Carbon accounting Biofuels and the issues with LCA

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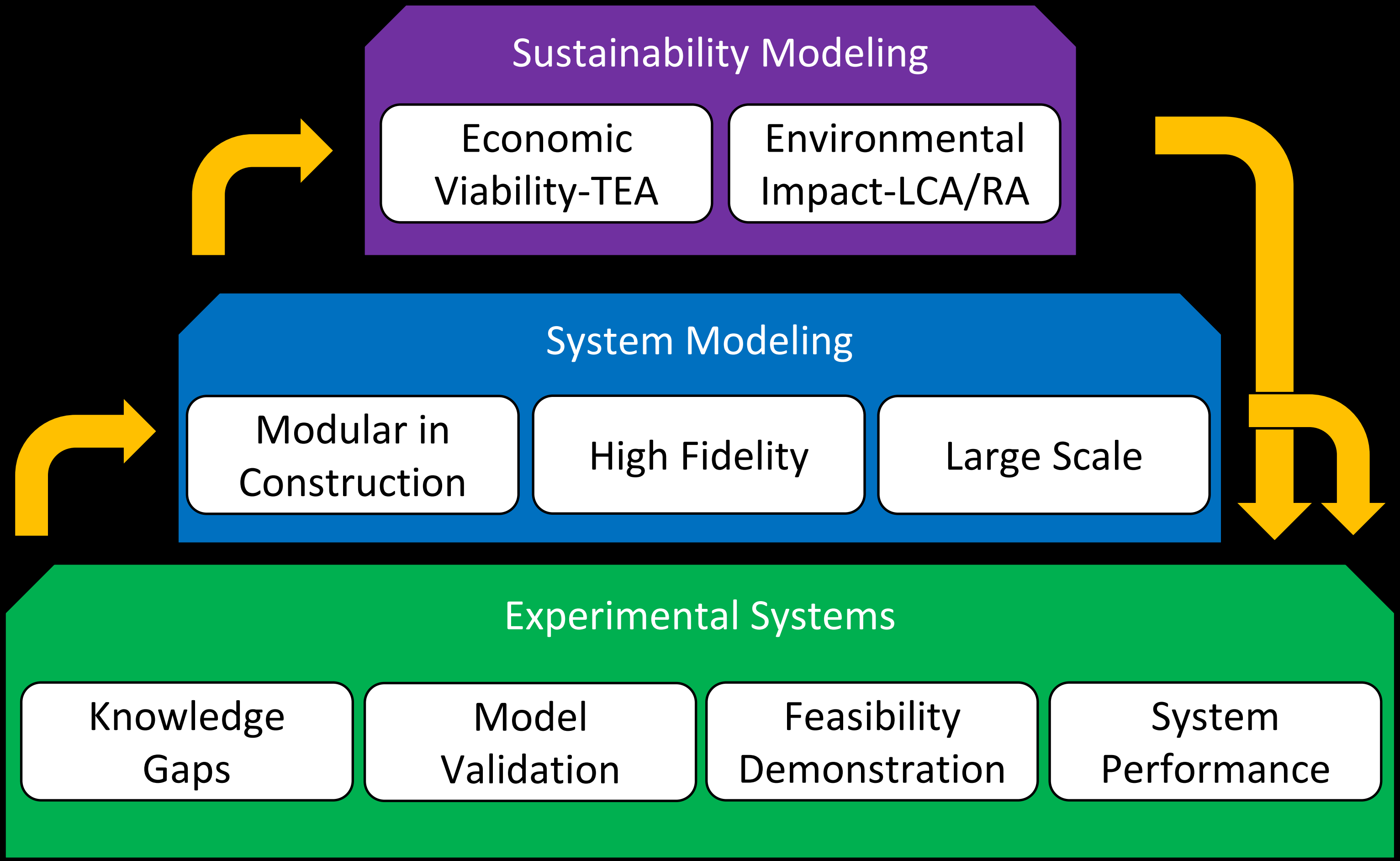
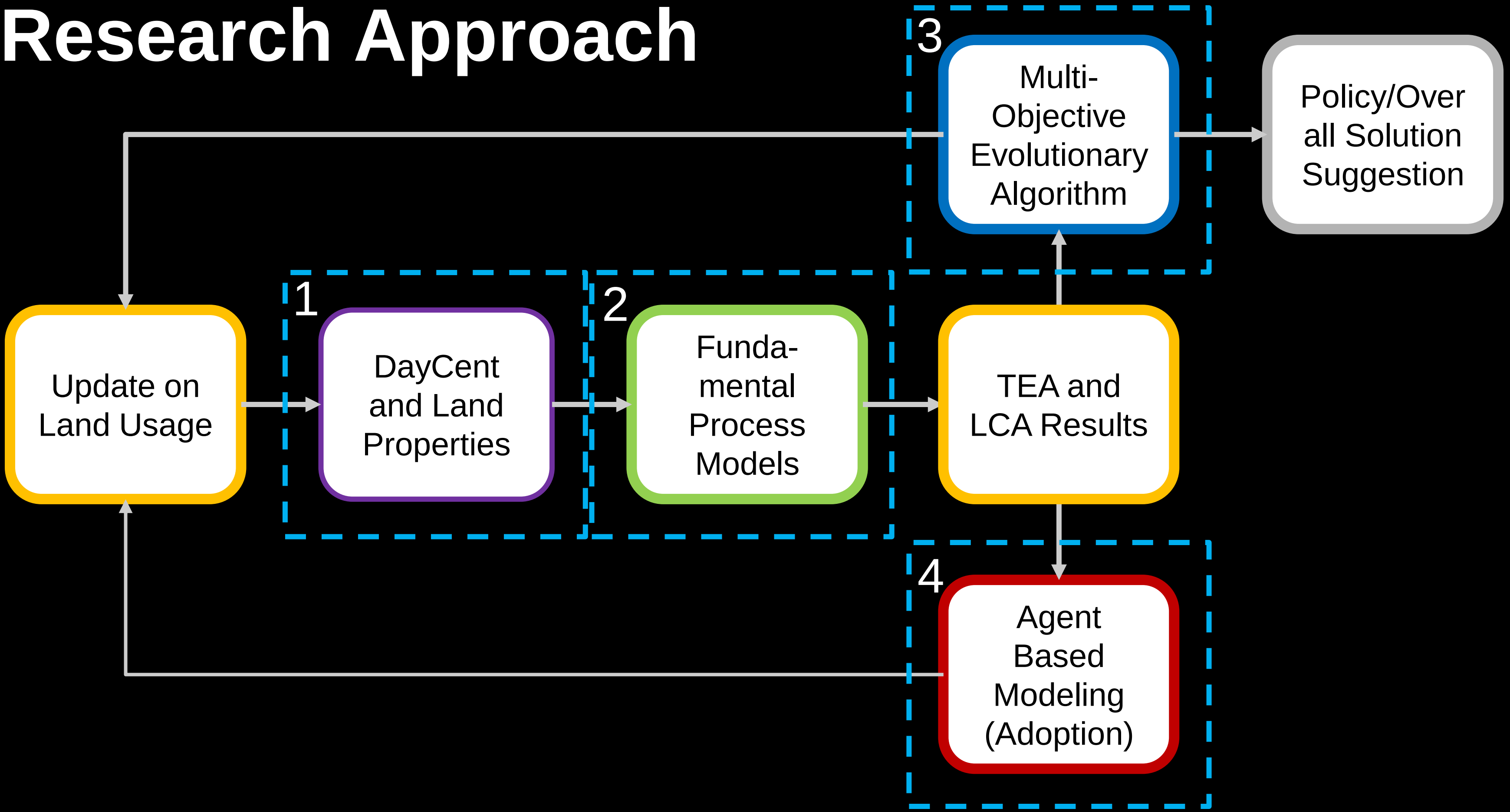
Research Approach



Research Approach



Agent Based System to Model Adoption

- Farmers
- Biorefinery Investment

Yearly Resolution

Framework for Adaptive Behavior

FOA targets:

- Reducing Consumption Water (10-30%), Energy Consumption (20-60%), GHG Emissions (50-80%), Pollutant Emissions (10-30%)

Program Connections:

- Optimization of the energy bioeconomy
- Defining from a systems level pathways and investments that lead to sustainable bio-economy

Approach
Modular Process Modeling

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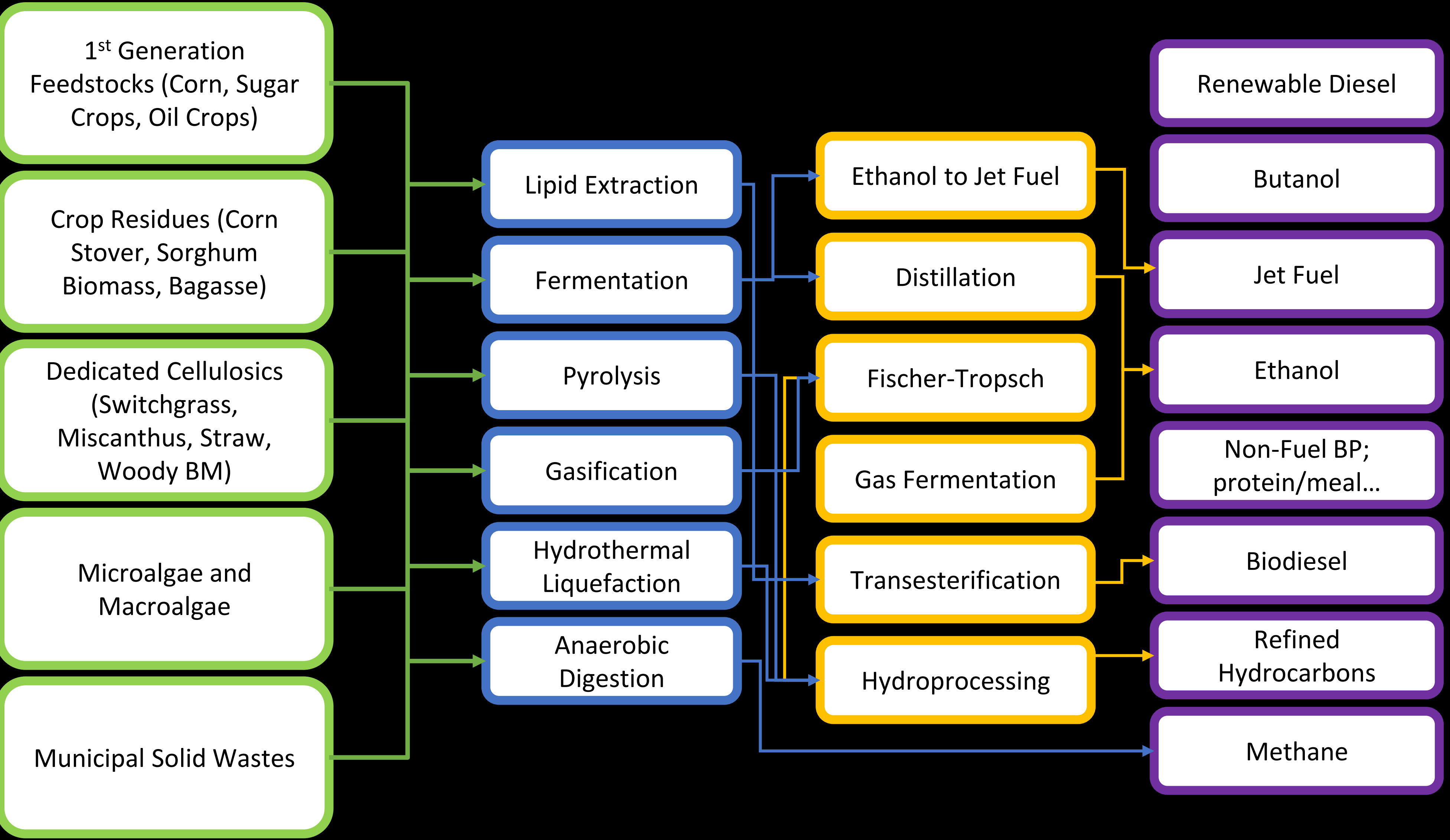
Fundamental Process Models



Numerous Pathways – Consistent Methodology

Defines Potential Solution Space (Enables Project)

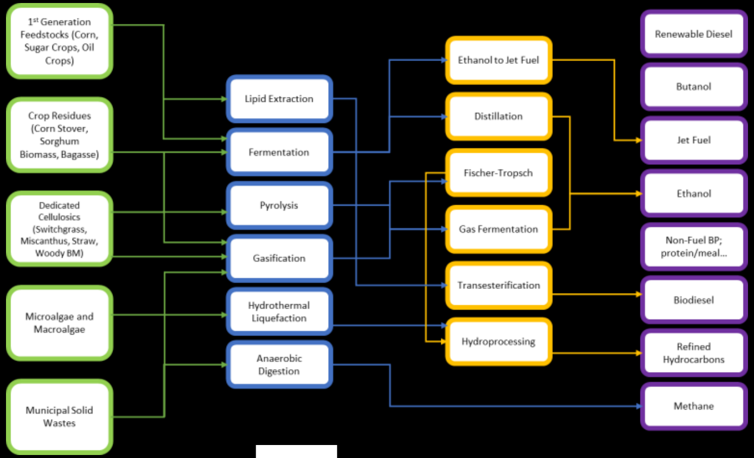
LCA and TEA Results
- MFSP
- Greenhouse Gas Impact
- Water Use
- Criteria Pollutants

Consumes Spatial Data (DayCent)

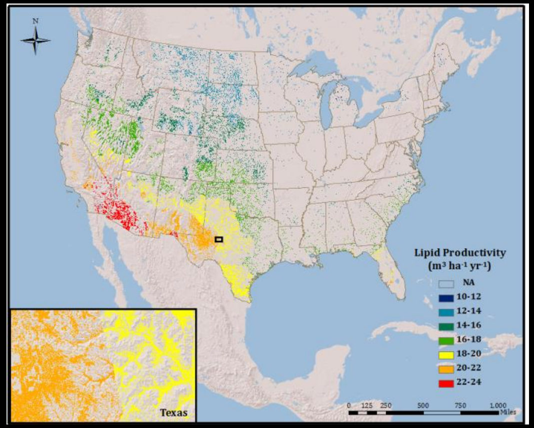
Feeds Optimization Algorithm

Approach
Future Work

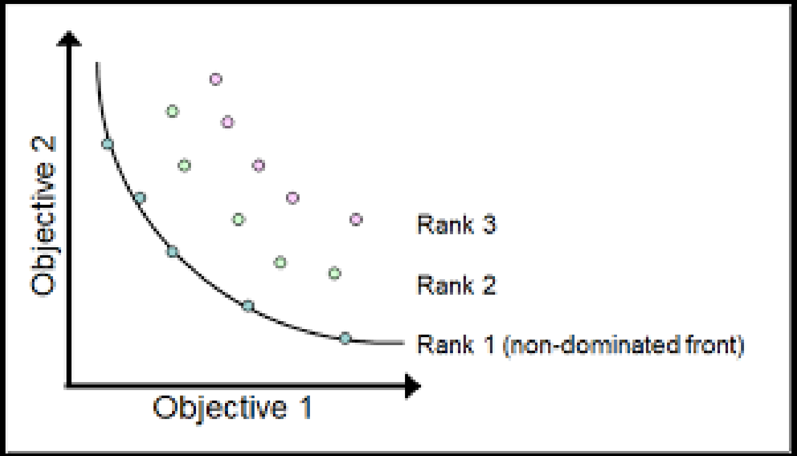
Expanding Process Modeling Pathways



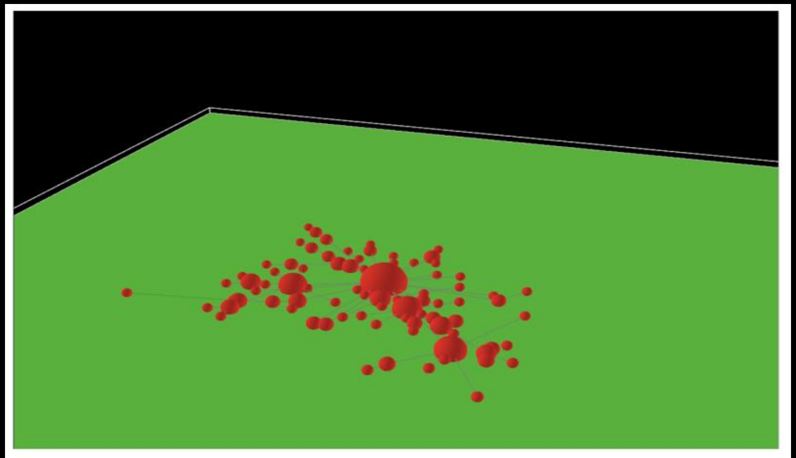
Continued Geospatial Modeling



US Policy



Multi-objective Optimization



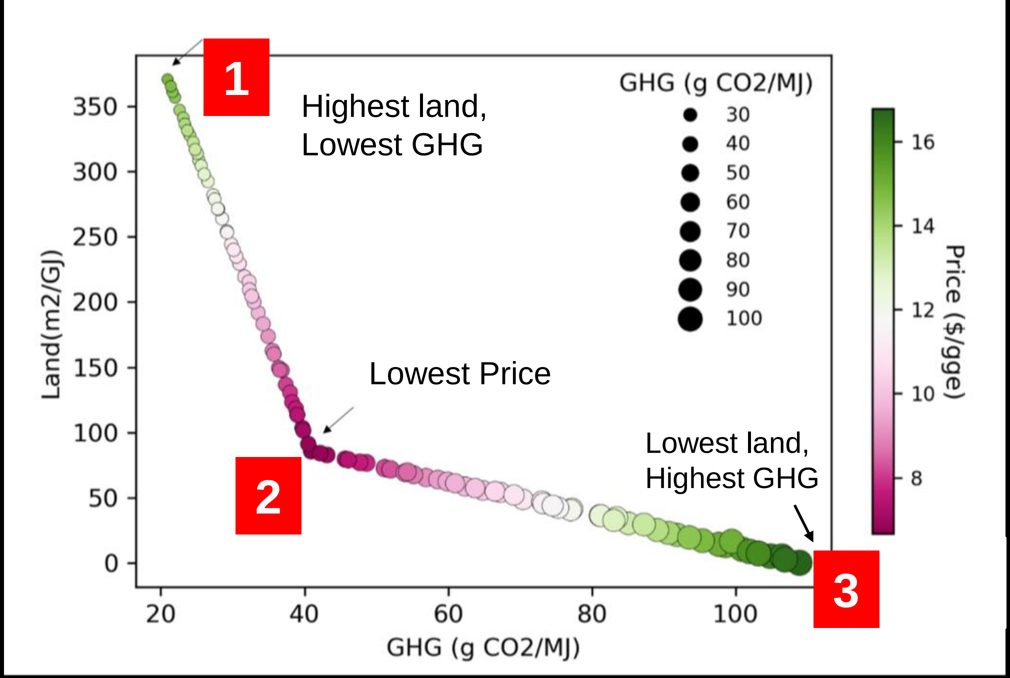
Agent Based Modeling

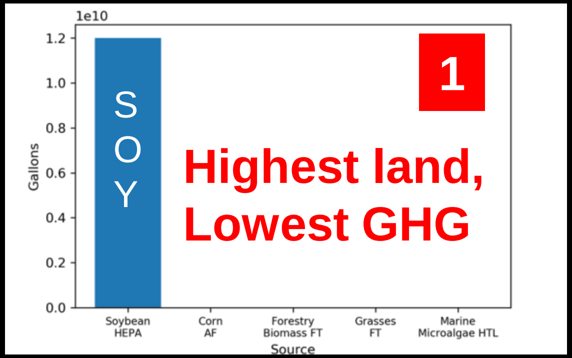
Progress and Outcomes
Multi-objective Optimization

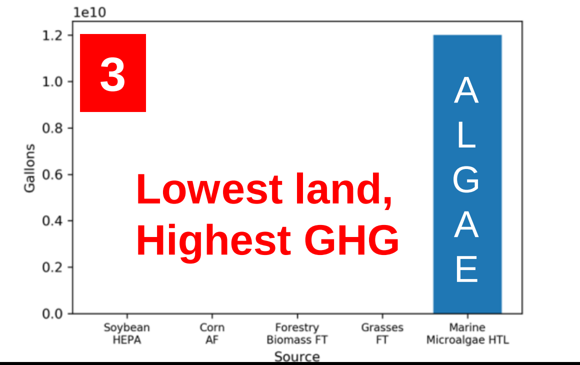
Multi-objective optimization of Biofuel Supply Chain (farm to fuel)

Initial proof-of-concept for 5 national jet fuel pathways: Balance cost, GHGs, and land use, produce 12M gallons

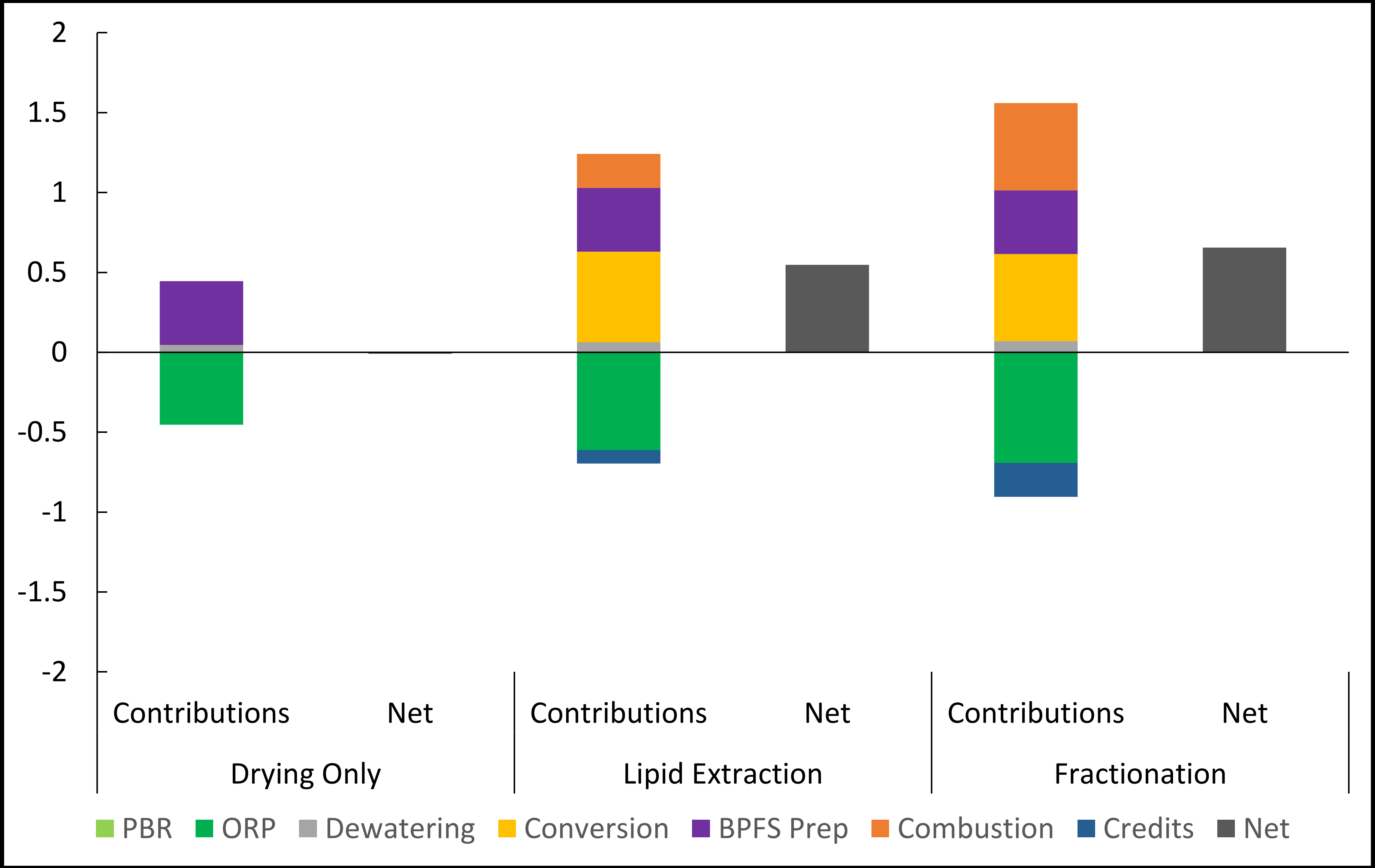
Source	Cost ($/gge)	Post-Combustion GHG (g CO2e/MJ)	Arable Land (m2/GJ/yr)	Nitrogen (g/GJ)
Soybean HEFA	$14.85	20.94	370.75	102.08
Corn AF	$6.66	40.92	85.52	1,186.38
Forestry Biomass FT	$7.11	70.88	99.64	354.82
Grasses FT	$8.24	41.87	128.17	1,512.40
Marine Microalgae HTL	$16.79	108.90	0.00	226.60





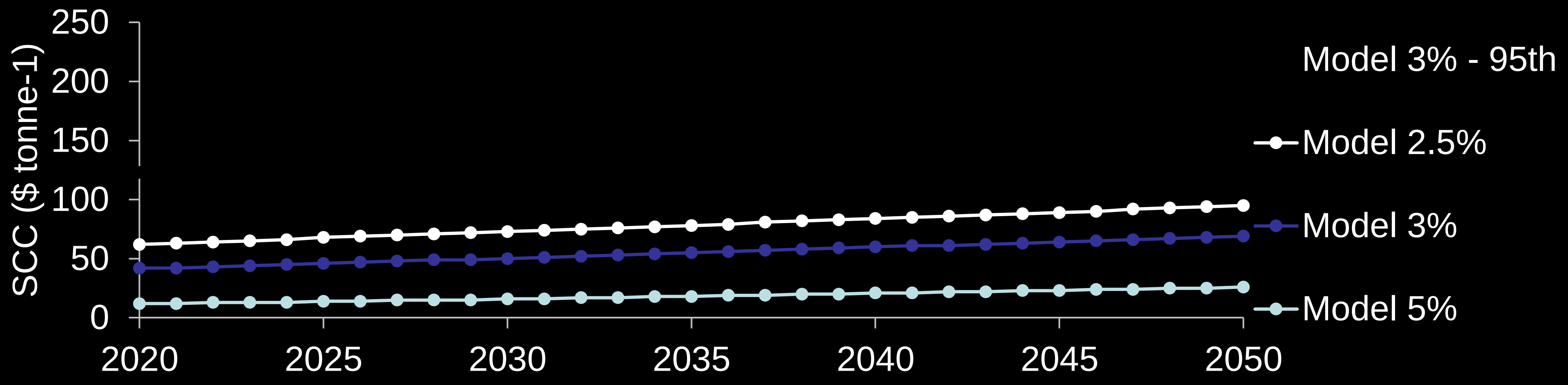


Issue with LCA and carbon accounting

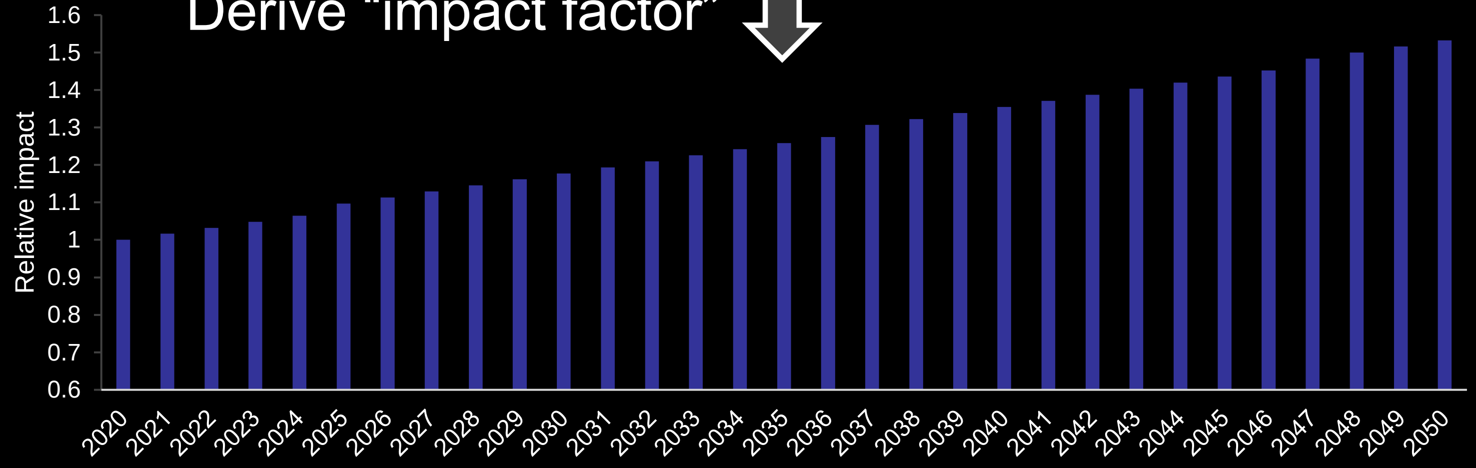


Time Value of Carbon

The impact of future emissions is expected to increase due to climate feedbacks:



Derive “impact factor”



New LCA Method

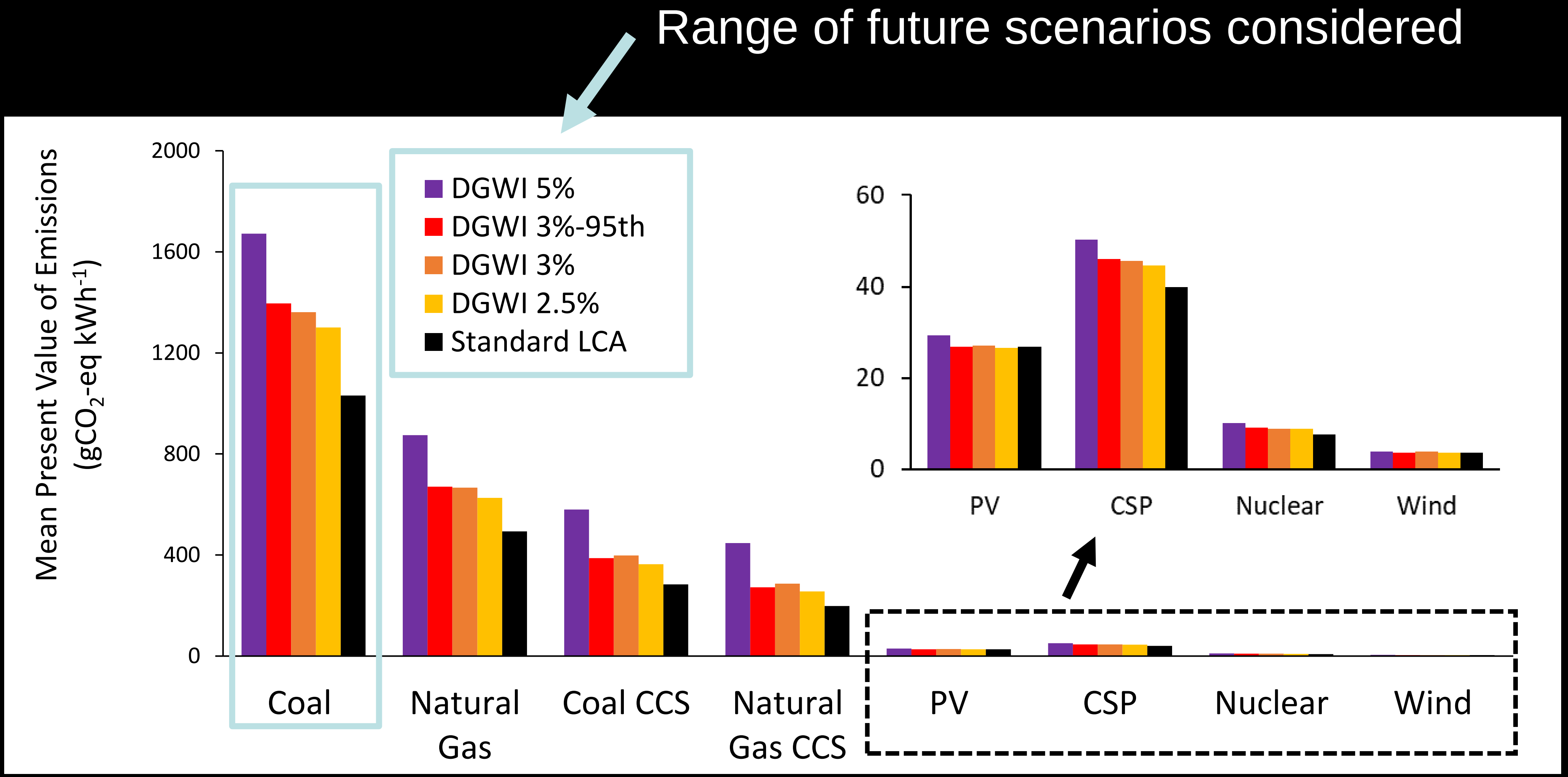
$$Dynamic\ Global\ Warming\ Impact_{GHG,i} = \frac{Social\ Cost_{\ GHG,i}}{Social\ Cost_{\ CO_2,2020}}$$

Dynamic Global Warming Impact (DGWI) Using 3% Social Costs of Greenhouse Gases

Year of Emission	CO_2	CH_4	N_2O
2020	1.00	29	357
2025	1.10	33	405
2030	1.19	38	452
2035	1.31	43	500
2040	1.43	48	548
2045	1.52	55	595
2050	1.64	60	643

$$Present\ Value_{GHG,i} = Emissions_{GHG,i} \times \mathrm{DGWI}_{GHG,i}$$

New LCA methods: Weighted LCA



Sproul, E., Barlow, J. & Quinn, J. C. Time Value of Greenhouse Gas Emissions in Life Cycle Assessment and Techno-Economic Analysis. *Environmental Science & Technology* **53**, 6073–6080 (2019).

Summary