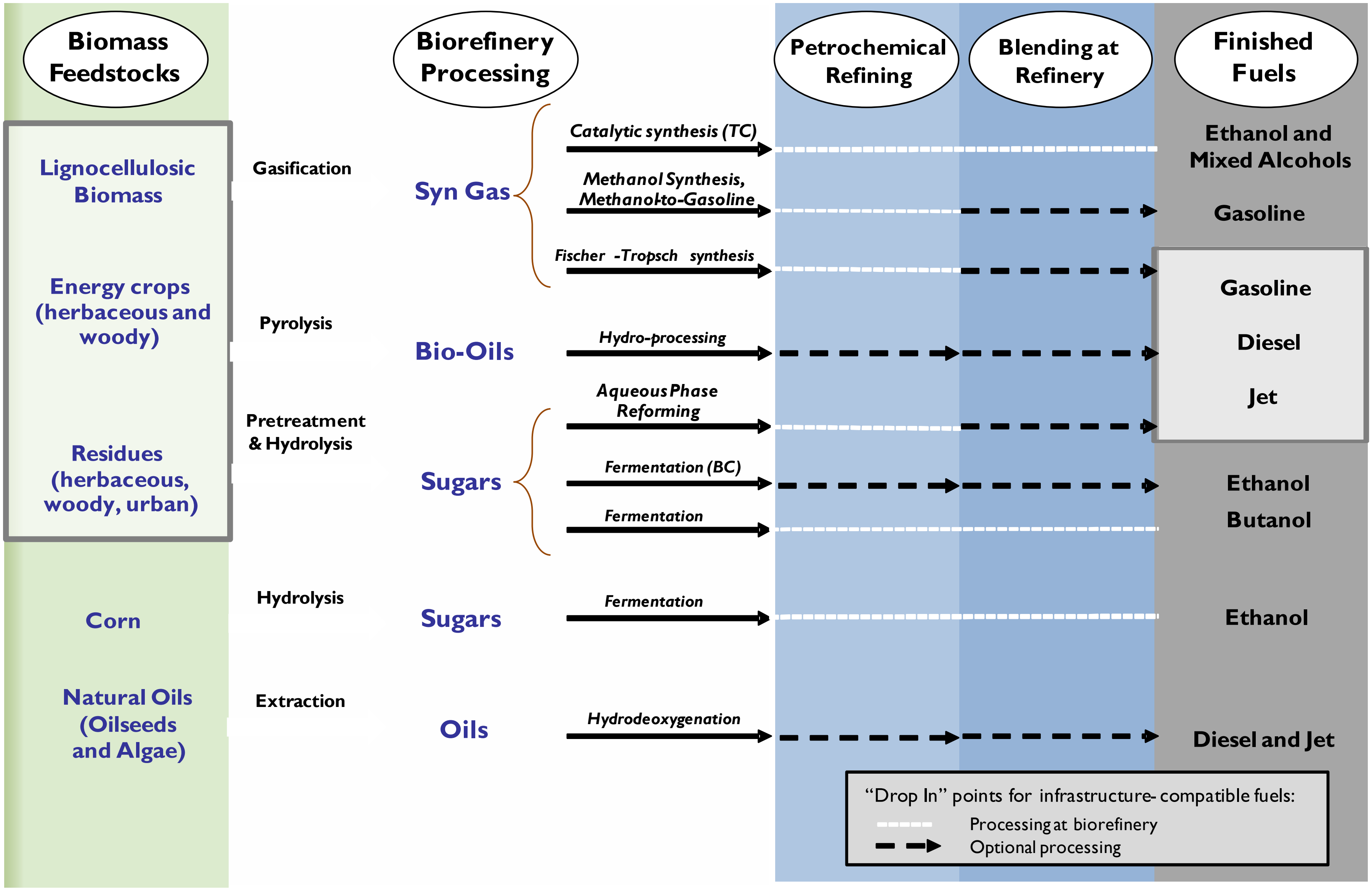
BSM Regionalization



Categorization of Cropland



Biofuel Pathways in the BSM

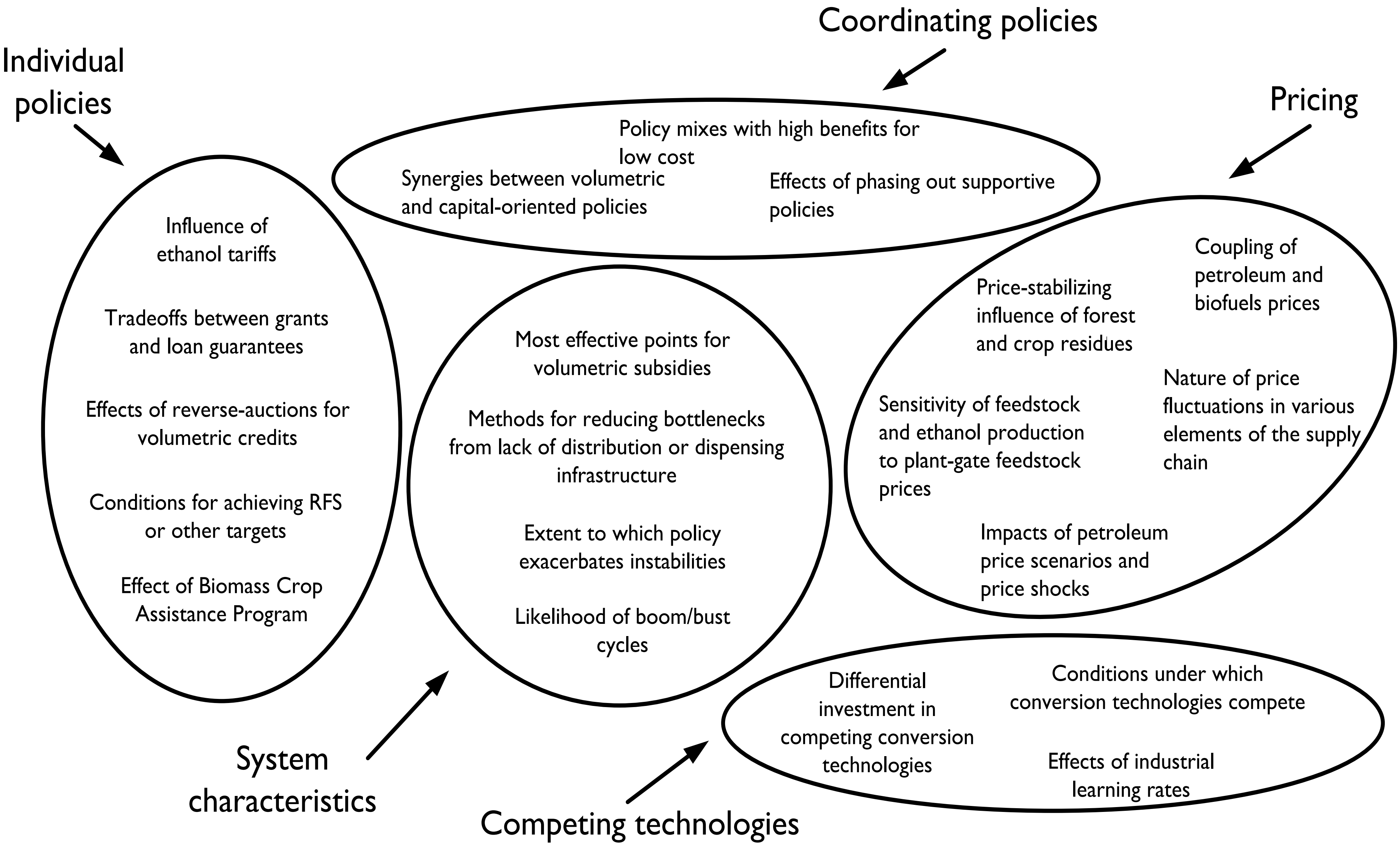


Appropriate Uses of the BSM

- The BSM is an excellent tool for generating and evaluating scenarios and relative impacts of cost targets, policy drivers, tipping points, etc. High-level system models such as the BSM cannot provide absolutes to a high degree of precision.

Designed to . . .	***Not Designed to . . .***
Generate scenarios to explore future biofuel landscapes.	Generate x gallons in y years with z dollars investment.
Identify areas of potential high leverage.	Identify specific numerical values of particular investments.
Assess relative merits of technologies and logistics in a gross sense, given solid technological assumptions.	Make fine distinctions between potential of technologies.
Explore the potential for tipping-point and lock-in/lock-out dynamics.	Predict tipping points precisely and pin them to specific times.
Build intuition, insight, and knowledge around the supply chain.	Represent a definitive embodiment of knowledge.
Think through the relative efficacy of different policy prescriptions.	Determine recommended policies in isolation.

Scenario Analyses Completed



Insights along the Cellulosic Ethanol* Supply Chain

The availability of forest residue helps stabilize feedstock prices in early years, as herbaceous energy crops are brought into production; crop residues, urban residues, and woody perennials play smaller roles.

Regional feedstock market prices tend to support growth of the cellulosic ethanol industry more than either constant-price or price-floor regimes.

Without sufficient external support (e.g., counter-cyclical policies), "boom and bust" development of ethanol production capacity is likely.

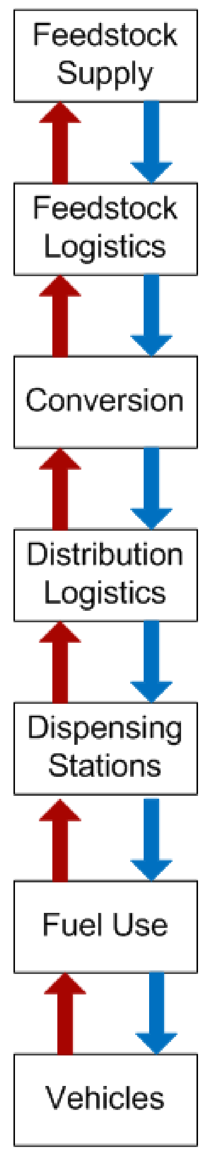
Competition between the different technologies is very noticeable in favorable cellulosic biofuels scenarios.

Bottlenecks in downstream distribution and dispensing infrastructure may significantly impede the growth of the cellulosic biofuels industry.

Due to the small operating margins of refueling stations, comprehensive subsidies are essential in fostering the installation of high-blend ethanol refueling capacity.

Dramatic gasoline price shocks are required to significantly shift the ethanol consumption curve.

Aggressive E85 penetration scenarios require FFV adoption substantially beyond AEO forecasts.



In most geographic regions, moderate feedstock prices are sufficient to meet near-term targets by 2015, but higher prices are necessary to meet aggressive targets by 2030. Prices are subject to periodic fluctuations in early years.

The prices of annual commercial crops, such as wheat and corn, are not unduly affected by EISA targets.

Sixty miles is the typical economical radius for crop residue and energy crop feedstock collection.

There is a "tipping point" related to levels of initial investment in pilot and demonstration plants: investment must cross a threshold of approximately ten demo plants for a pathway to flourish.

The balance between industry learning and implemented policies is vital to maintain industry growth.

Favorable ethanol selling prices substantially accelerate industry development.

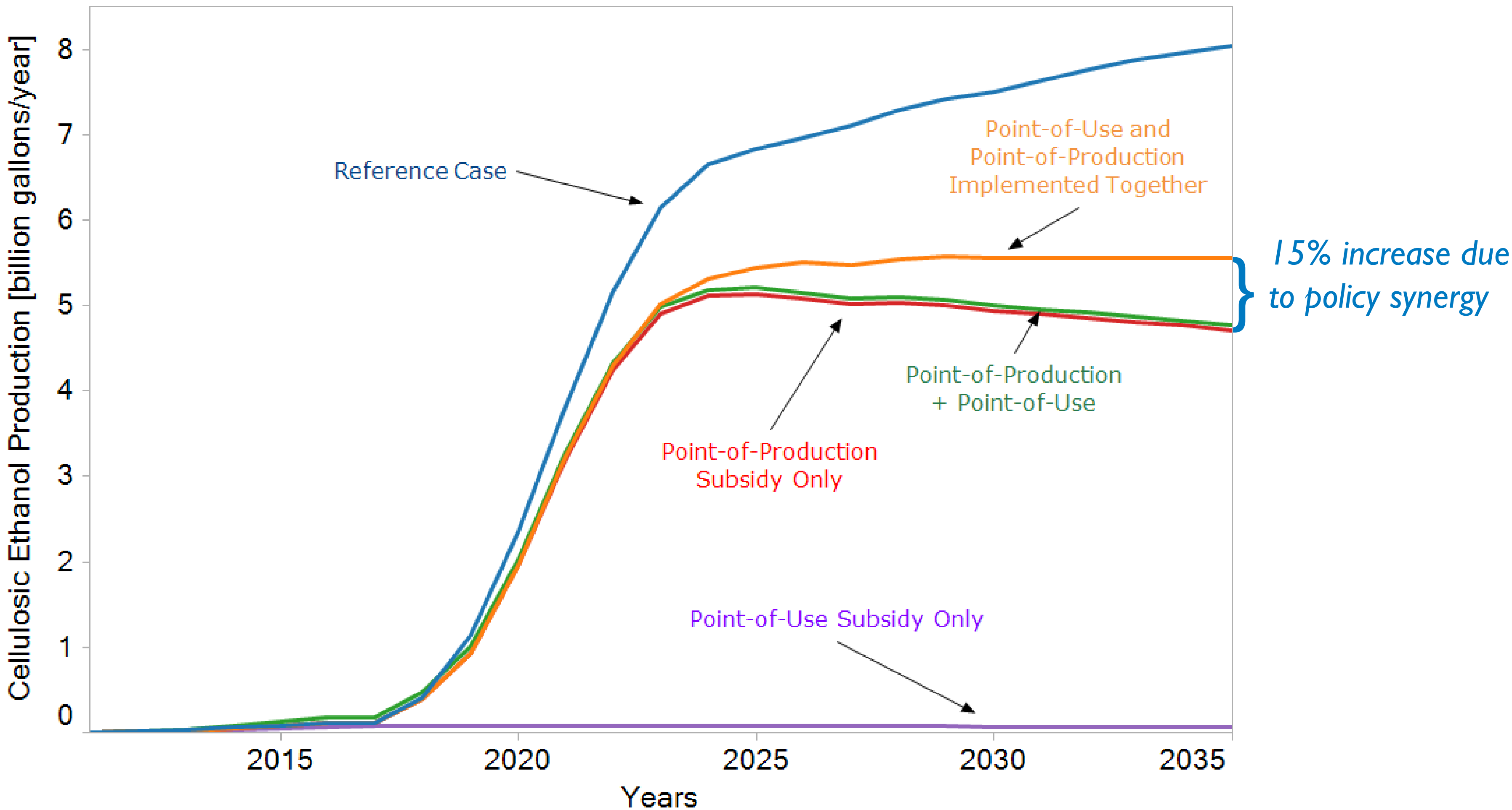
There is a strong tension between maintaining high feedstock prices for farmers and high ethanol mark-ups for producers, distributors, and dispensors while keeping ethanol prices low for end users.

The market for E85 does not persist in cases where E85 price advantage or parity is lost: consumption quickly reverts mostly to gasoline when the price gap with E85 closes.

Aggressive initial investment in conversion plants combined with sustained support policies in downstream portions of the ethanol supply chain effectively underwrites industry takeoff.

** Most of these insights hold for other biofuels in addition to cellulosic ethanol.*

Policies Implemented in Isolation Are Not as Effective as Certain Policies Implemented in Coordination



Dynamic Interaction: the point-of-use subsidy decreases financial risk for gas station owners, causing more E85 tankage to be installed. The resulting increase in ethanol demand, in conjunction with the point-of-production subsidy, decreases the risk for those wanting to invest in biorefineries. This increased confidence results in more biorefineries being built and increased cellulosic ethanol production.

Key Insights from Biofuels Supply-Chain Analyses

Four keys to industry development:

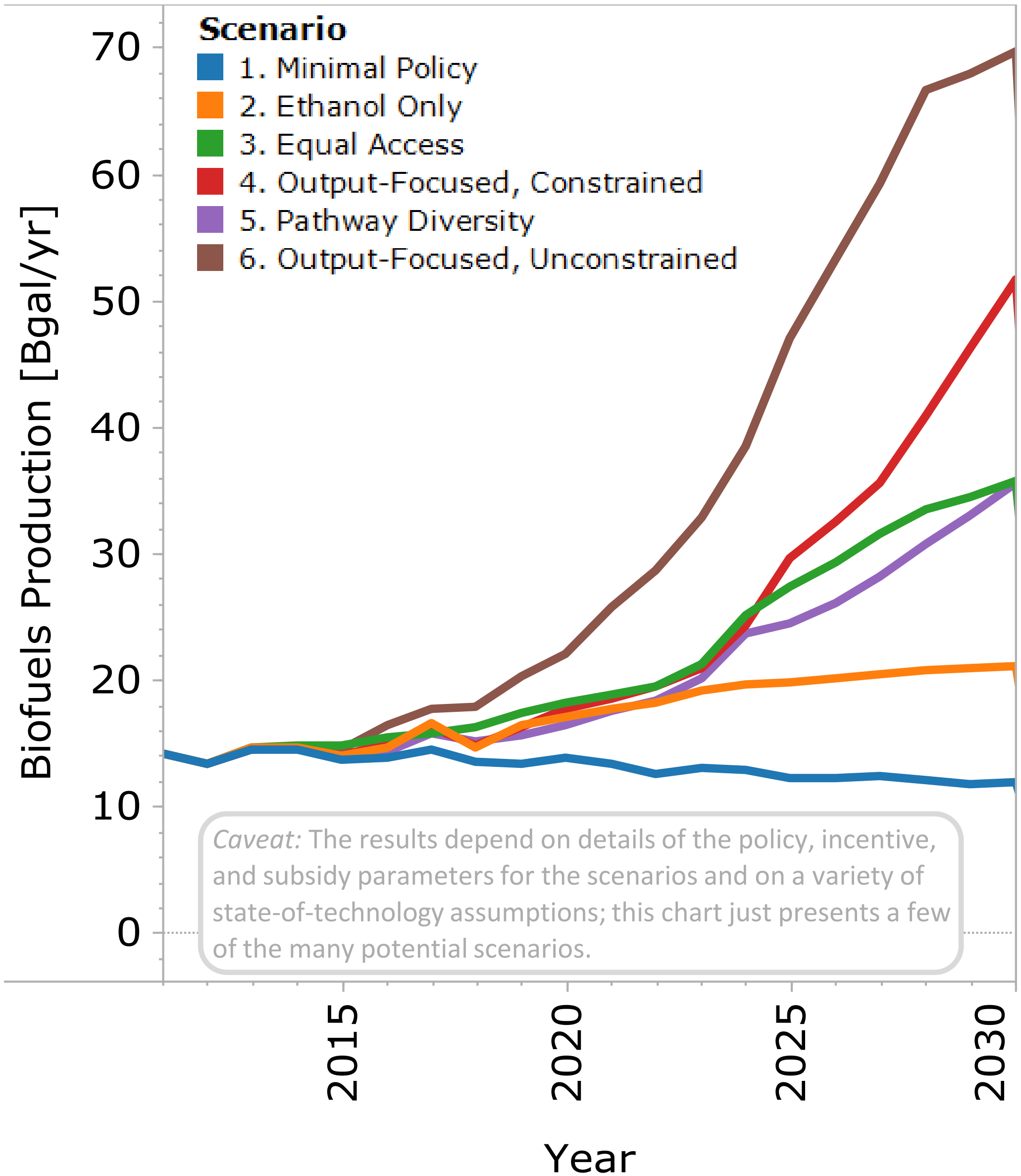
1. Profitability at point of production
2. High rates of industry learning
3. An aggressive start in building pilot, demo, and pioneer-scale plants
4. For ethanol, a high level of infrastructure investment to sustain low enough point-of-use prices

The "take off" is likely to be wild and wooly:

1. Unstable, higher than anticipated, feedstock prices
2. Boom/bust development of production capacity
3. Potential for biofuel price instability

Significant production volumes are feasible.

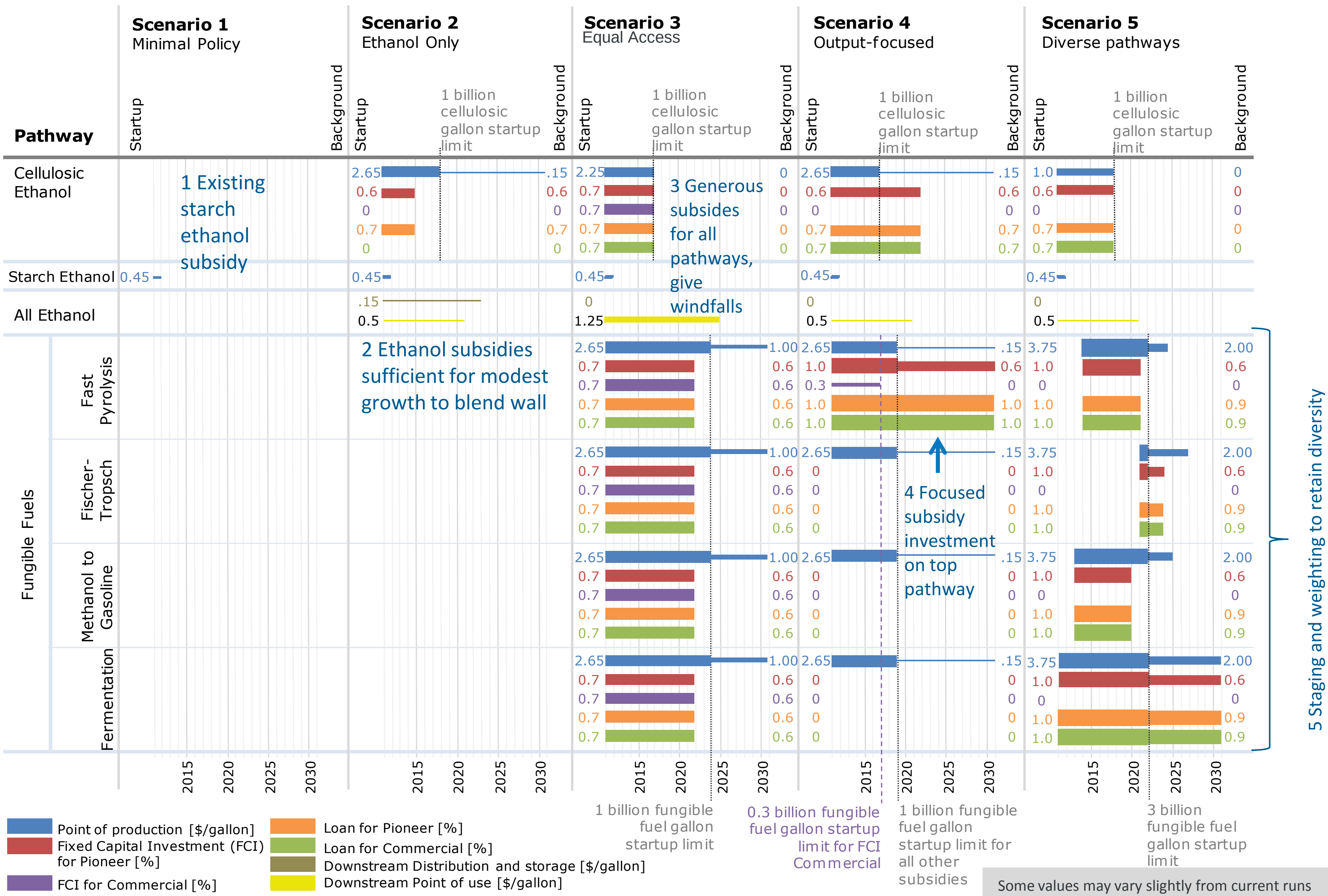
1. RFS2 volumes are achievable in 2030 with heavy startup subsidies.
2. When subsidies are limited to promoting the most economically attractive pathway, production levels can be greater than RFS2 levels.
3. Technologies with favorable long-term economic cost structures can succeed if subsidies are deliberately designed to overcome initial maturity deficiencies.



Scenario Library Examples

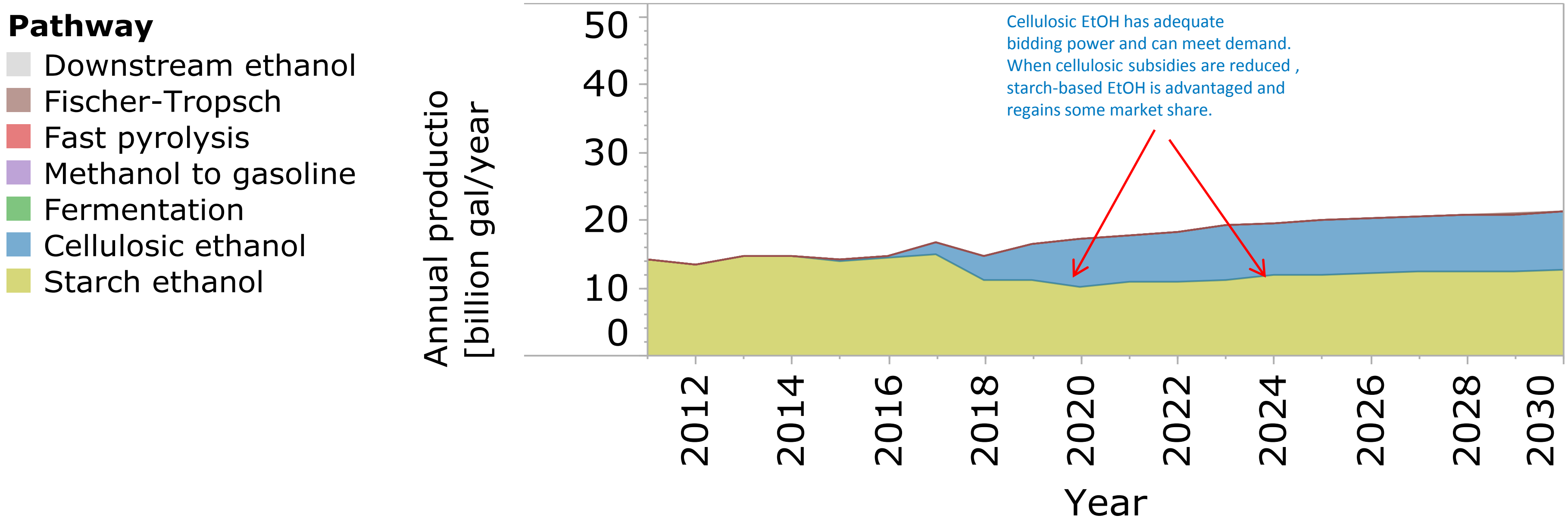
Scenario	Subsidize …	Strategy
1: Minimal Policy	Starch until 2012	Apply only existing subsidies and policies
2: Ethanol Only	Ethanol pathways only	Provide support for ethanol only
3: Equal Access	All pathways in order to produce 36 billion gallons/year by 2031	Allow all fuel types equal access to generous scenario subsidies
4: Output-Focused, Constrained	To maximize growth restricted to $10 billion per year	Target most promising technology and withhold most subsidy access from other pathways
5: Pathway Diversity	To maximize pathways restricted to $10 billion per year	Design subsidy timeline to enable take-off of multiple fuel pathways by staggering start and end dates based on pathway progress and potential
6: Output-Focused, Unconstrained	To maximize growth with no spending limit	Design a subsidy scheme to most rapidly produce the maximum volume of biofuels that the system can produce

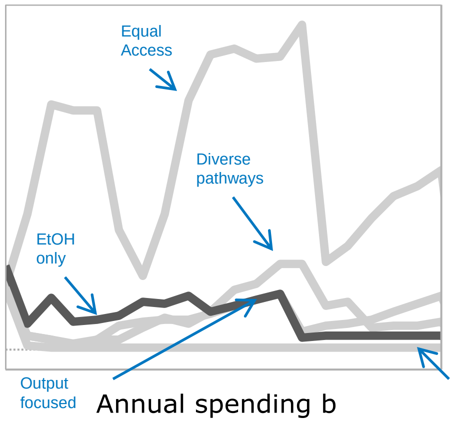
Different subsidy levels shape scenarios



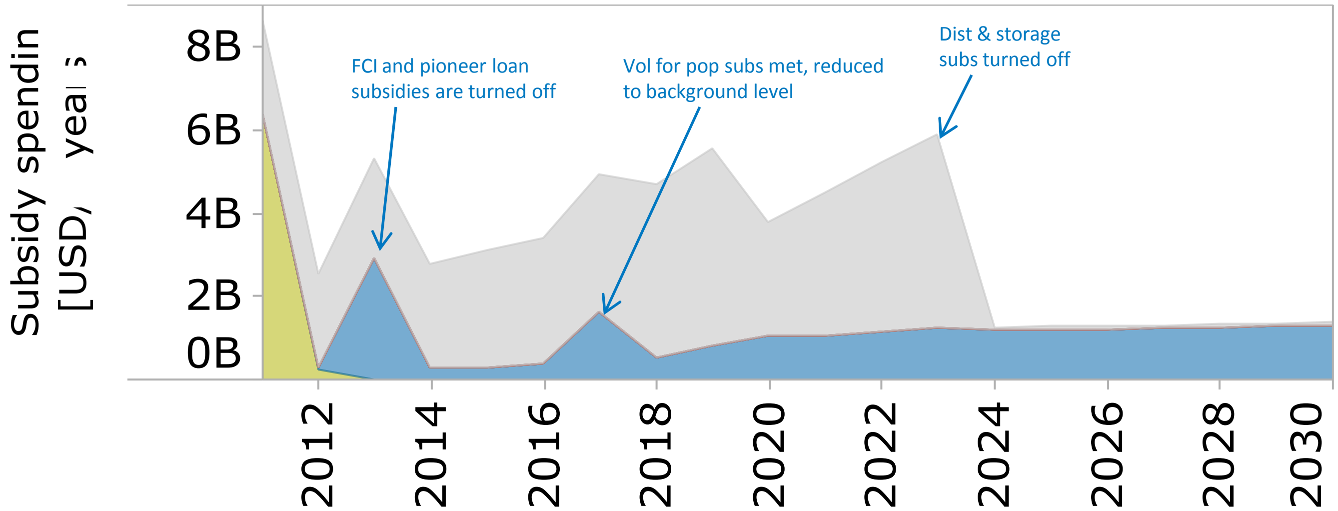
Some values may vary slightly from current runs

2. EtOH only: Intra-EtOH competition for market share

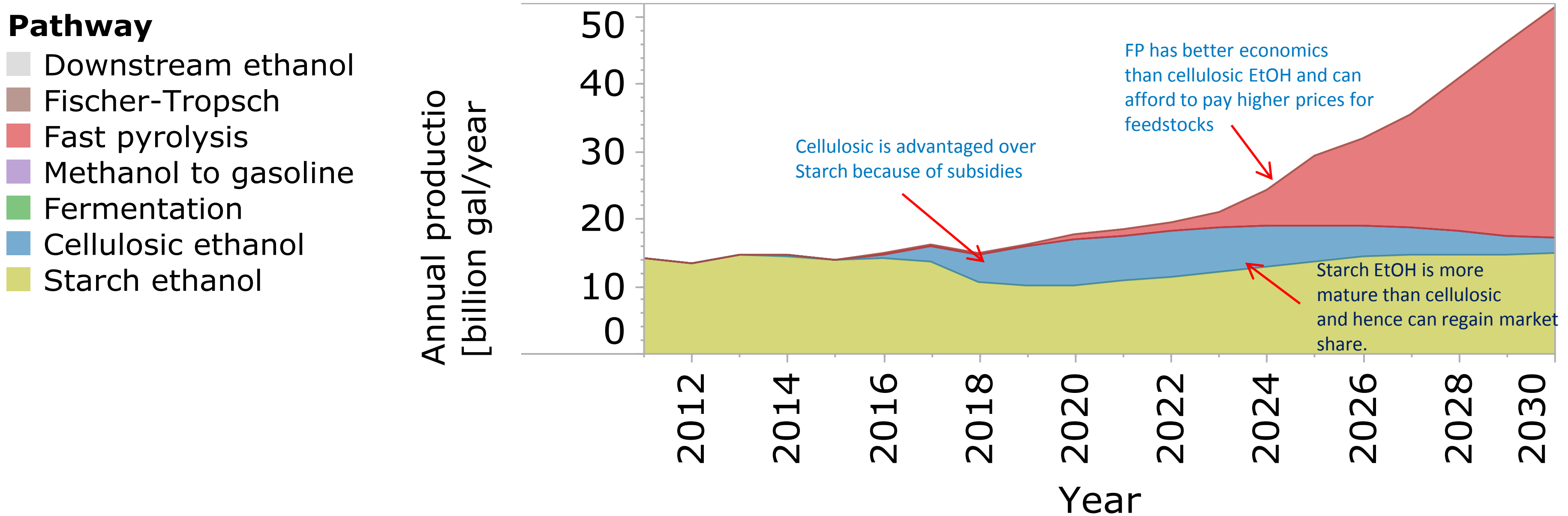


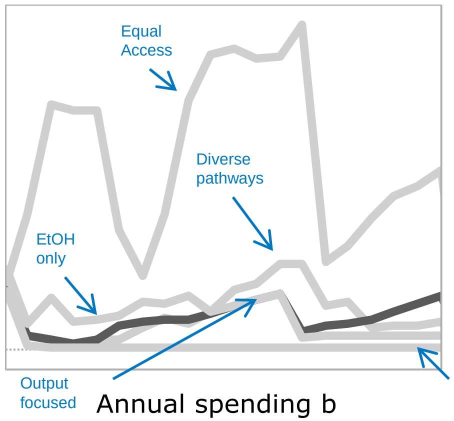


Annual spending b scenario in tim

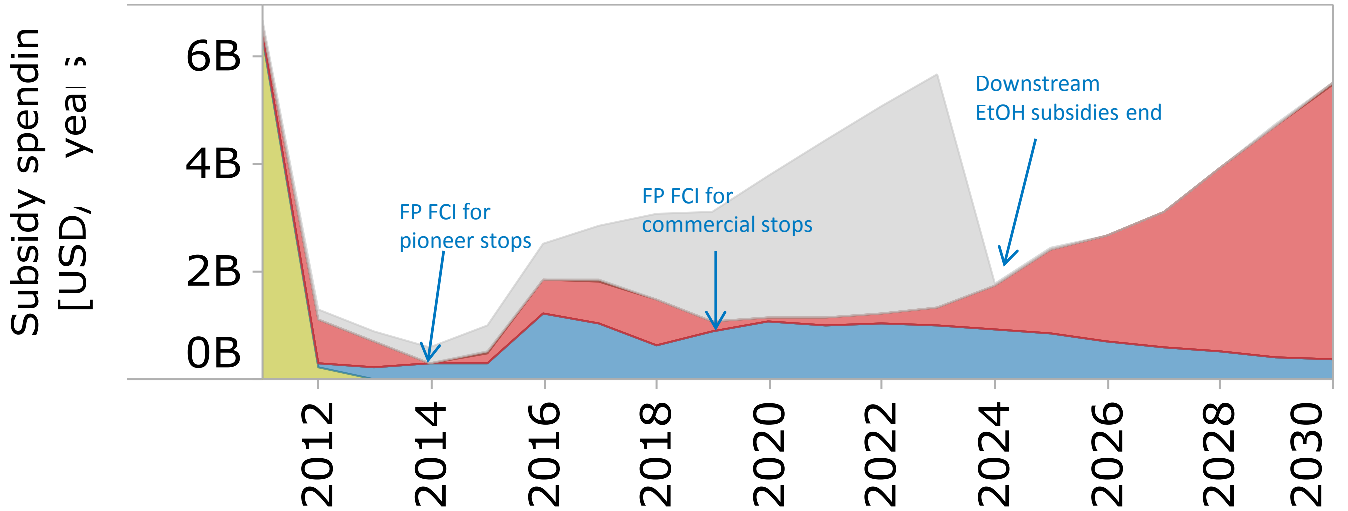


4. Output focused: competition for market and feedstock

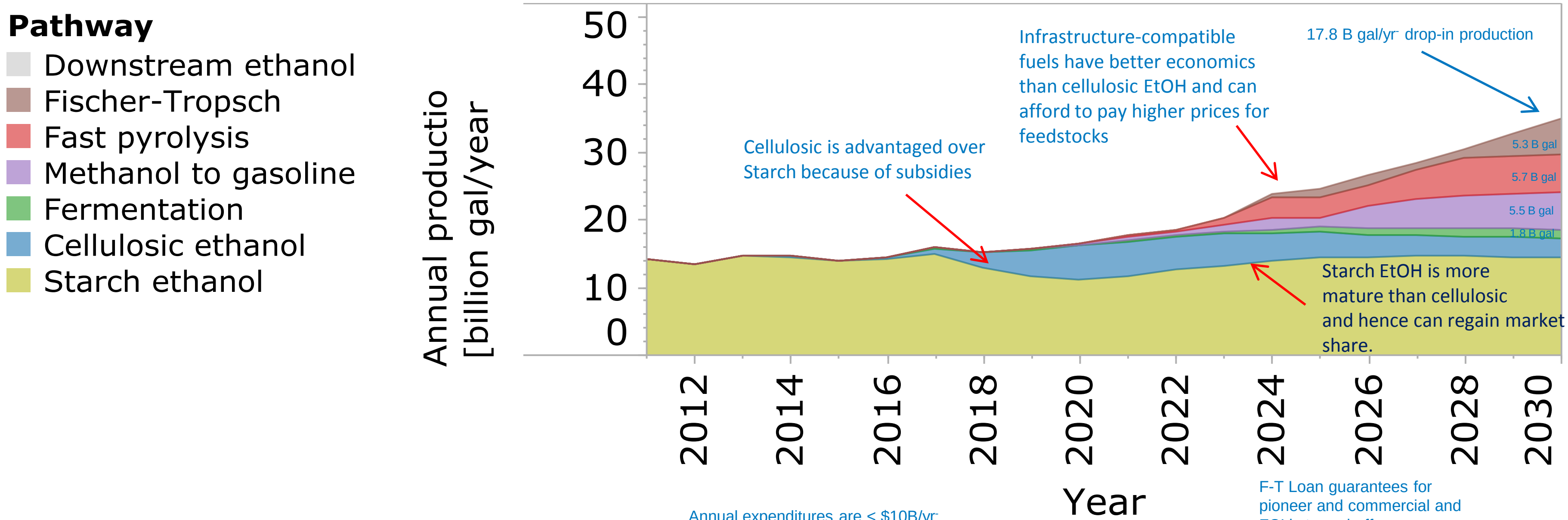


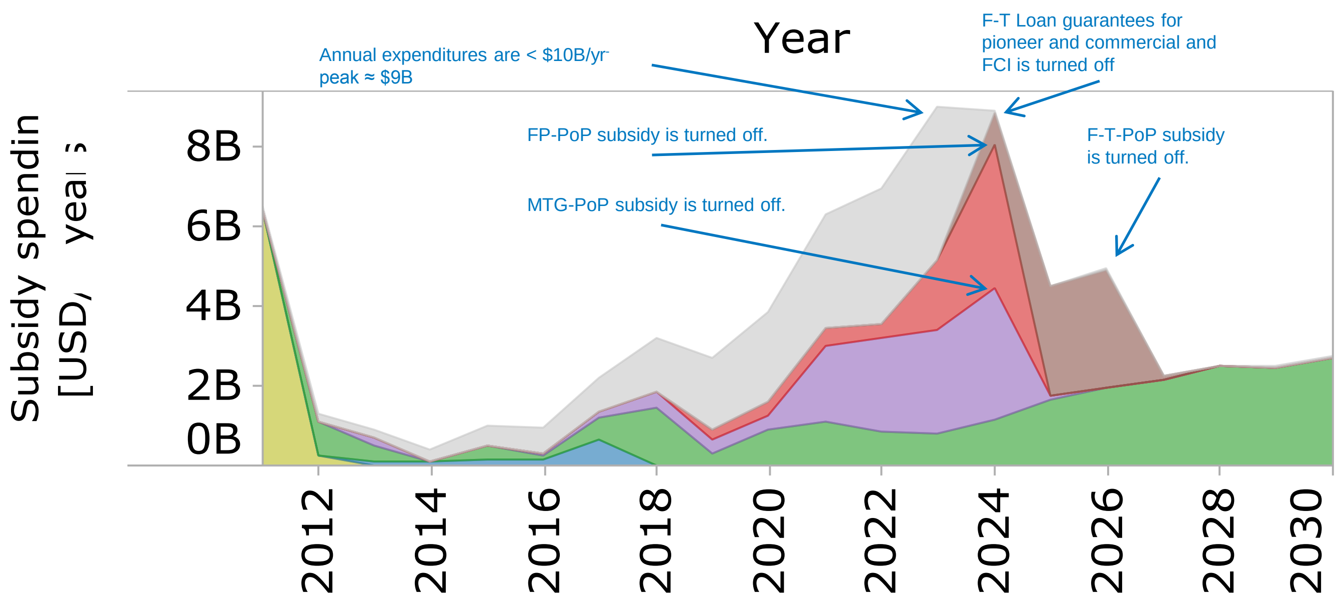


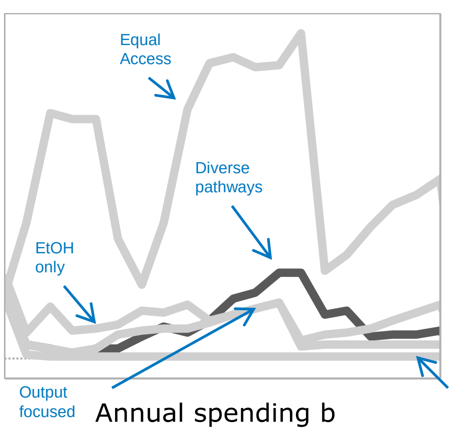
Annual spending b scenario in tim



5. Diverse pathways: competition for market and feedstock



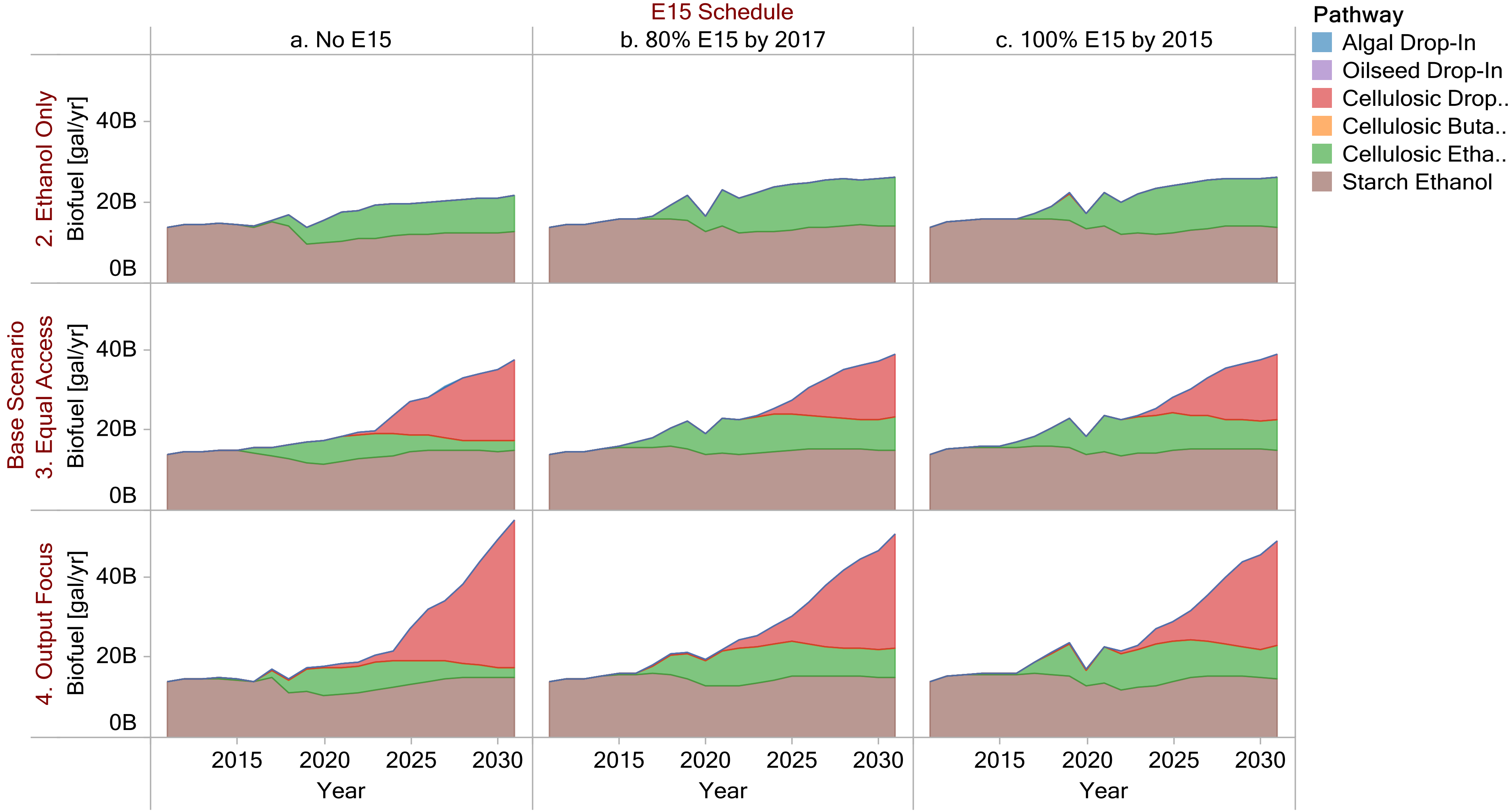




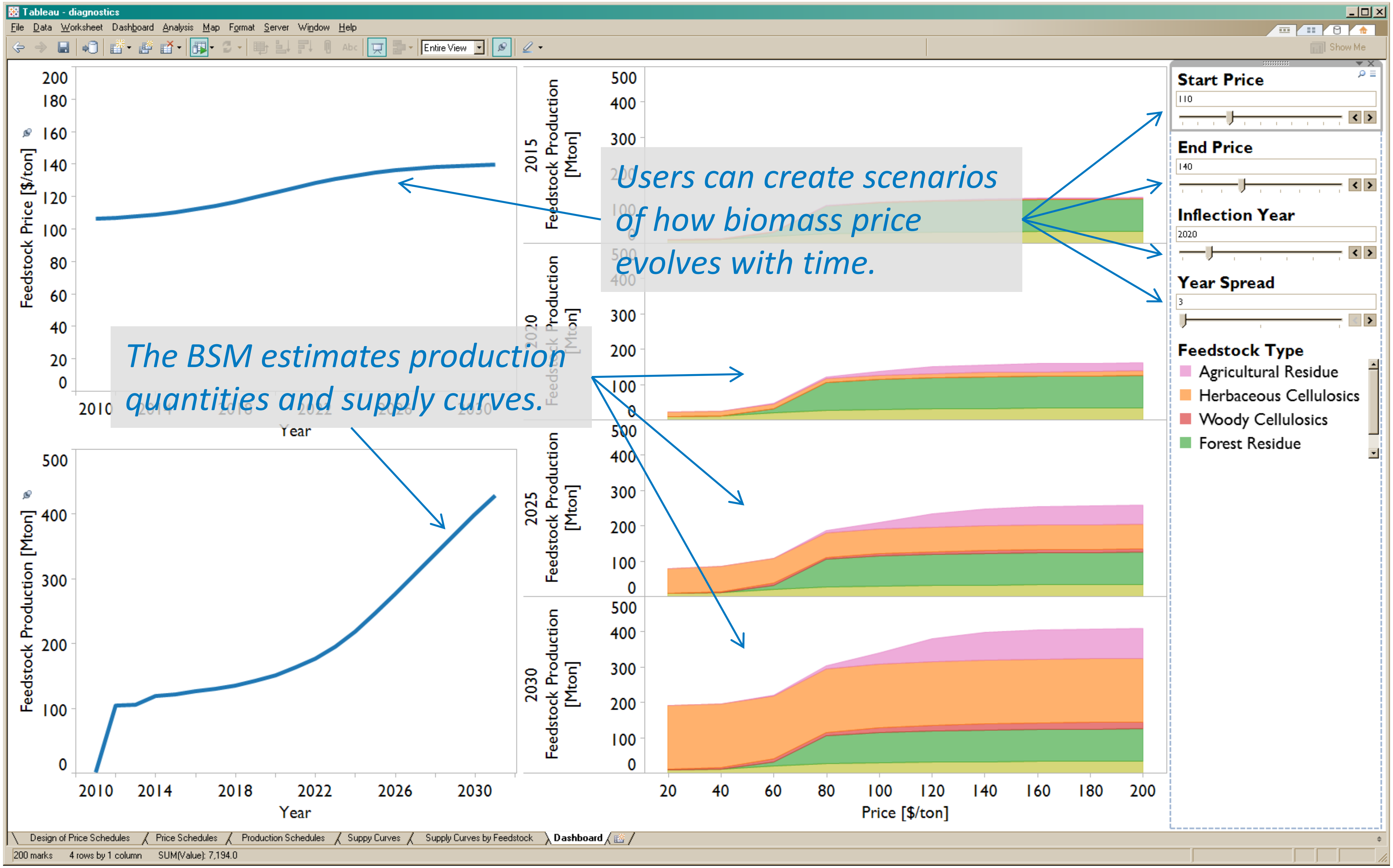
Annual spending b
scenario in tim

Insights Related to a Transition from E10 to E15

- Widespread E15 adoption moves the "blend wall" and can greatly alter the proportion of cellulosic ethanol in the mix of biofuels.



Library of Biomass Supply Curves



Conclusion

- Selected publications
  - Ethanol Distribution, Dispensing, and Use: Analysis of a Portion of the Biomass-to-Biofuels Supply Chain Using System Dynamics
    <http://dx.doi.org/10.1371/journal.pone.0035082>
  - Understanding the Developing Cellulosic Biofuels Industry through Dynamic Modeling
    <http://dx.doi.org/10.5772/17090>
  - Using System Dynamics to Model the Transition to Biofuels in the United States
    <http://dx.doi.org/10.1109/SYSOSE.2008.4724136>

- Invitation:
  - We are seeking input and collaboration on the development of biofuels scenarios.

- Questions?