

Biofuel Deployment Studies on the US-Mexico Border Region

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Commercialization of Micro-Nano Systems Conference

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Sandia National Laboratories is a multi-program laboratory operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin company, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

The BNSL—A Unique Partner

- Outgrowth of a Sandia initiative for US/Mexico border security and economic development
- Bi-National Organization focused on technology-based business development and permanent change to an dynamic innovation culture in the border region
- Bi-National Board of Directors, Advisory Board and Funding
- Strong Networking connectivity to major organizations in the border region and in Mexico/US
- Personal relationships with key individuals and organizations in both countries.
- Strategic areas of focus include, alternative energy, security, advanced manufacturing (MEMS/Nano) and health.

Background

- Strategic focus on alternative energy evolved from:
 - ➡ *Bi-national Partnership for Innovation agreement signed by Governors Richardson and Baeza-Reyes (Apr 2008)*
 - ➡ *Biofuels Summit held in Albuquerque (Dec 2008)*
 - ➡ *BNSL Alternative Energy Workshop in Santa Teresa (Mar 2009).*
- Strong interest from outside private investors on non-ethanol biofuels
 - ➡ *Need for objective analysis of opportunities in the Paso del Norte region*
 - ➡ *Potential investments of \$10's to \$100's of millions in the US and Mexico border communities*
- Public Policy and Leadership need to understand and balance private sector interests with that of the public interests for sustainability, jobs, infrastructure, etc.
- These needs dove-tailed with the efforts Sandia and DOE to create a systems analysis tool with GM

Objective

- **Develop a decision support model to assist**
 - ➡ Investors, and entrepreneurs in evaluating the
 - *costs and benefits, as well as*
 - *risks and opportunities*
 - associated with alternative biofuels*
 - development strategies along the U.S.-Mexico border.*
 - ➡ Local and regional decision makers in understanding the tradeoffs such development poses to their communities.

Leverage

Project leverages significant collaboration between General Motors and Sandia National Labs to develop a model to explore the potential for biofuels deployment



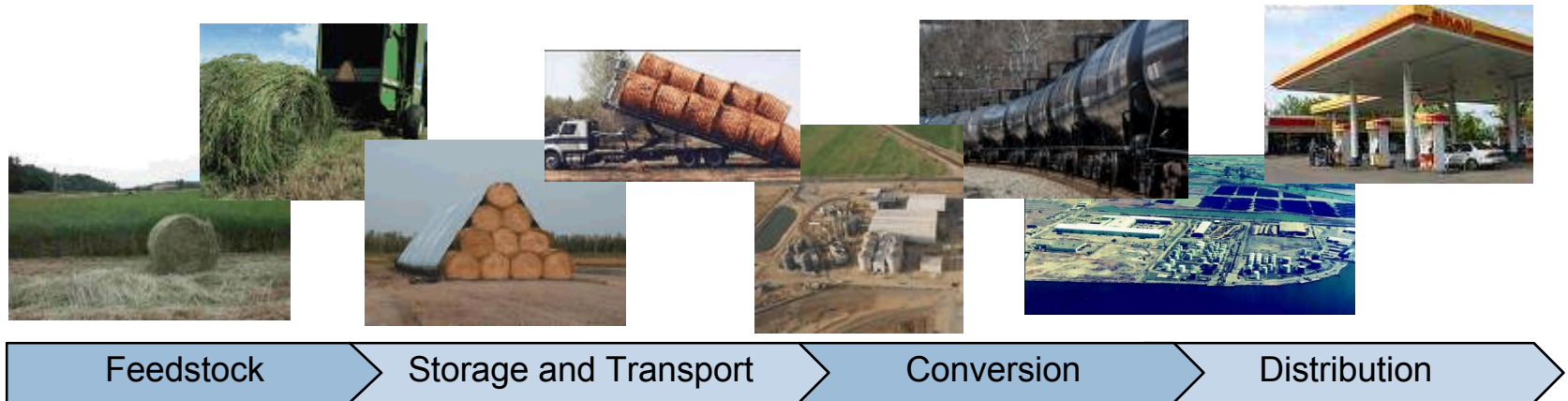
- Todd West, Sandia Lead
- Katherine Dunphy-Guzman
- Jim Ellison
- Patty Hough
- Lenny Klebanoff
- Rich Larson
- Len Malczynski
- David Reichmuth
- Amy Sun
- Robert Taylor
- Vince Tidwell



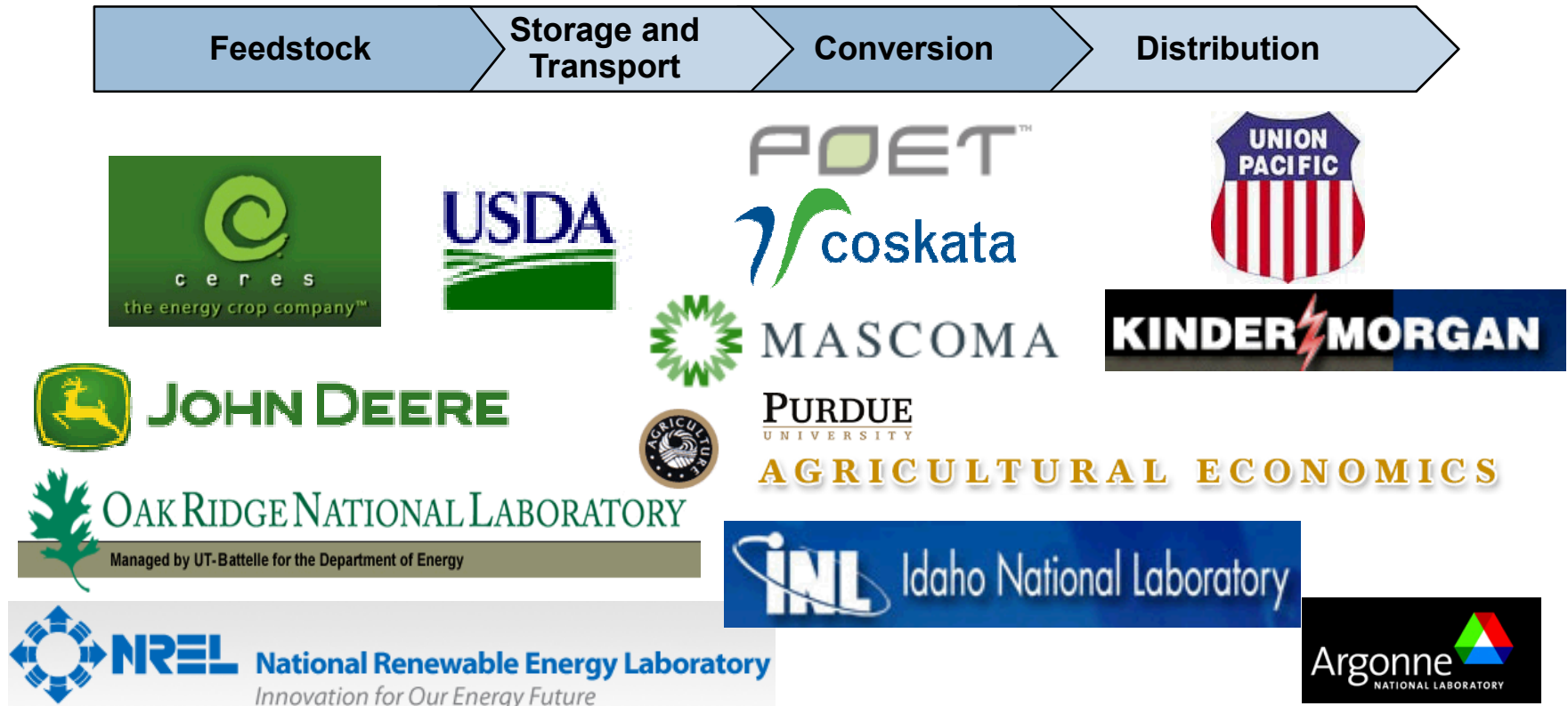
- Norman Brinkman, Technical Fellow, GM Lead
- Andreas Lippert, Director
- David O'Toole, Senior Researcher
- Robert Stephens, Staff Researcher
- Candace Wheeler, GM Technical Fellow

Joint project conducted by GM and Sandia National Laboratories is the first true value-chain approach to future large-scale biofuels

- **Purpose**: Assess feasibility, implications, limitations, and enablers of producing 90 billion gallons ethanol (~60 billion gallons of gasoline-equivalent) per year by 2030
 - ➔ Ethanol used to illustrate biofuel potential without ruling out alternatives
- **Scope**: Focus on ethanol production from residues and energy crops for 2006 to 2030; corn ethanol capped at 15B gallons per year under 2007 Energy Independence and Security Act (EISA); cellulosic ethanol production accelerated beyond EISA to enable 90B gallons total production.

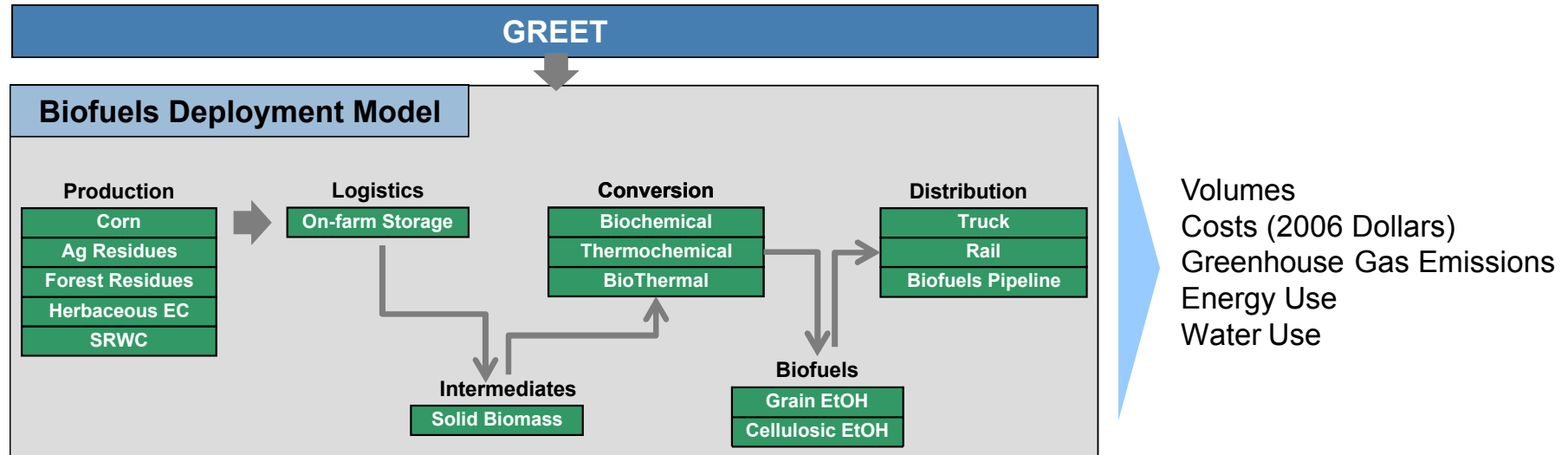


A number of organizations provided direct input and reference materials for our study*



*Views expressed in this presentation are those of the study authors and do not necessarily reflect the views of organizations listed here

We built a 'Seed to Station' system dynamics model to explore the feasibility of 90 billion gallons of ethanol



Key constraints:

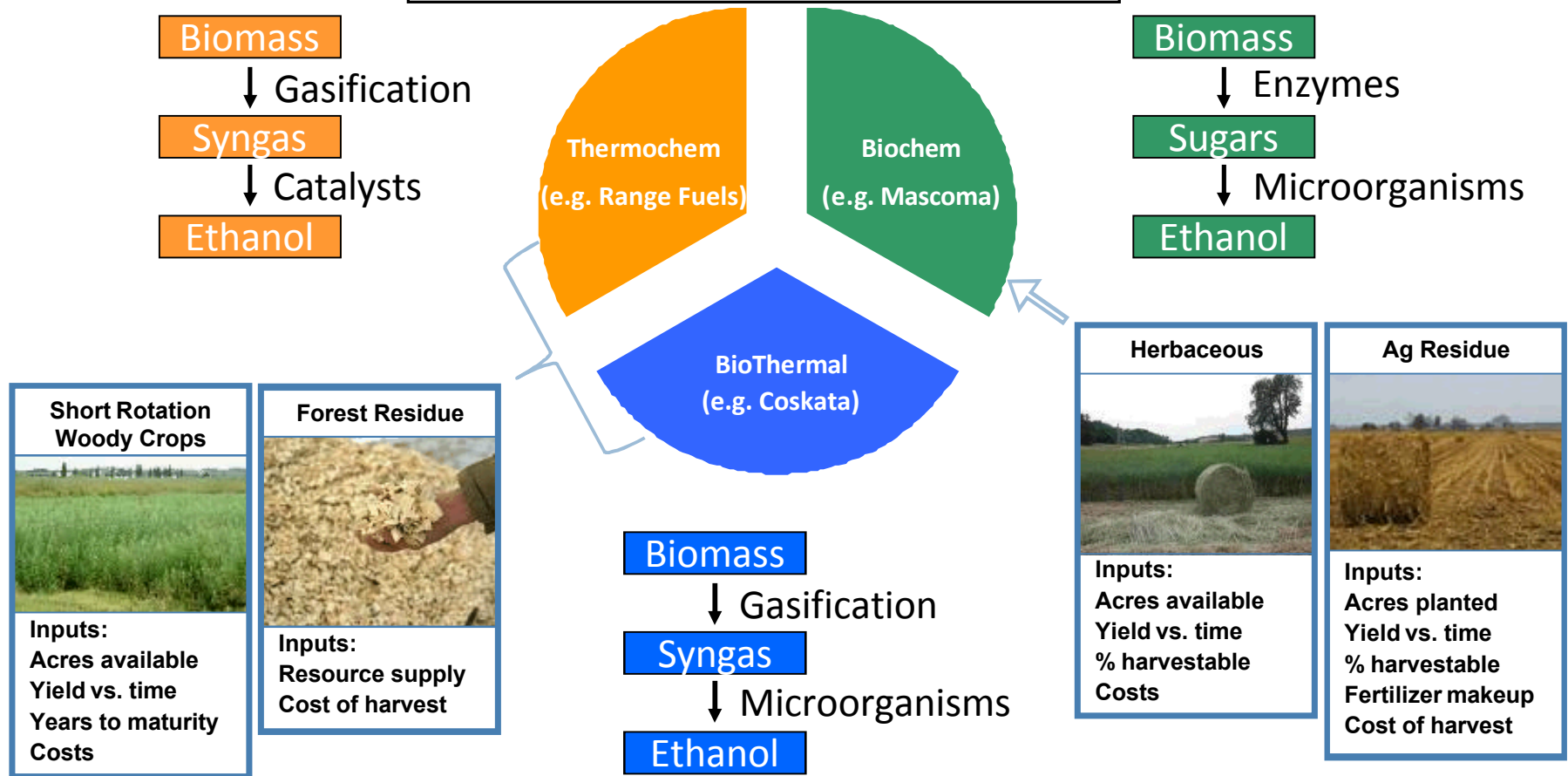
- Timeframe considered: 2006 to 2030
- State-level granularity

Model limitations:

- No modeling of markets
- Several real world constraints are not explicit in the model, but were analyzed separately
 - ➡ limitations on the availability of capital and distribution constraints
- Difficulty accurately assessing key costs and other values, especially for technologies that do not currently exist
 - ➡ sensitivity analyses were conducted to account for leading uncertainties

Conversion technologies are linked with specific feedstocks (initial linkage is not exhaustive)

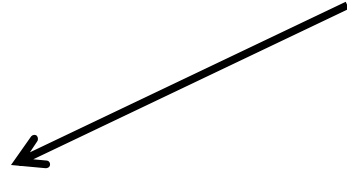
For each new plant constructed, Biofuels Deployment Model (BDM) selects a feedstock/conversion pair giving lowest cost of ethanol



These are representative – can expand combinations in the future

Modification to the border specific model

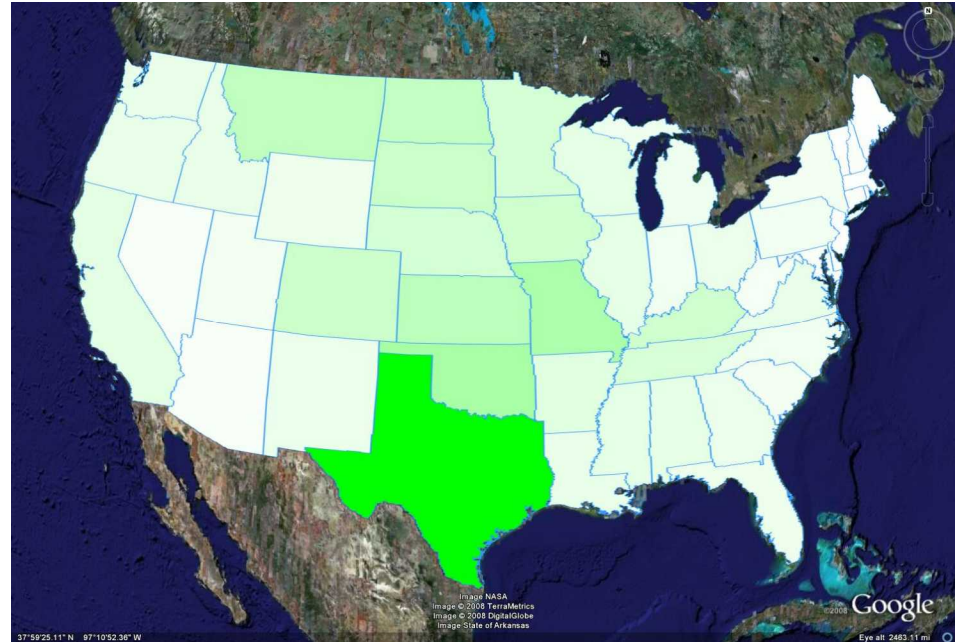
U.S. down to border



US - Mexico Border States



7- U.S. Counties
7- Mexican Municipios



Focus first on
El Paso/Juarez
area

Modification to the border specific model

- **Expand list of feedstocks**

- ➡ algae,
- ➡ jatropha,
- ➡ castor oil, and
- ➡ agricultural waste products from chile and pecans



Examples of Model Operation

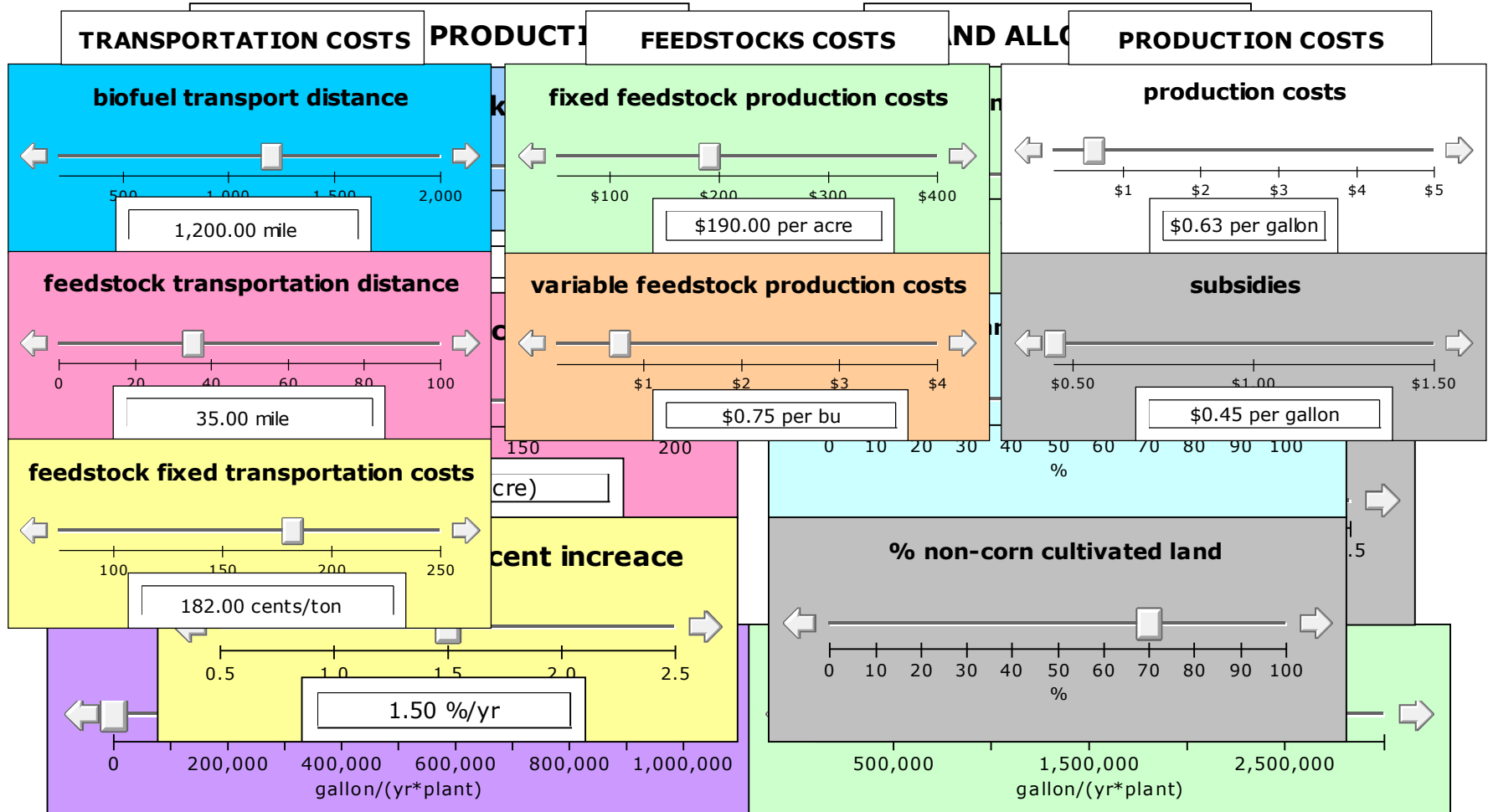
1. Support regional decision makers in evaluating tradeoffs that biofuel development poses to their communities.
2. Support investors, and entrepreneurs in evaluating the costs, benefits, risks and opportunities associated with alternative biofuels development strategies along the U.S.-Mexico border.

Exploring future biofuel growth scenarios

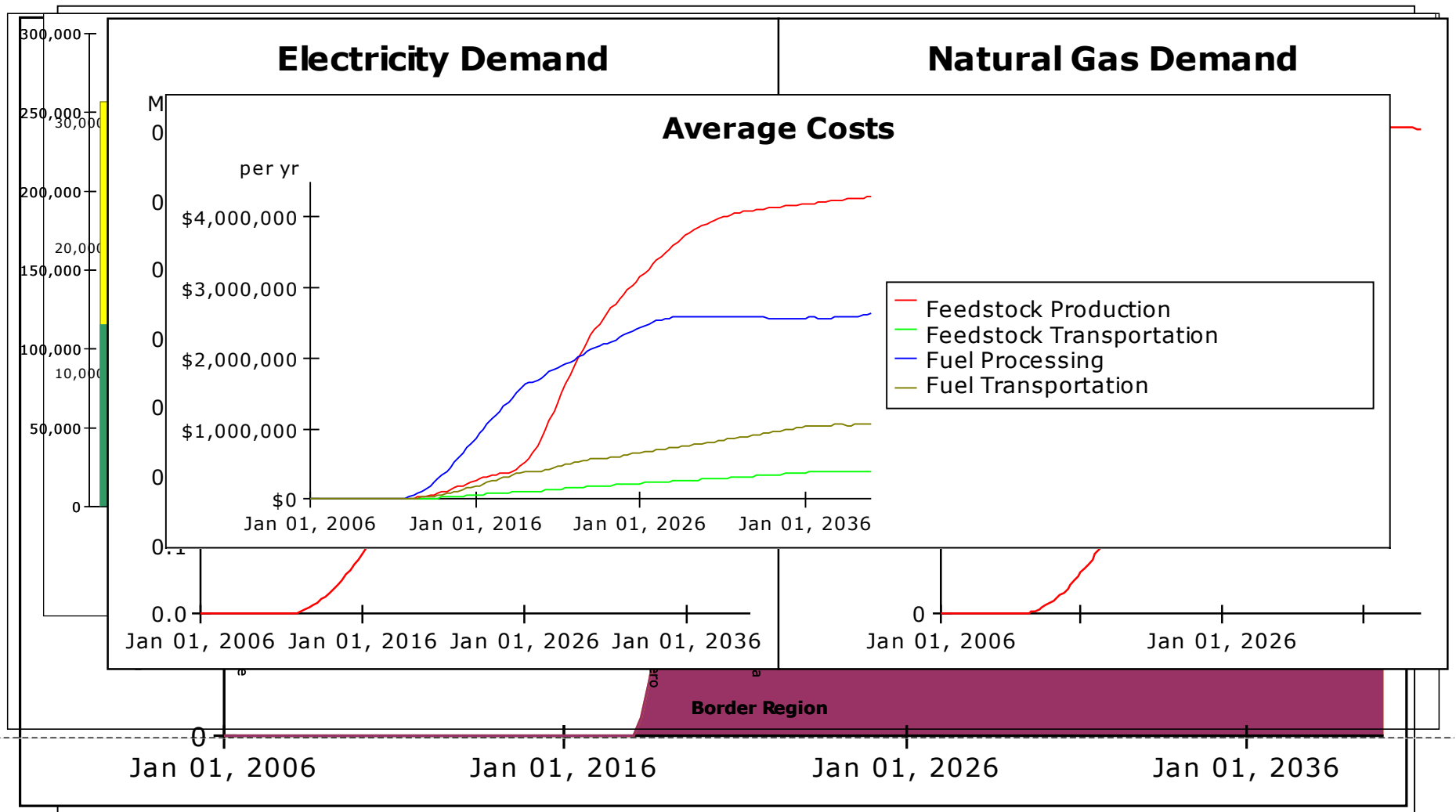
LA

COST SETTINGS

GS

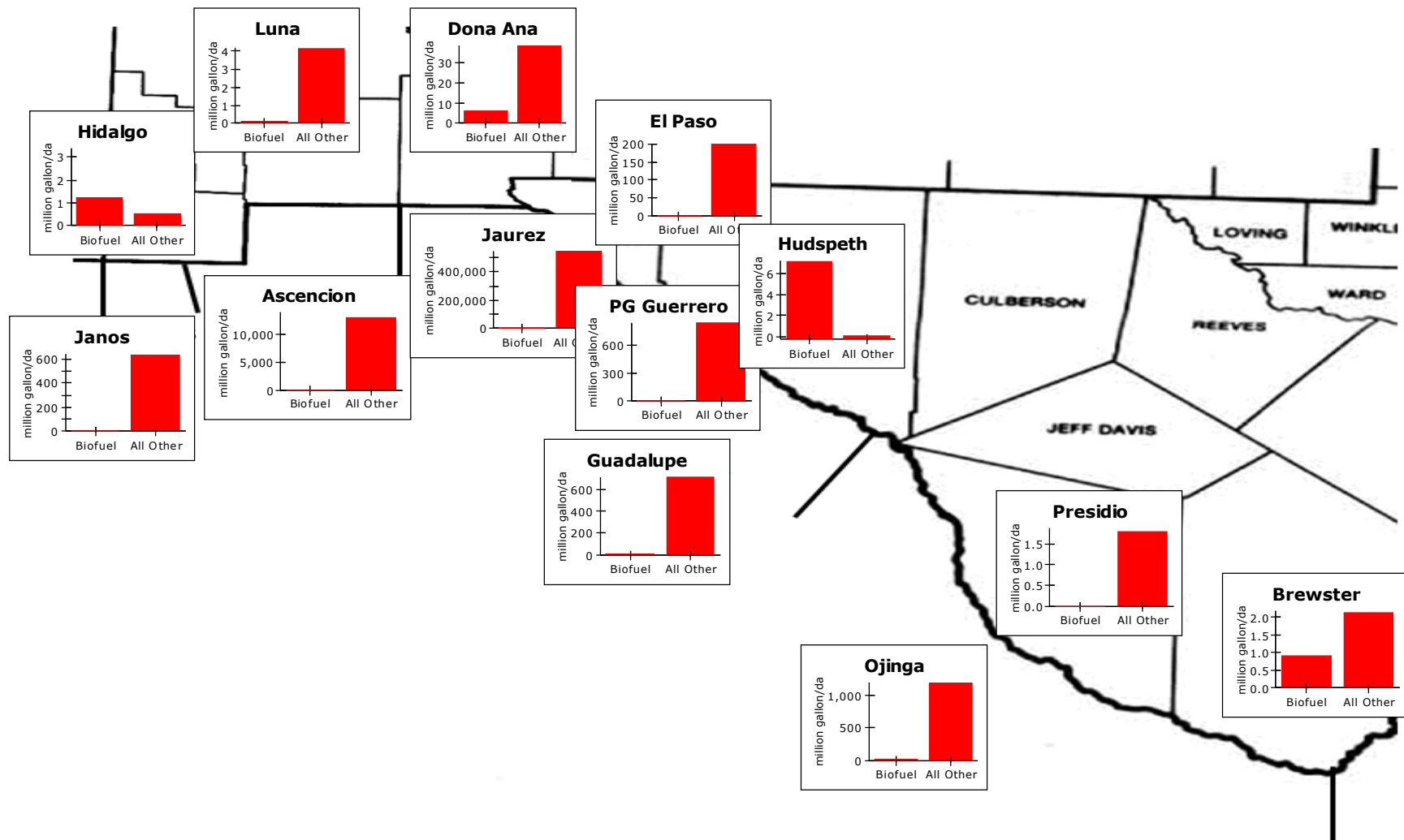


Regional impacts analysis



Impact on water demand

ADDITIONAL WATER CONSUMPTION SINCE 2004



Examples of Model Operation

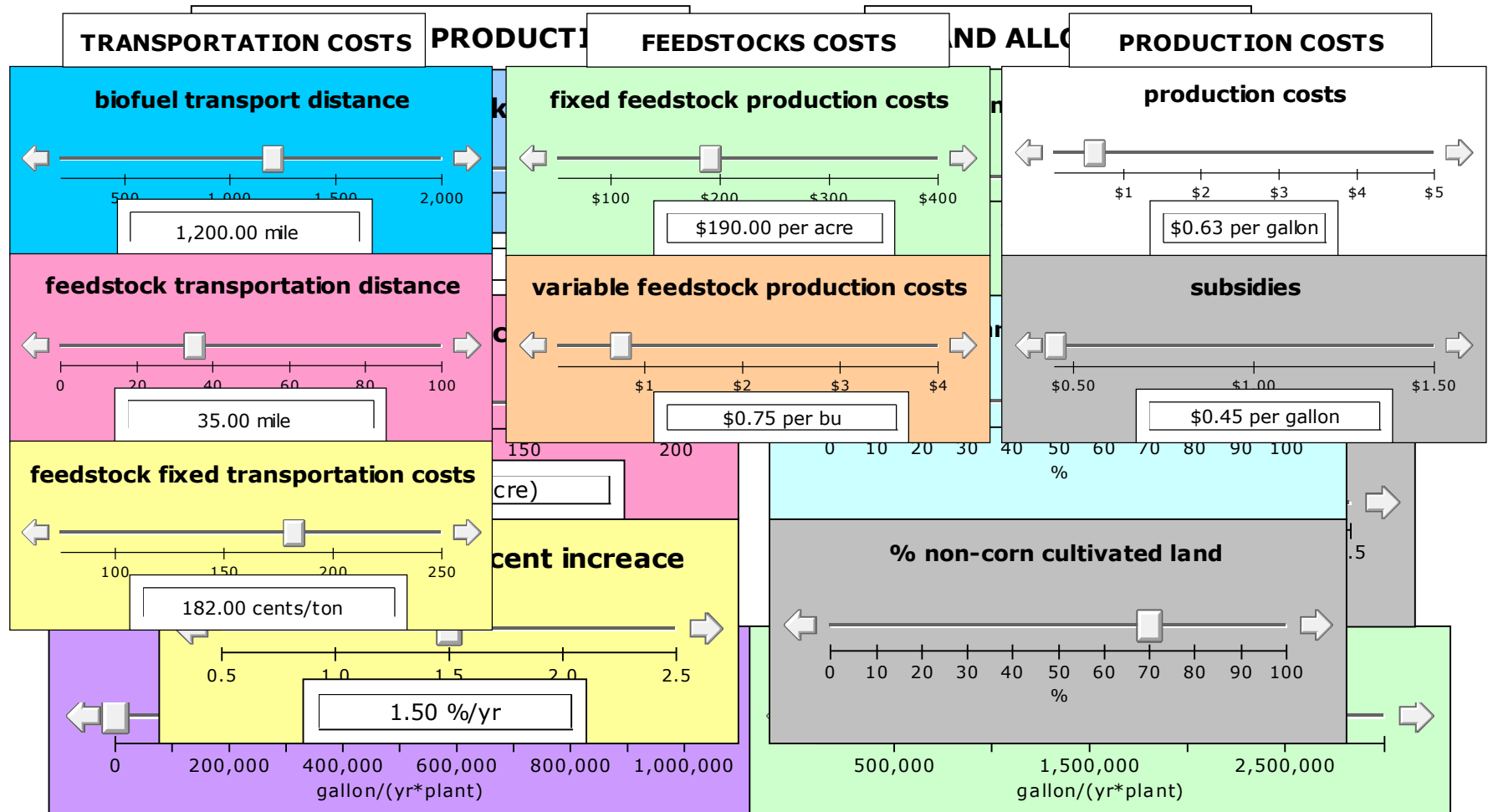
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Exploring an investor's biofuel scenario

LA

COST SETTINGS

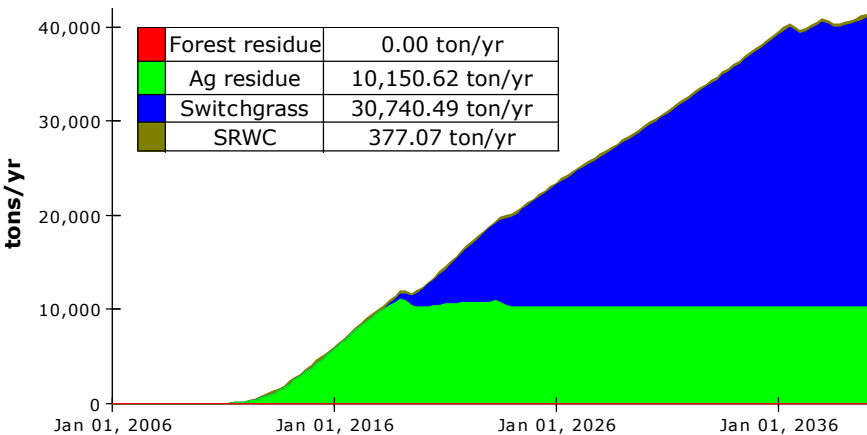
GS



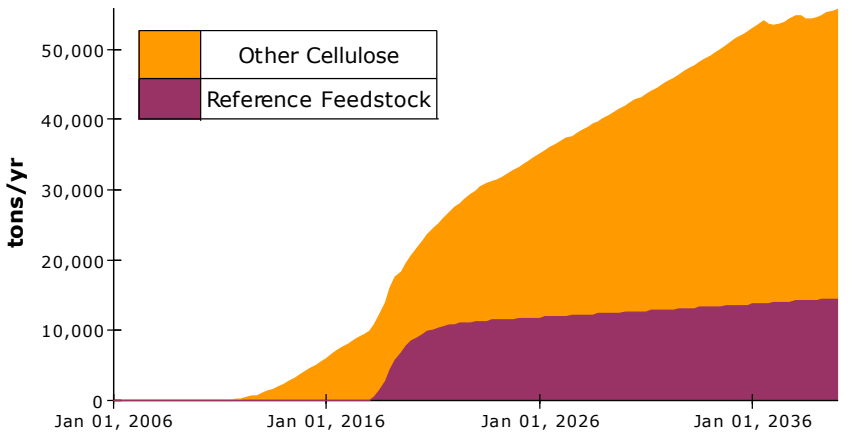
Comparison of development pathways

FEEDSTOCK UTILIZATION

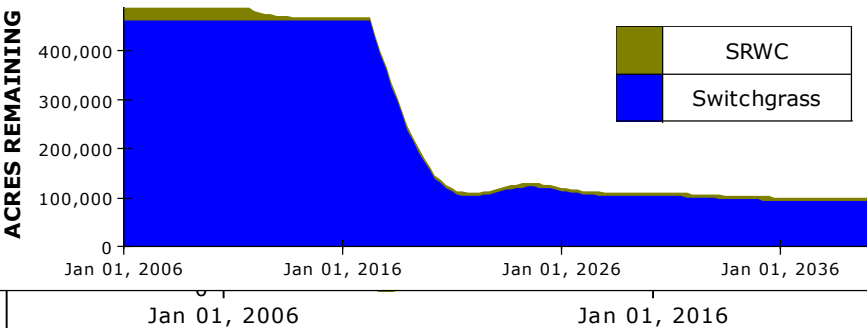
Total cellulosic feedstock used



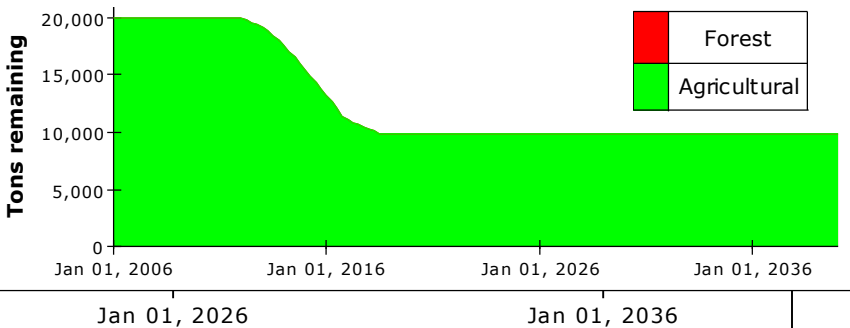
Total feedstock used



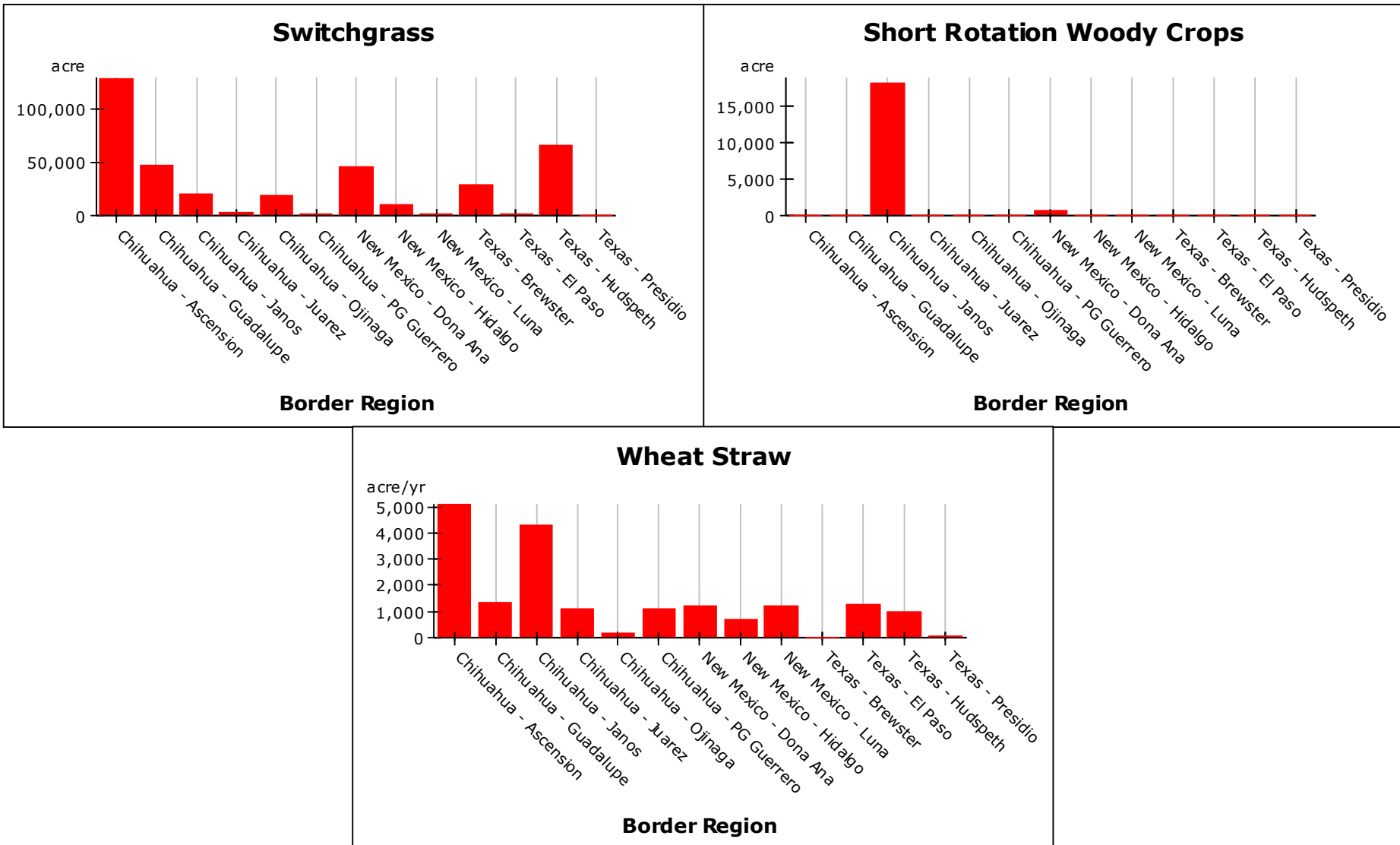
POTENTIAL ACRES SUITABLE REMAINING



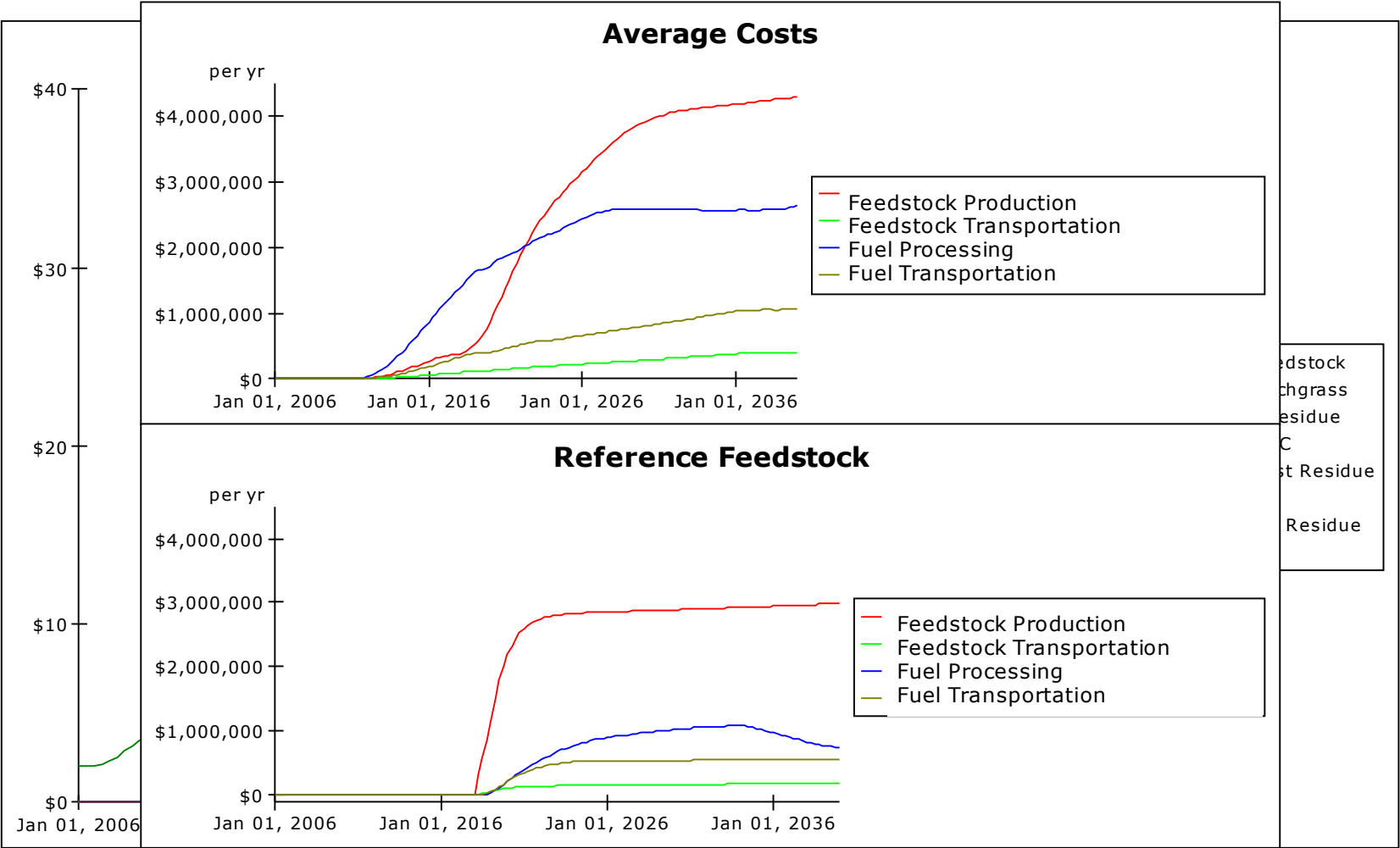
POTENTIAL RESIDUE TONS REMAINING



Land considerations



Cost analysis



Modification to the border specific model

- **Expand list of feedstocks**

- ➡ algae,
- ➡ jatropha,
- ➡ castor oil, and
- ➡ agricultural waste products from chile and pecans



Collaboration

“**Metrics for Success**”, an analytical model capable of determining those fuels most ready for commercial development in the Land of Enchantment.

Combining the strength of:

- **‘Seed to Station’ system dynamics modeling, with**
- **Econometric modeling (POC Meghan Starbuck, NMSU, starbuck@ad.nmsu.edu).**