Wind, Green Ammonia, and Wealth Retention: A Novel Economic Viability Strategy for Small Towns and Rural Communities

Vincent Amanor-Boadu & Catherine Obiribea Ofori-Bah

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Contact: vincent@ksu.edu

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Disclaimers: The opinions and views expressed are not necessarily shared by all FEWtures researchers, participating institutions, and the NSF. All errors and omission are solely the authors.

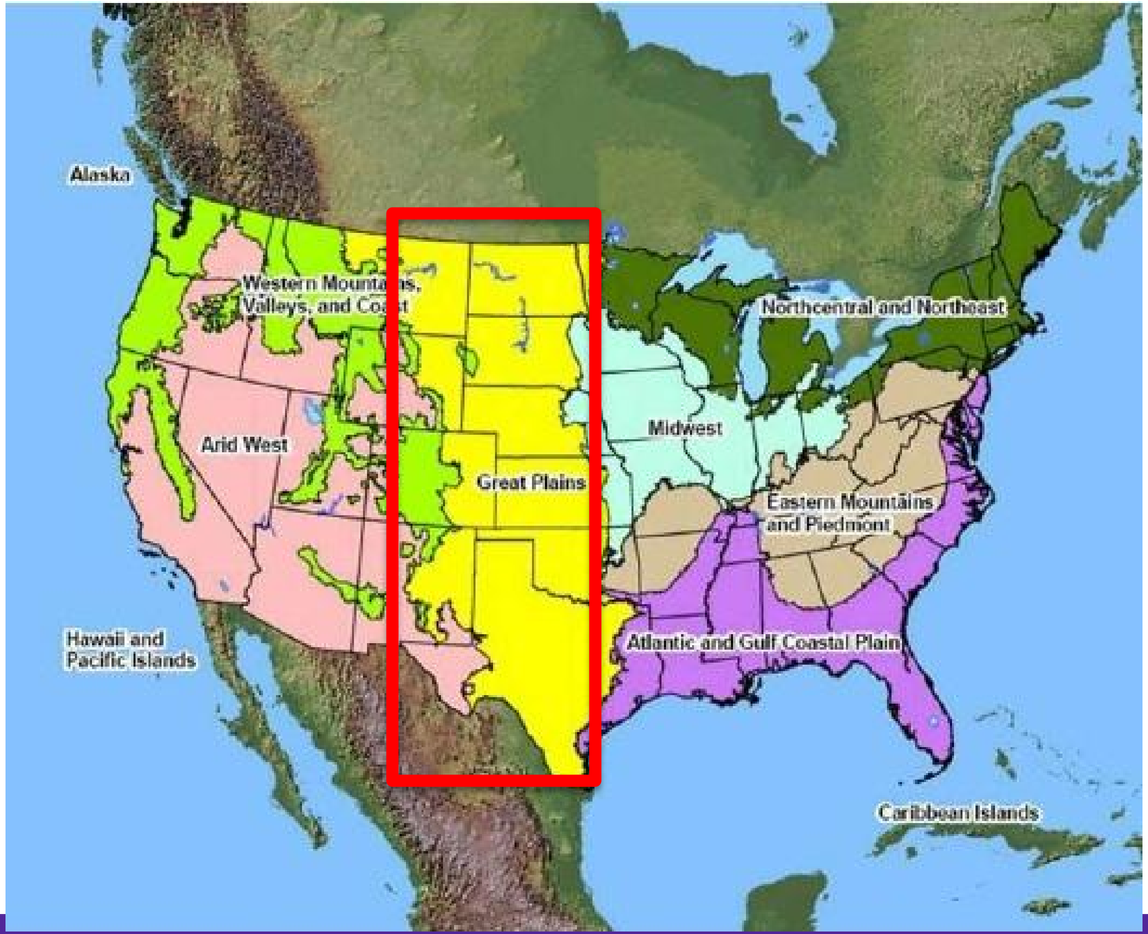
Conversation Topics

Small towns and rural (STAR) communities and the Great Plains

Harvesting the wind for STAR communities' economic development

Economic feasibility of green ammonia production: A case of southwestern Kansas

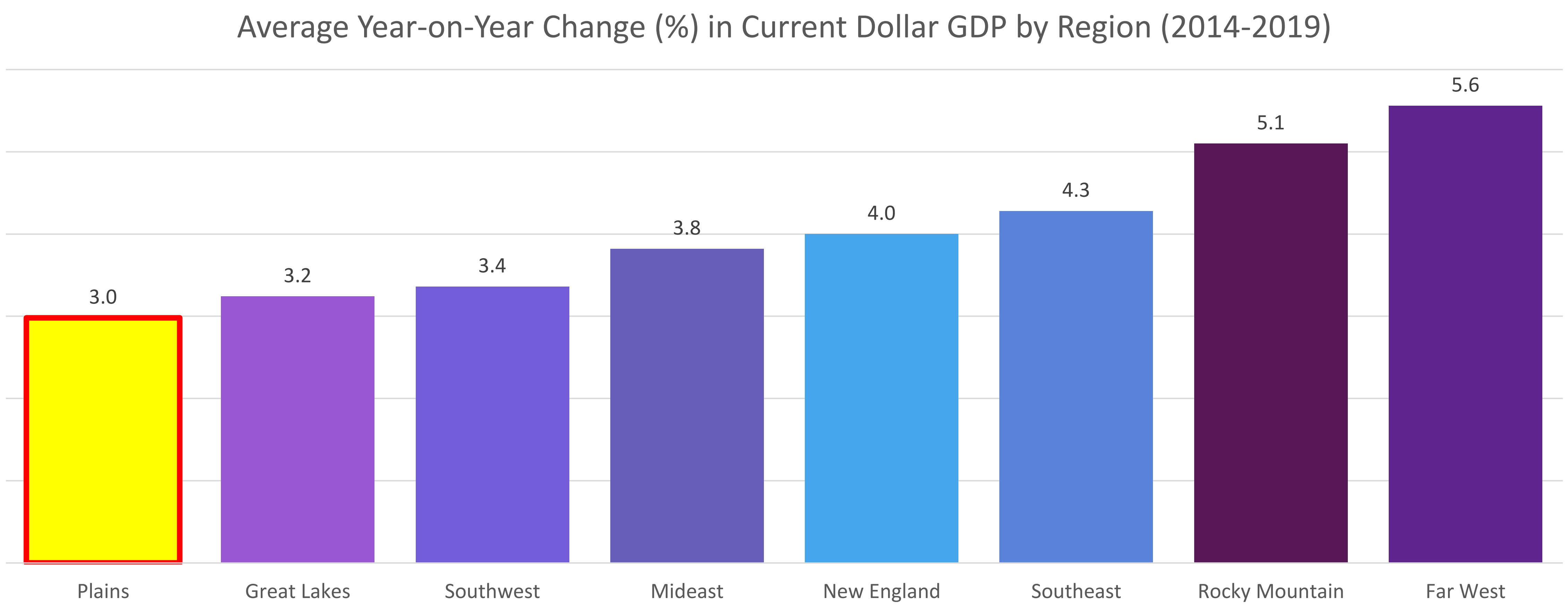
The Great Plains is Not the Midwest



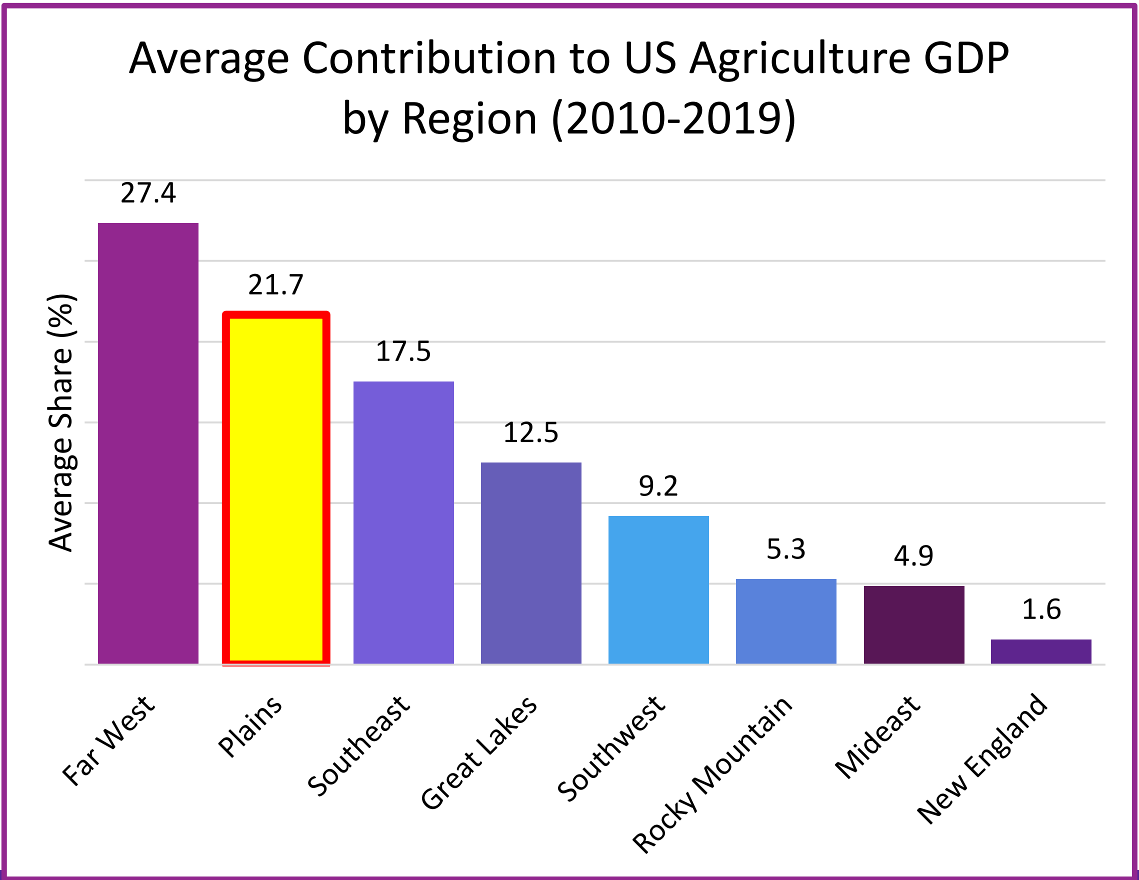
The Great Plains begins in Texas and reaches all the way to the Canadian border. The "Midwest" offers images of "tree-lined rivers winding through bucolic hills covered in emerald green fields of corn or grass." The Great Plains, on the other hand, engenders images of "flat, treeless expanses interrupted only rarely by a modest creek or river. Tall white grain elevators overlook towns where each straight, wide, sunlit street opens onto a stretch of lime-green buffalo grass or yellow wheat."

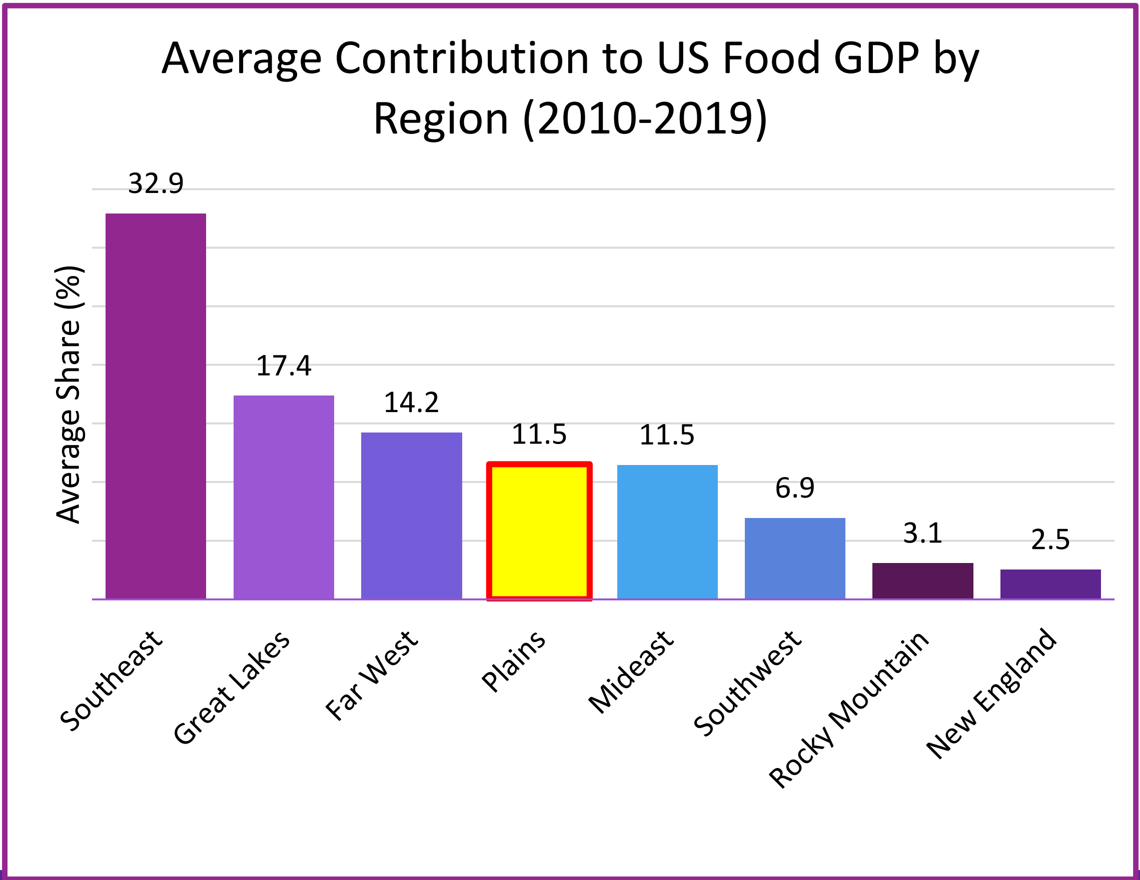
Julene Bair, Kansan, award-winning writer on HPPR on Sept. 27, 2018. (https://www.hppr.org/post/our-turn-earth-great-plains-not-Midwest)

The Plains in the US Economy

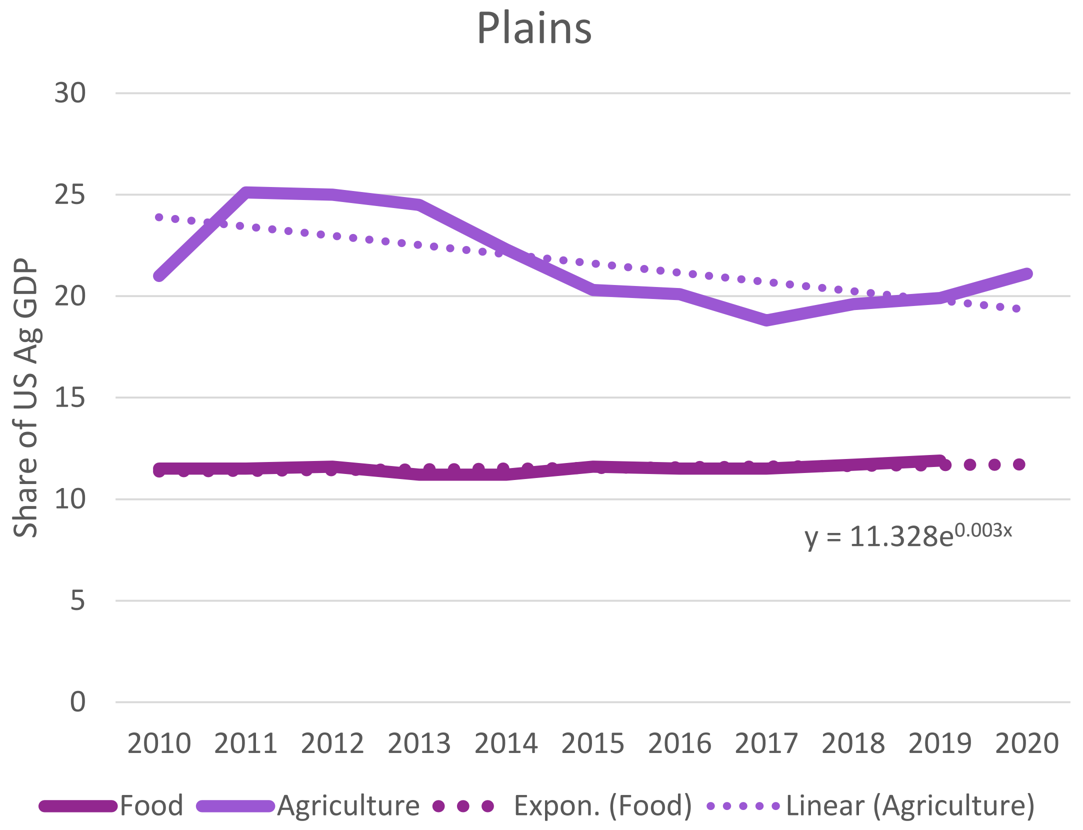


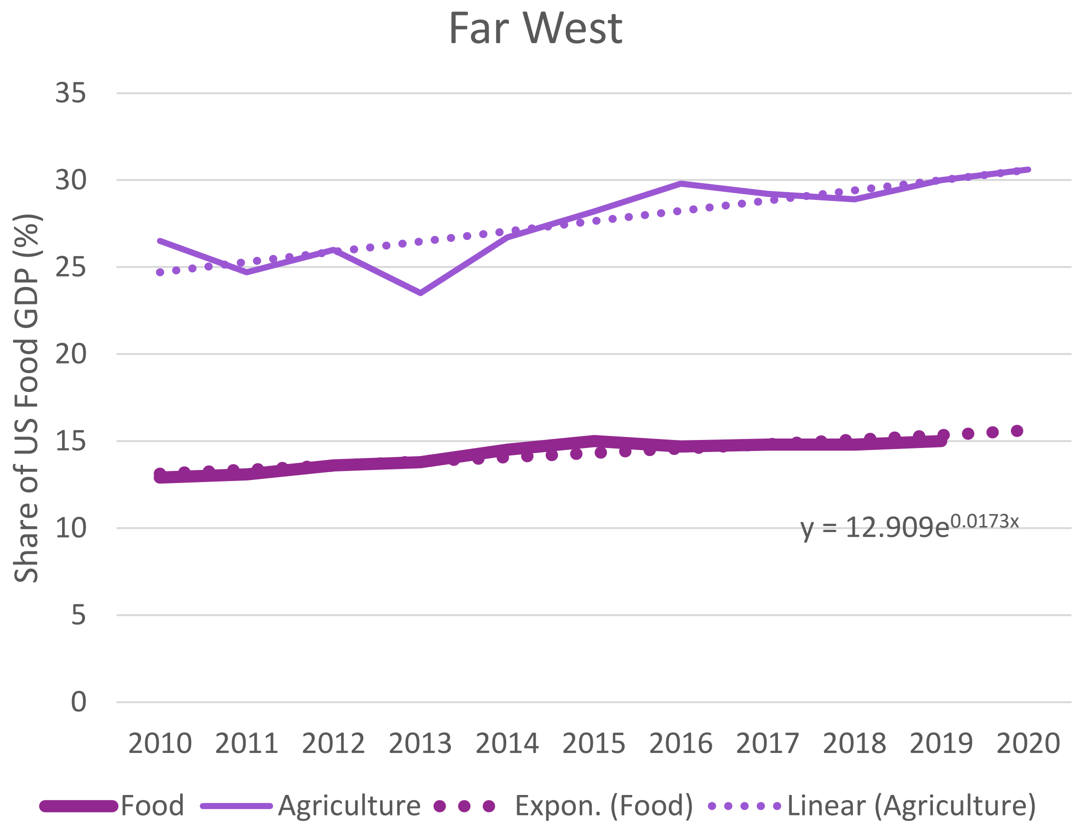
The Plains in US Agriculture and Food Sector



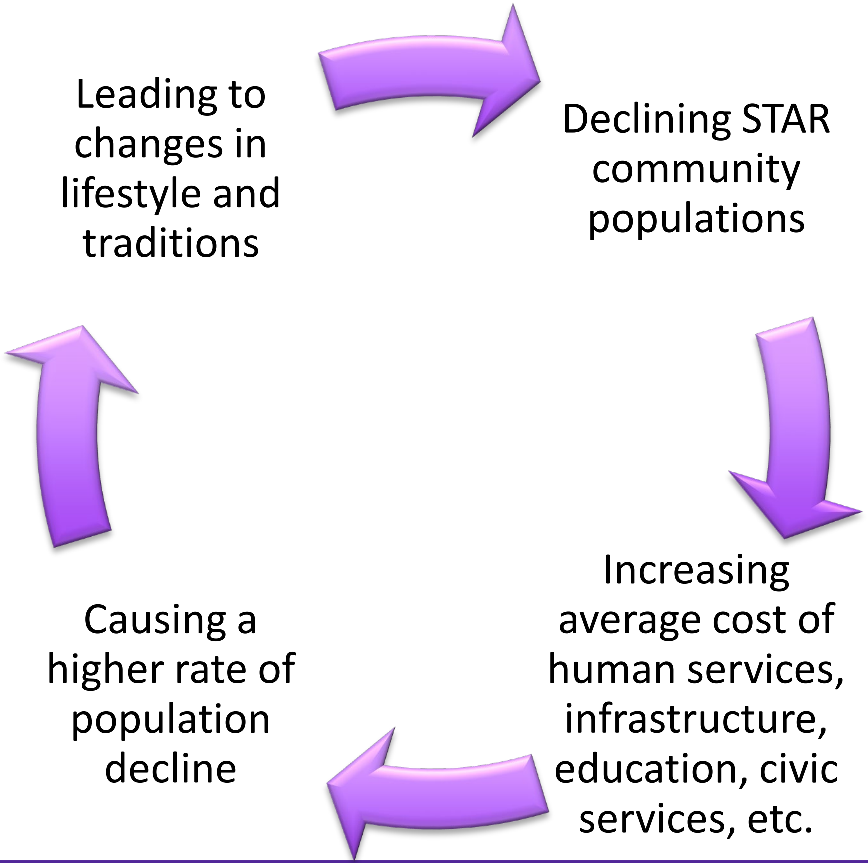


Trend in Region's Share of US Agriculture and Food GDP (Plains v. Far West)

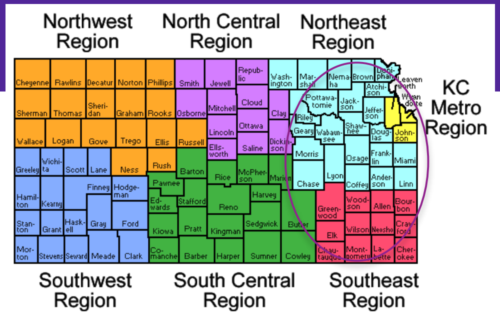




Plains’ Reality and Need to Get Creative



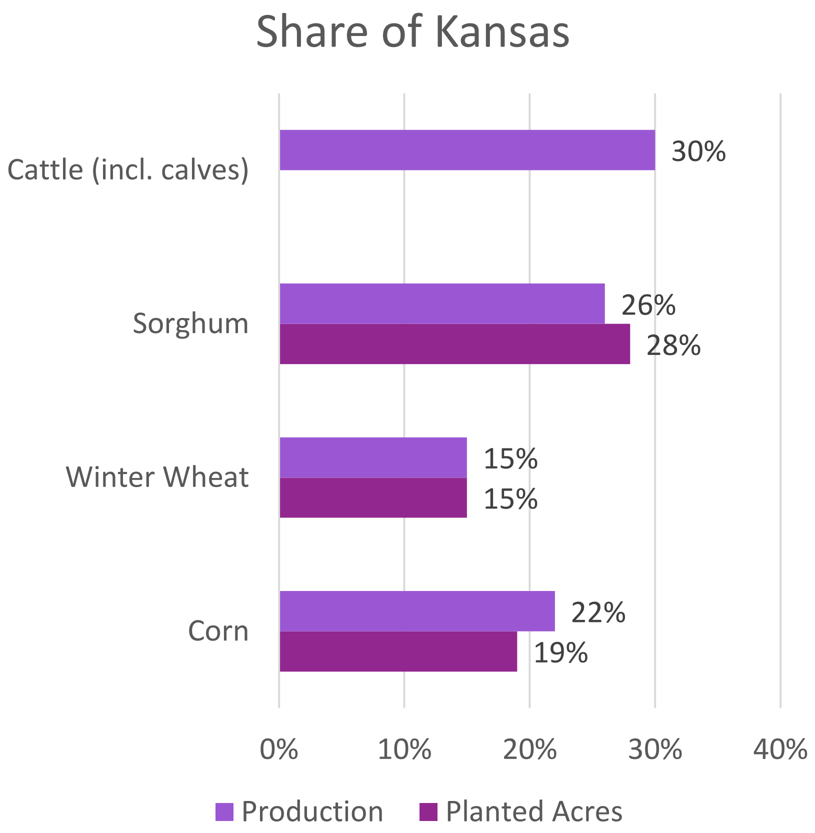
- Farmers in the Plains import most consumable farm inputs and sell the majority of their production a bulk or intermediate products
- SW KS alone spends about $120 mil/year on ammonia fertilizer alone
- That is $1.2 billion in 10 years



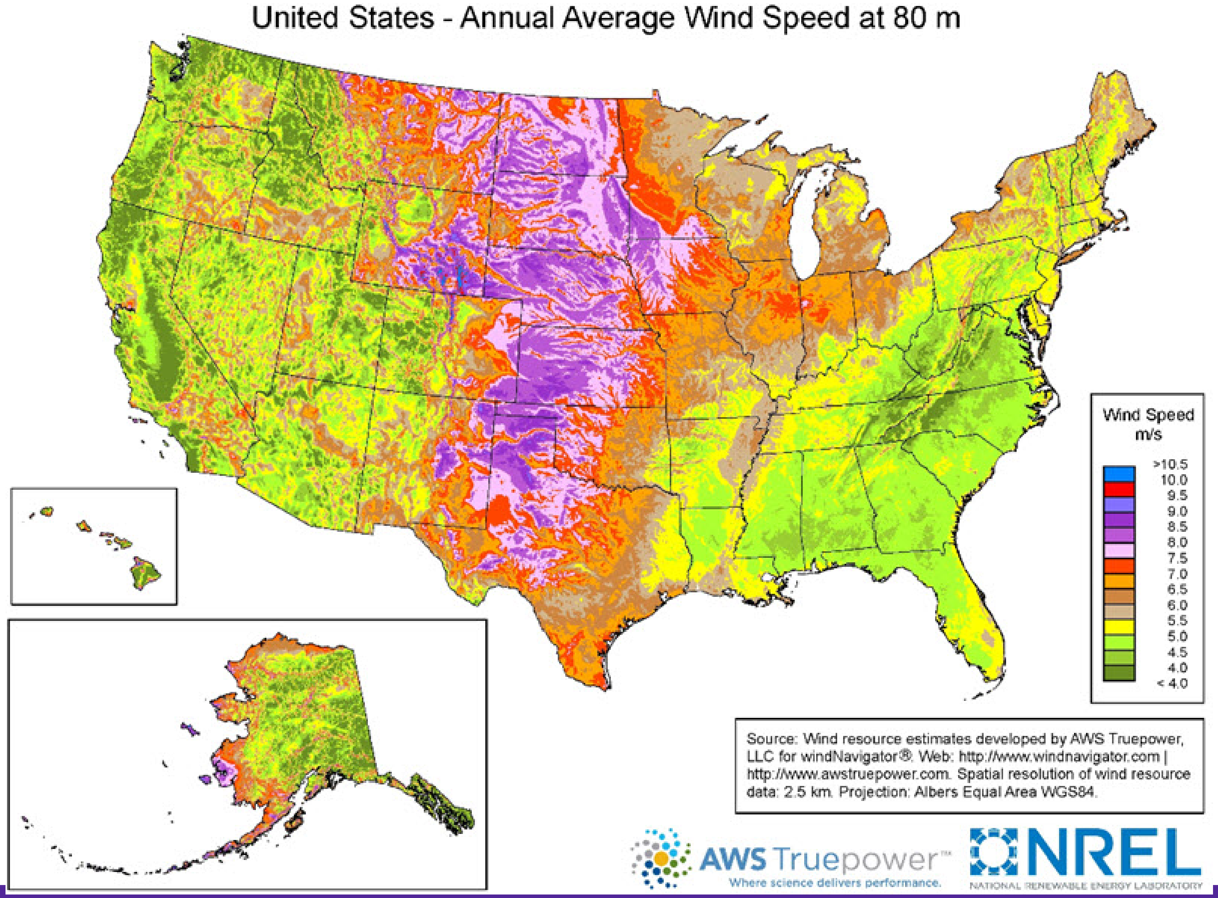
FEWtures' Story

- Let's imagine regional ag community comprising the 18 counties in the USDA Southwest Agricultural Area
- They produce a significant proportion of Kansas agricultural commodities:
  - Corn, wheat, and sorghum and livestock

  (https://www.nass.usda.gov/Statistics_by_State/Kansas/Publications/County_Estimates/index.php)
- Let's imagine an economic development strategy for the area that focuses on leveraging wind to enhance community wealth and wealth creation potential
  - Use wind energy to produce all the ammonia fertilizer needed



Opportunity to Reimagine Economic Development



Crop Acres and Ammonia Needs Assumptions

Crop	2019 Acres	2018 Acres	2017 Acres	3-Year Average Acres	N Fertilizer Need (#/Acre)	Anhyd. NH_3 Applied (#/Acre)	Anhyd. NH_3 (MT) (3-Year Average)
Corn	1,201,000	881,000	1,018,000	1,033,333	174	212.2	99,458
Cotton	41,200	44,400	26,200	37,267	174	212.2	3,587
Sorghum	715,000	770,000	766,000	750,333	100	122.0	41,506
Soybeans	87,800	116,500	137,500	113,933	160	195.1	10,084
Wheat	1,408,500	1,414,000	1,405,500	1,409,333	120	146.3	93,551
Total	3,453,500	3,225,900	3,353,200	3,344,200			248,185

While NH_3 is typically not applied to soybeans, some farmers do to boost yields.

Source: https://quickstats.nass.usda.gov/; AgManager.info; Others

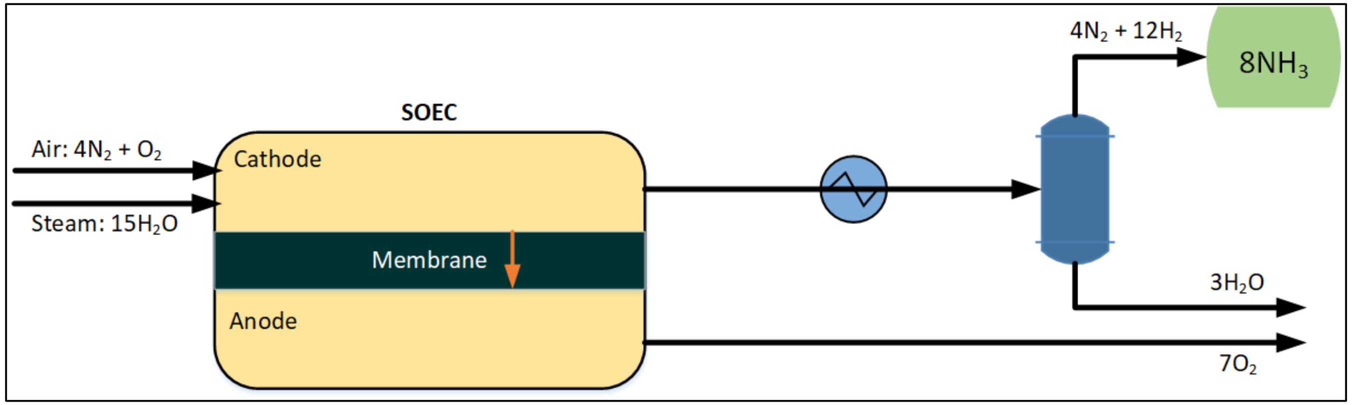
Decision-Maker Assumptions

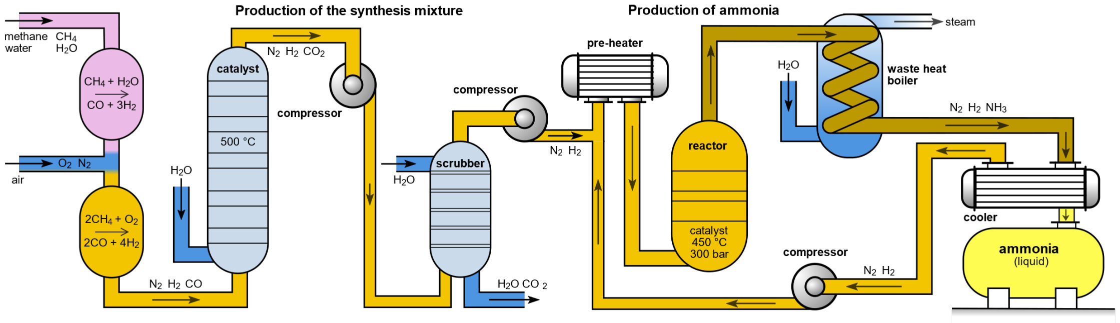
- Local production of inputs benefits the community if it is globally competitive
- Local consumption of locally-produced globally-competitive inputs adds value
  - Therefore, farmers will use locally-produced ammonia if it is competitive
- Research seeks to assess the conditions for globally-competitive local green ammonia production
- Production capacity to replace all imported ammonia into community, i.e., 248,185 MT

Ammonia Production Technology Assumptions

6.5 MWh/MT

Green Ammonia using the Solid Oxide Electrolysis Cell

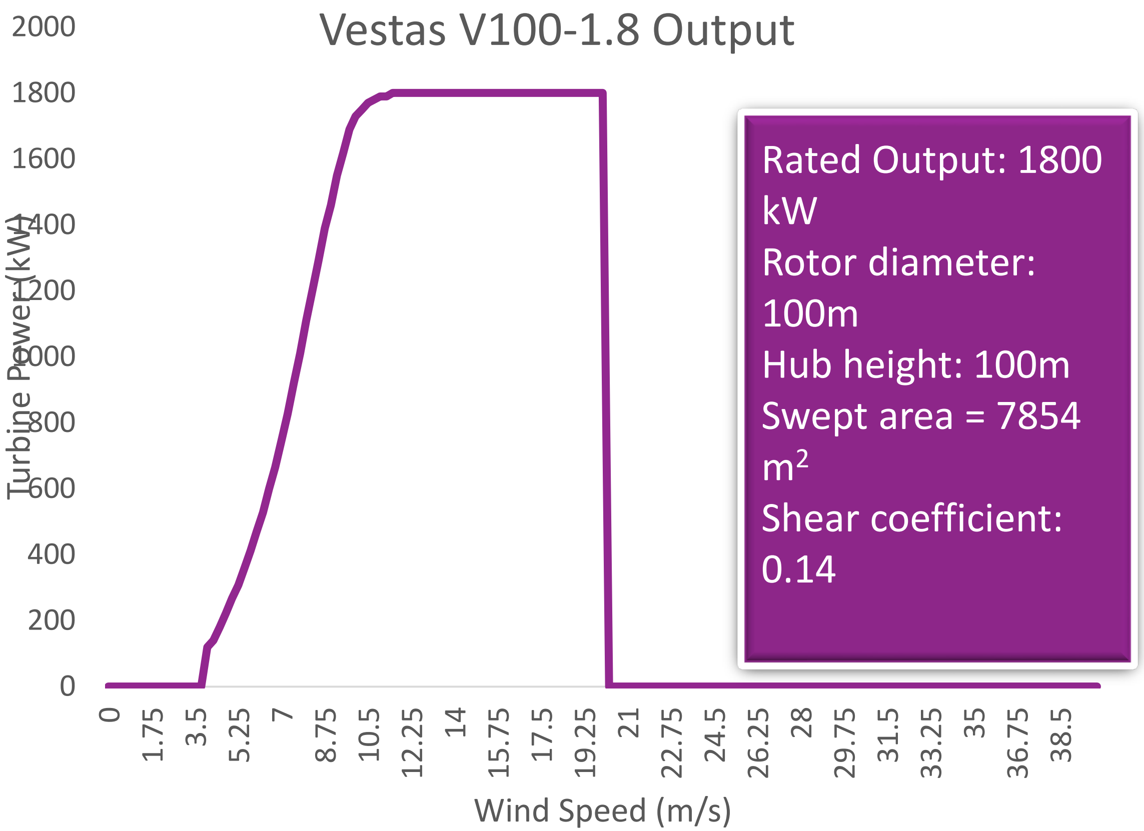




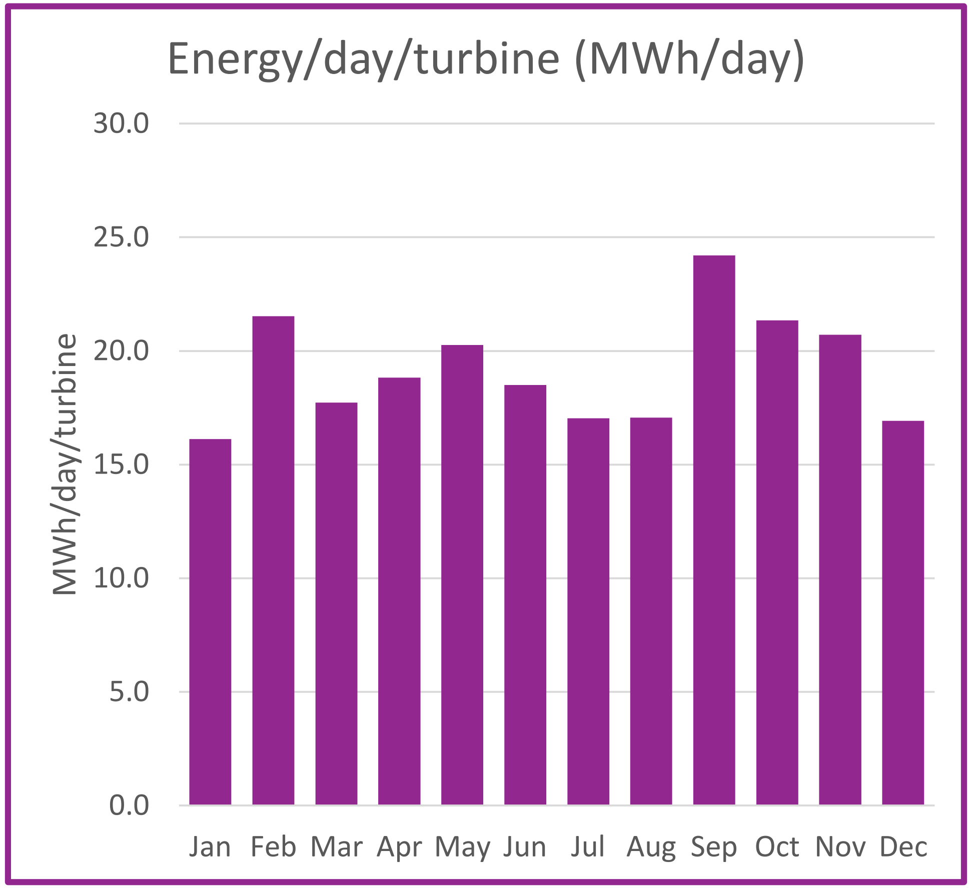
Ammonia using Haber-Bosch Technology

10.5 MWh/MT

Energy Production Technology Simulations Output



Rated Output: 1800 kW
Rotor diameter: 100m
Hub height: 100m
Swept area = 7854 m^2
Shear coefficient: 0.14



Energy Production Technology Assumptions

All system costs and performance assumptions procured from NREL using the SAM (System Advisors Model – Wind Module)

- SAM simulations produced 19.2 MWh/day/turbine
- Implying an average output of about 2.9 MT/day
- Implying about 233 turbines to produce 248,185 MT/year

Cost of Production

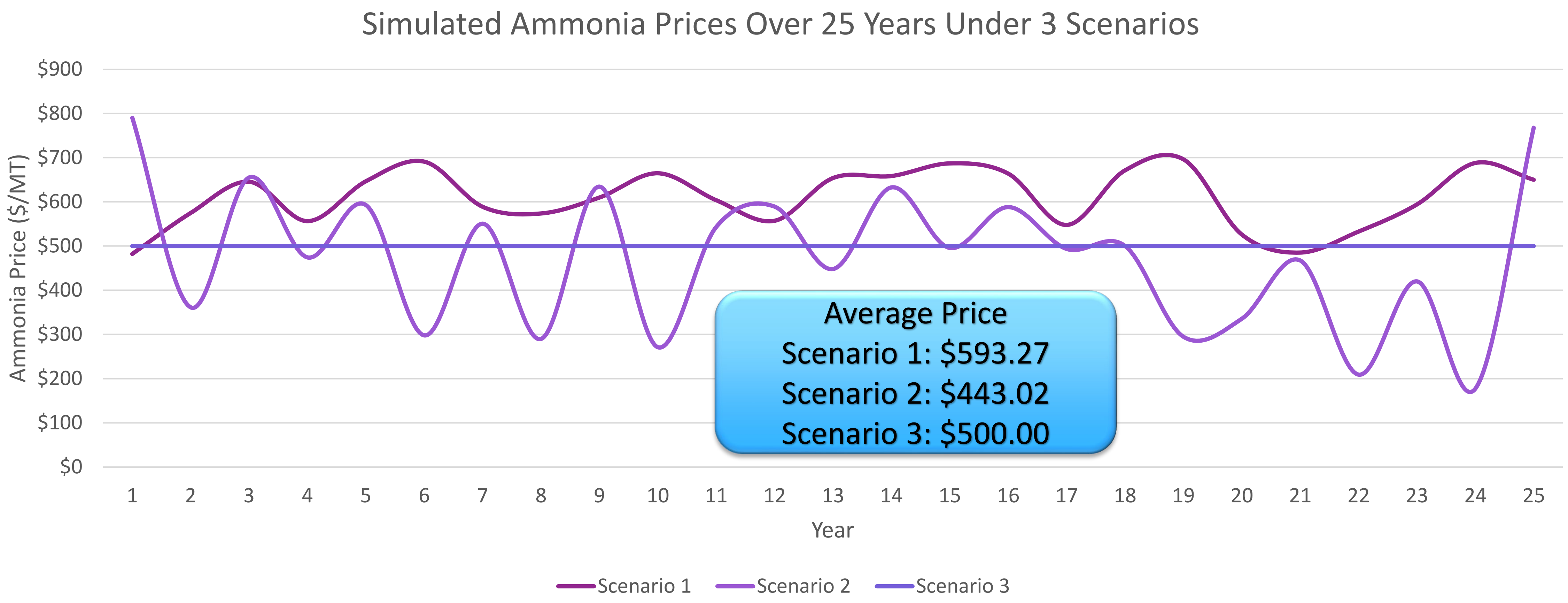
Capital Expenditure

Turbines	Ammonia Production	Total CAPEX
$605.6 million	$173.5 million	$779.1 million

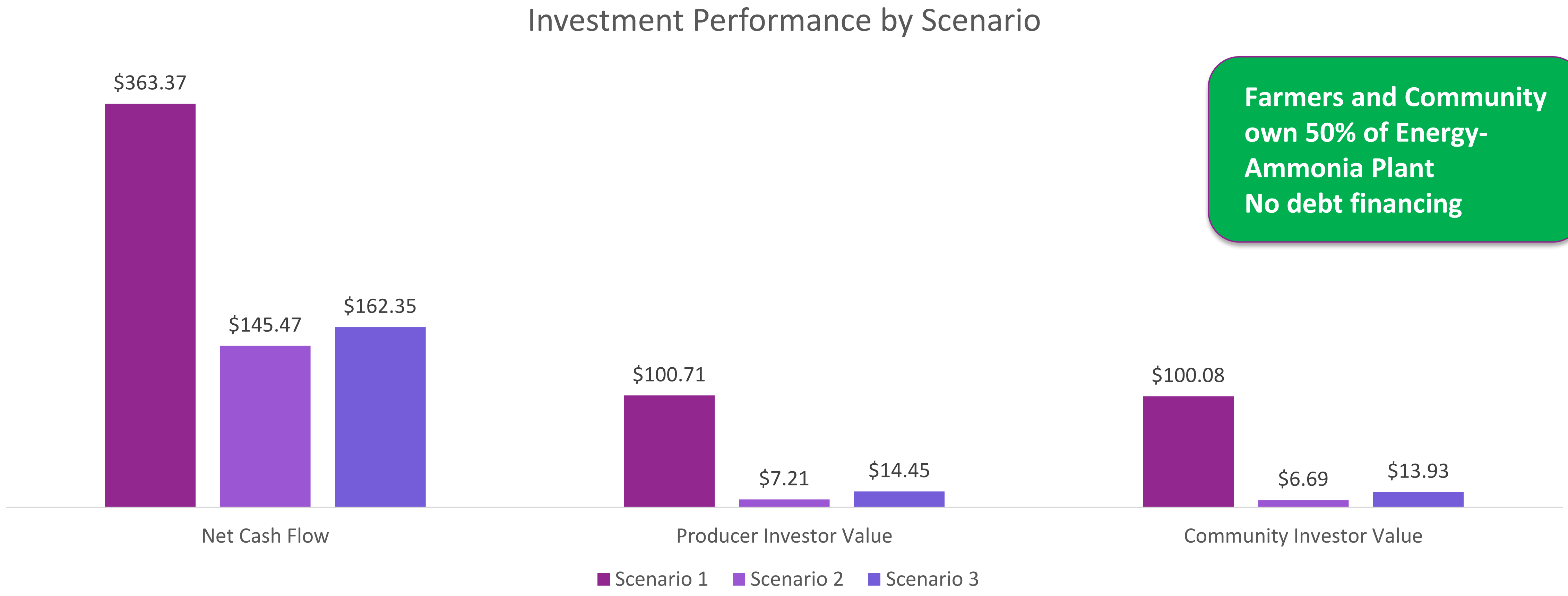
25-year life expectancy

- The capital cost per metric ton of ammonia over 25 years is $97.61
- Total operating cost per metric ton of ammonia is assumed at $6.95
  - Includes manager, engineers, and other HR plus water and maintenance
- Total cost/MT = $104.56

Ammonia Price Assumption (Simulation)



Discounted Investment Performance with 23% Ammonia Price Discount, 30% Dividend, and 5% Discount Rate Over 25 Years



Farmers and Community own 50% of Energy-Ammonia Plant
No debt financing

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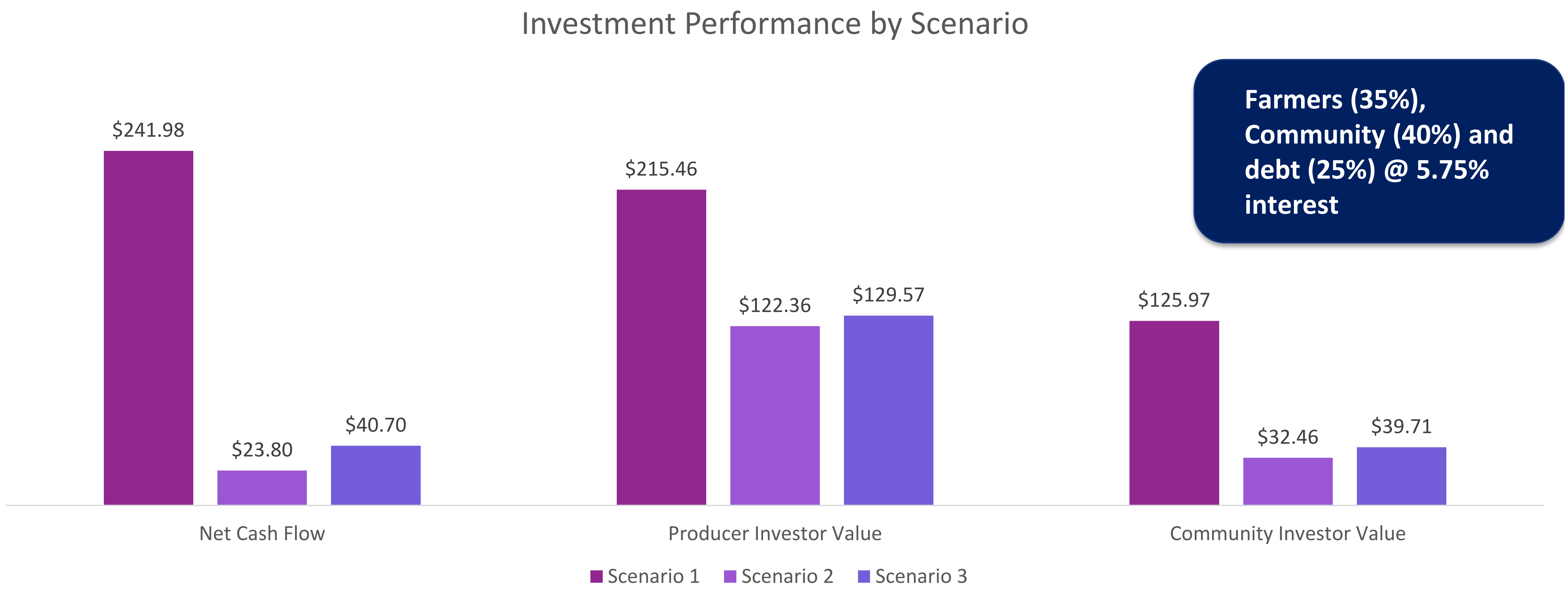
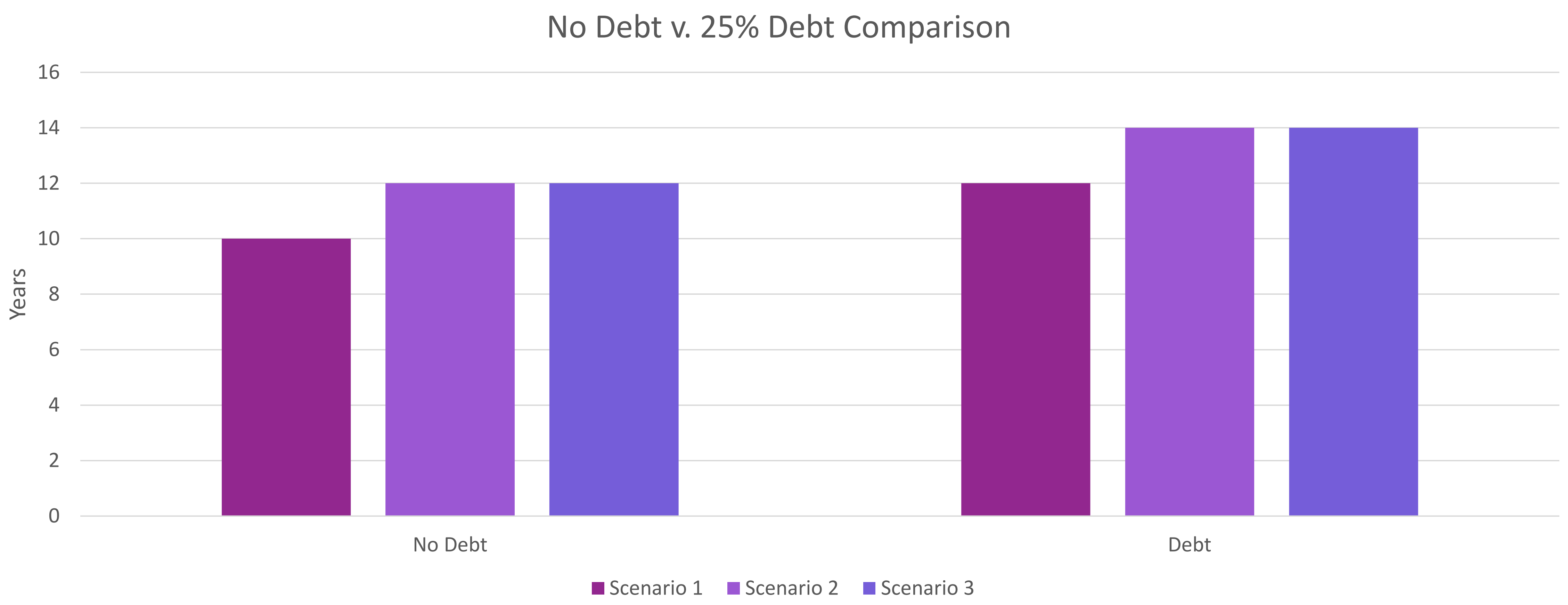


Farmers (35%), Community (40%) and debt (25%) @ 5.75% interest

Discounted Payback Period



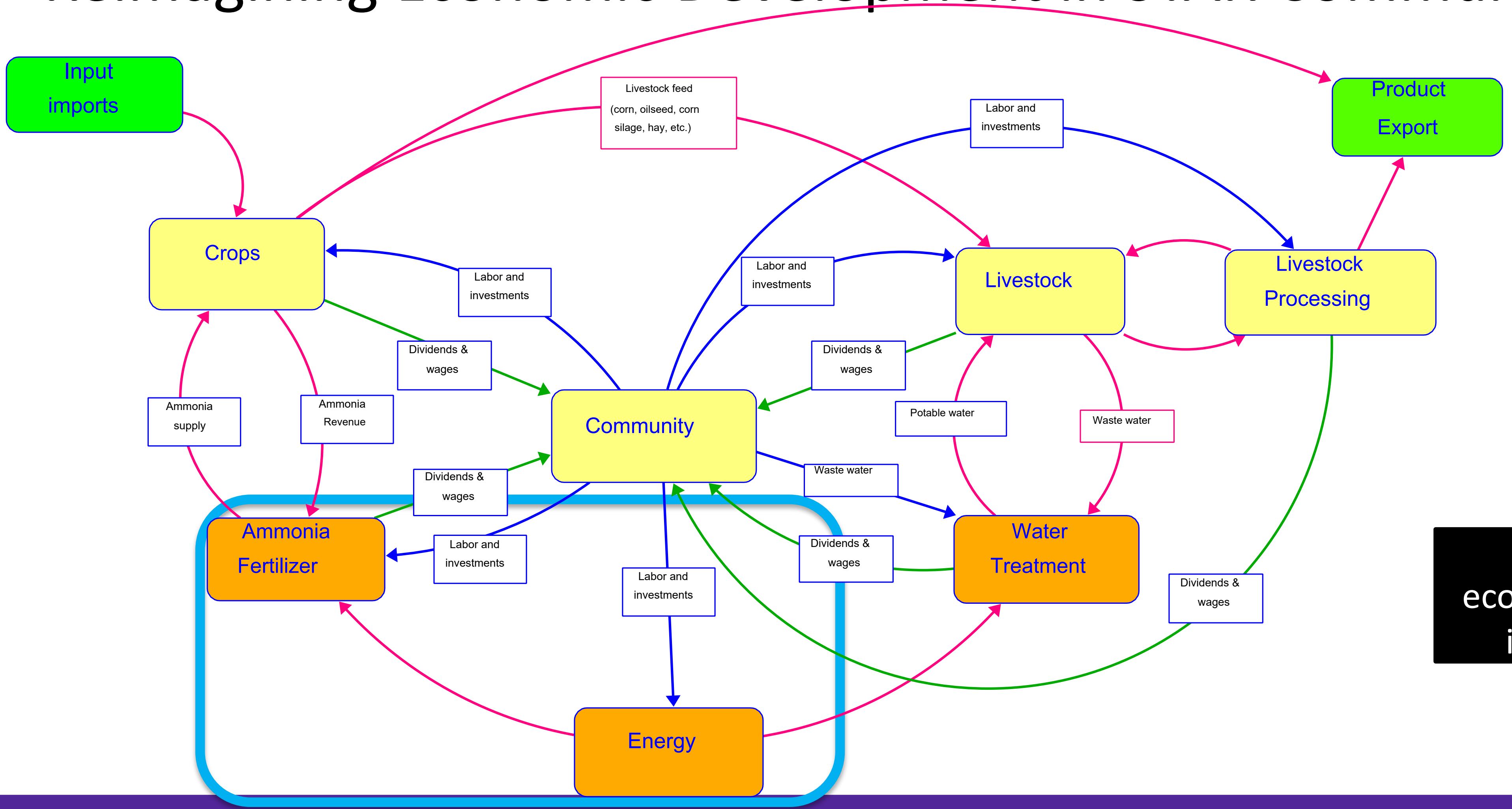
Recall…It's About People (and Profit)

- Dividend payments come to community residents
- What will they do with it?
  - Opportunity to invest in local value adding initiatives to enhance community attractiveness to young innovative entrepreneurs
  - Diversify economic base and begin importing talent and exporting products and services
  - Transform the community and improve its vitality, viability, and sustainability

Conclusion

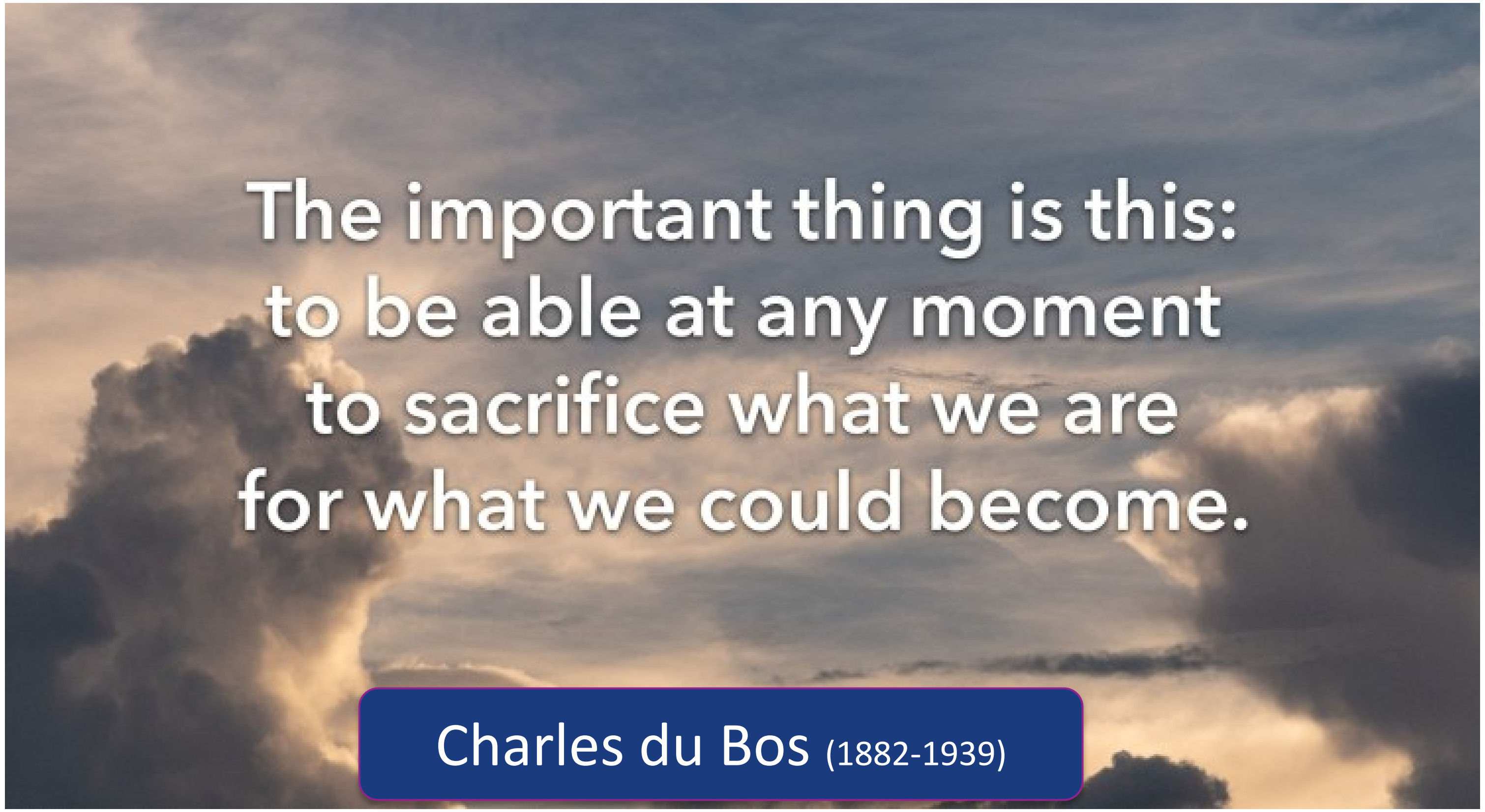
- Emerging technologies support globally-competitive local green ammonia production
- Despite competing interests (battery, transportation fuel, grid electricity, etc.), best use of locally produced green ammonia is for local consumption to produce value-added crops and livestock
- This could differentiate local producers in the market, allowing them to sell their produce at premiums in an increasingly discriminating market
- Increase wealth, increase community viability, increase sustainability

Reimagining Economic Development in STAR Communities



Maximizing economically-sound internalization

Final Thought



Charles du Bos (1882-1939)

Vincent Amanor-Boadu
Department of Agricultural Economics
Kansas State University
vincent@ksu.edu