Can Large-Scale Biofuels Provide A Real and Sustainable Solution to Reducing Petroleum Dependence?

The 90-Billion Gallon Biofuel Deployment Study

Todd West, Ph.D.

Sandia National Laboratories
Livermore, California

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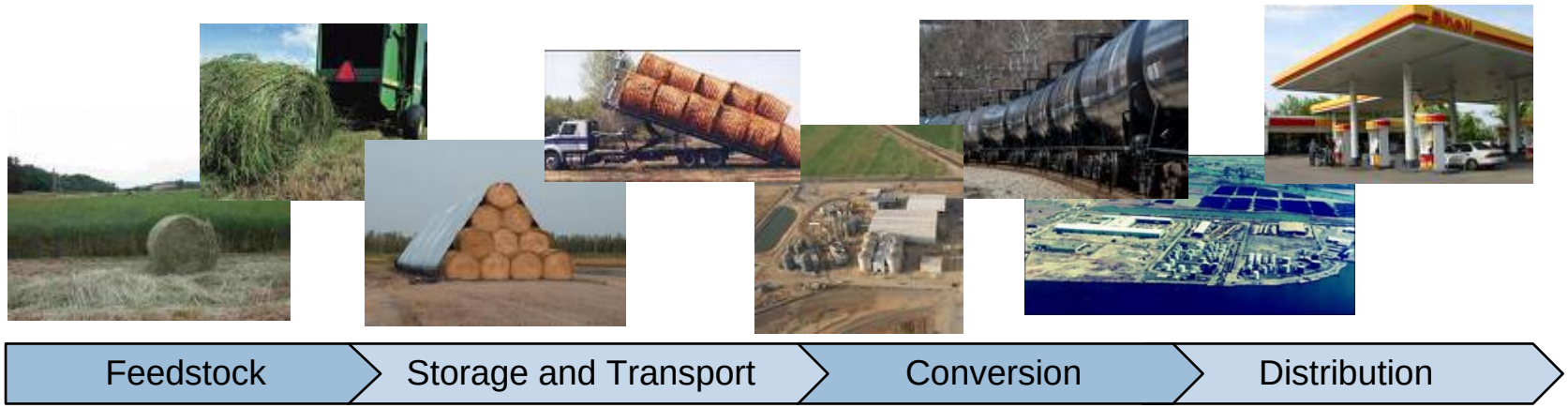
Joint project conducted by GM and Sandia National Laboratories is the first true value-chain approach to future large-scale biofuels



Sandia National Laboratories

GM

What questions did we seek to answer?

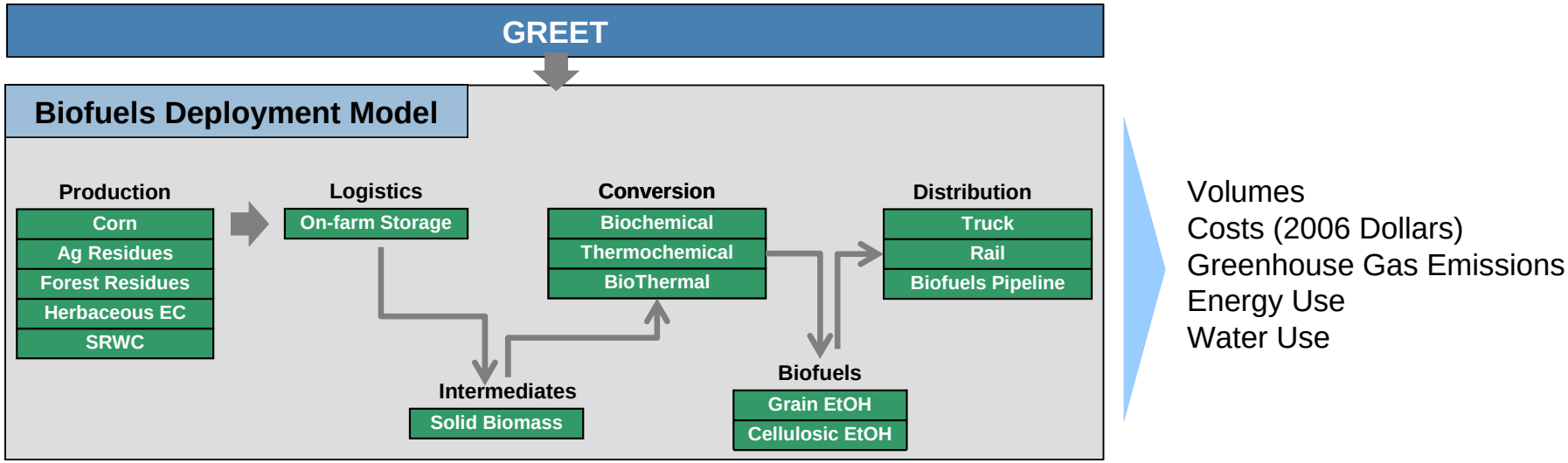
1. **What must happen to grow ethanol production to 90B gal by 2030?**

2. **What is required for cellulosic ethanol to be cost competitive with gasoline?**

3. **What are the greenhouse gas, energy, and water footprints associated with this level of ethanol production?**

4. **What risks could impact cellulosic ethanol's production and competitiveness goals and how can we mitigate these?**

We built a 'Seed to Station' system dynamics model to explore the feasibility of large-scale ethanol



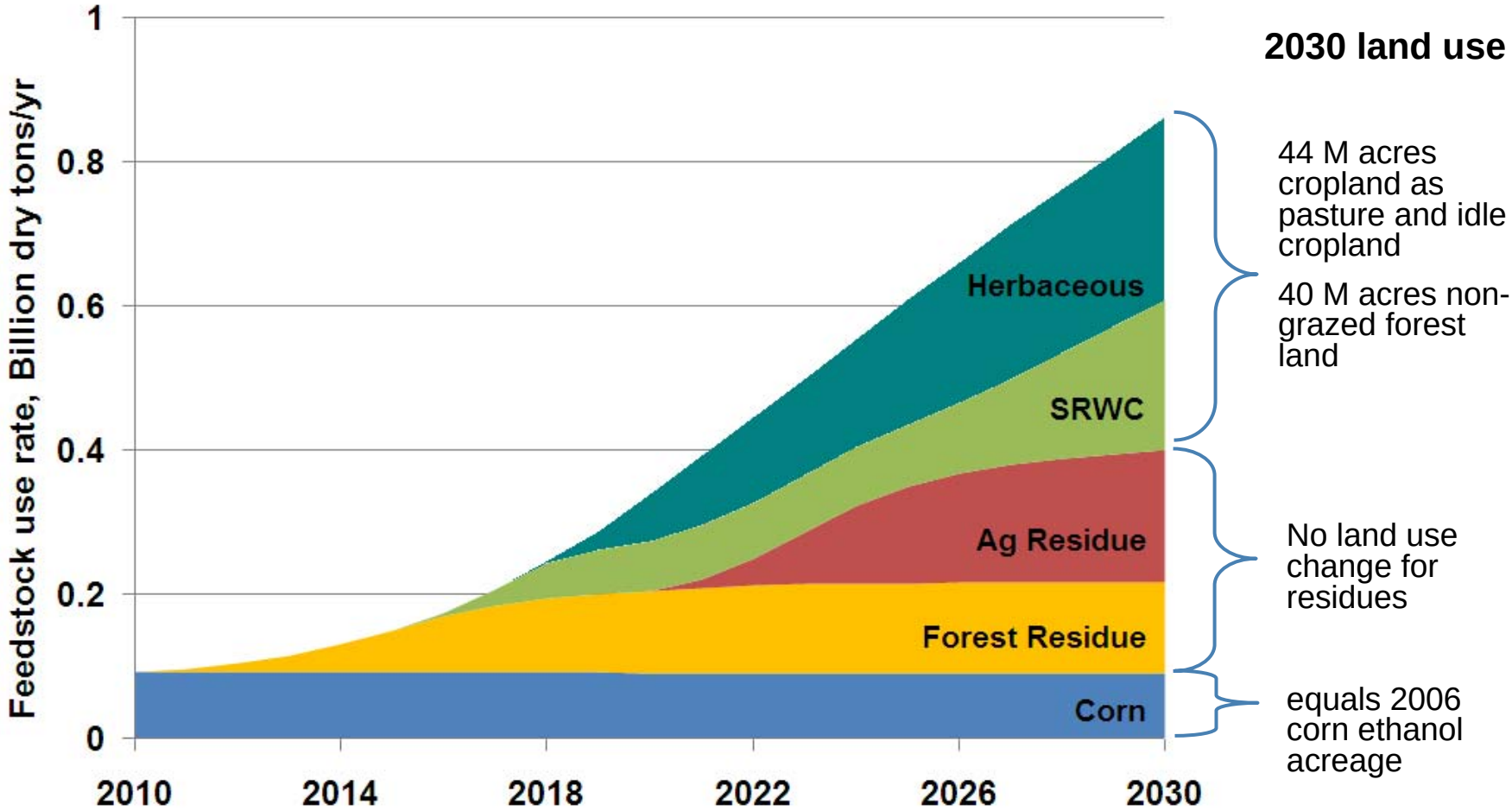
Model scope:

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

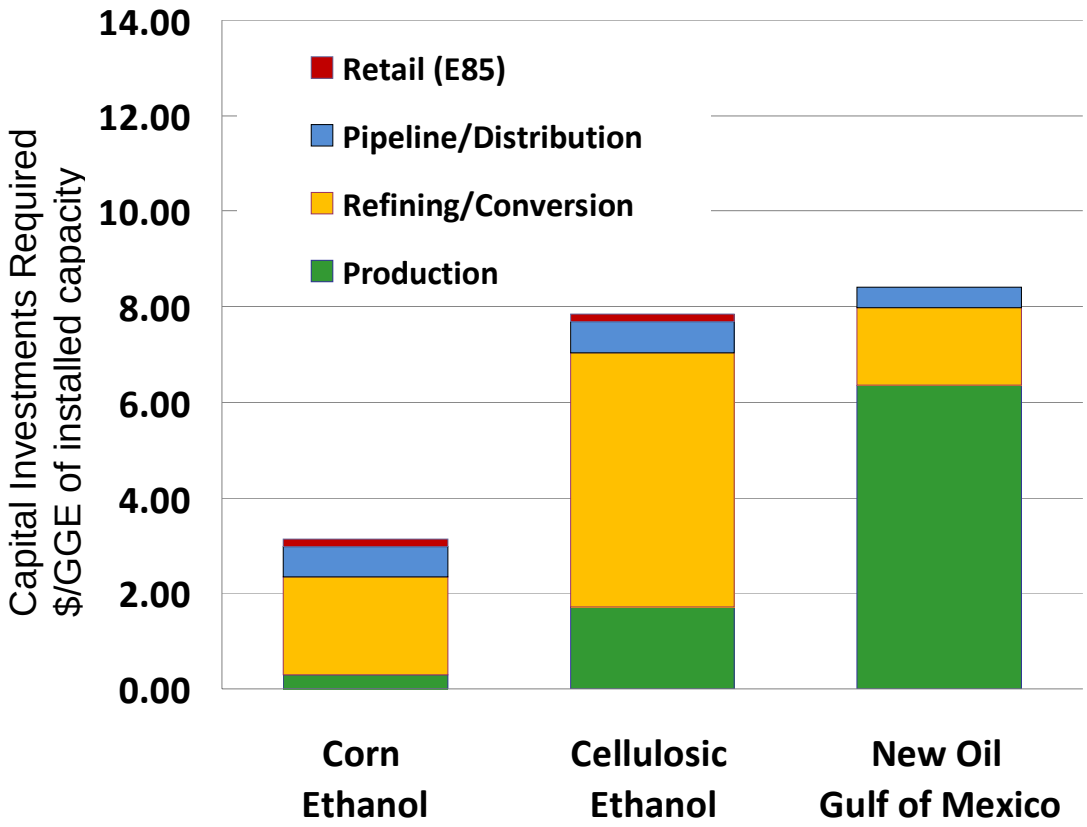
Model purpose:

- Understand how key variables affect the cost and volume of ethanol production from biomass sources and how these variables may interact
- Allows a study of variable sensitivity, which should provide a better understanding of the forces at work in the development of a national bioethanol production capability

Biomass for 90 billion gallons of ethanol can be produced largely without reducing current active cropland



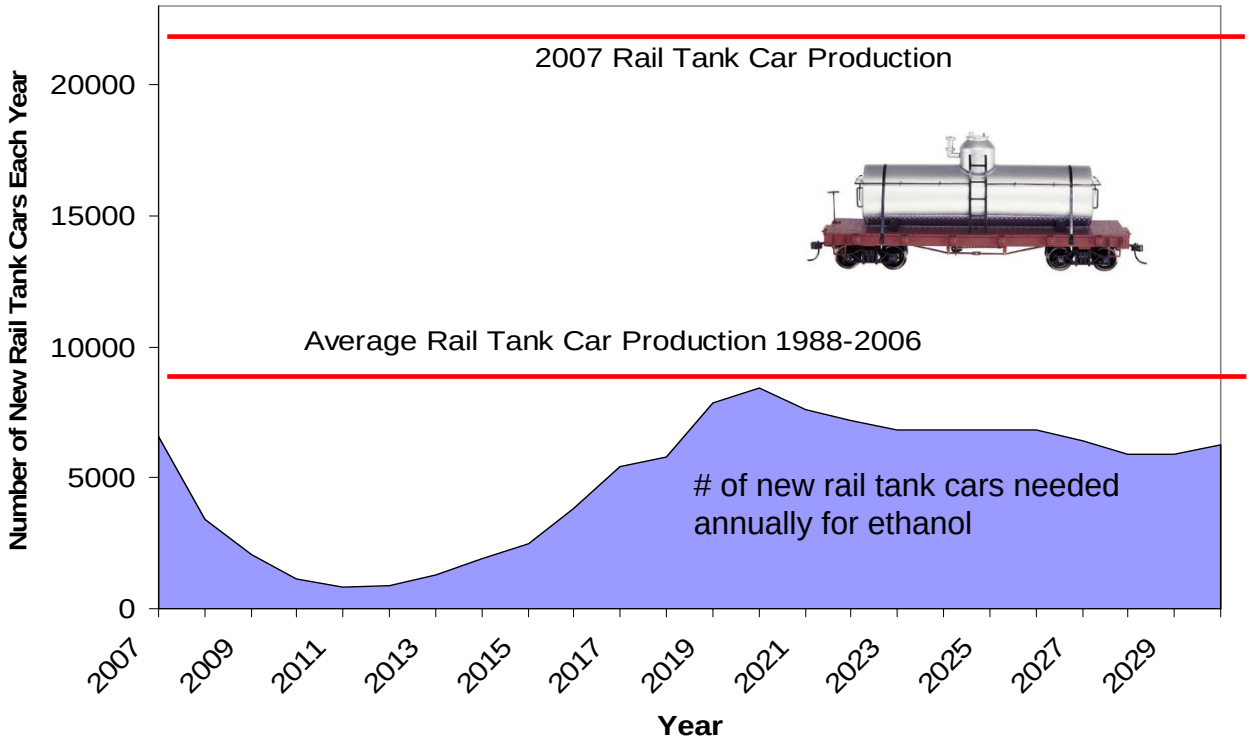
Domestic investment per gallon of capacity for biofuels production is of the same order as the investment required to develop new long-term domestic petroleum production



➡ *Total CAPEX for 75 BGY capacity cellulosic ethanol by 2030: $390 B*

Transportation and distribution infrastructure for biofuels is challenging but not a fundamental obstacle

Rapid, but not unprecedented, growth



Investment will be necessary to overcome projected rail line capacity constraints, with or without biofuels

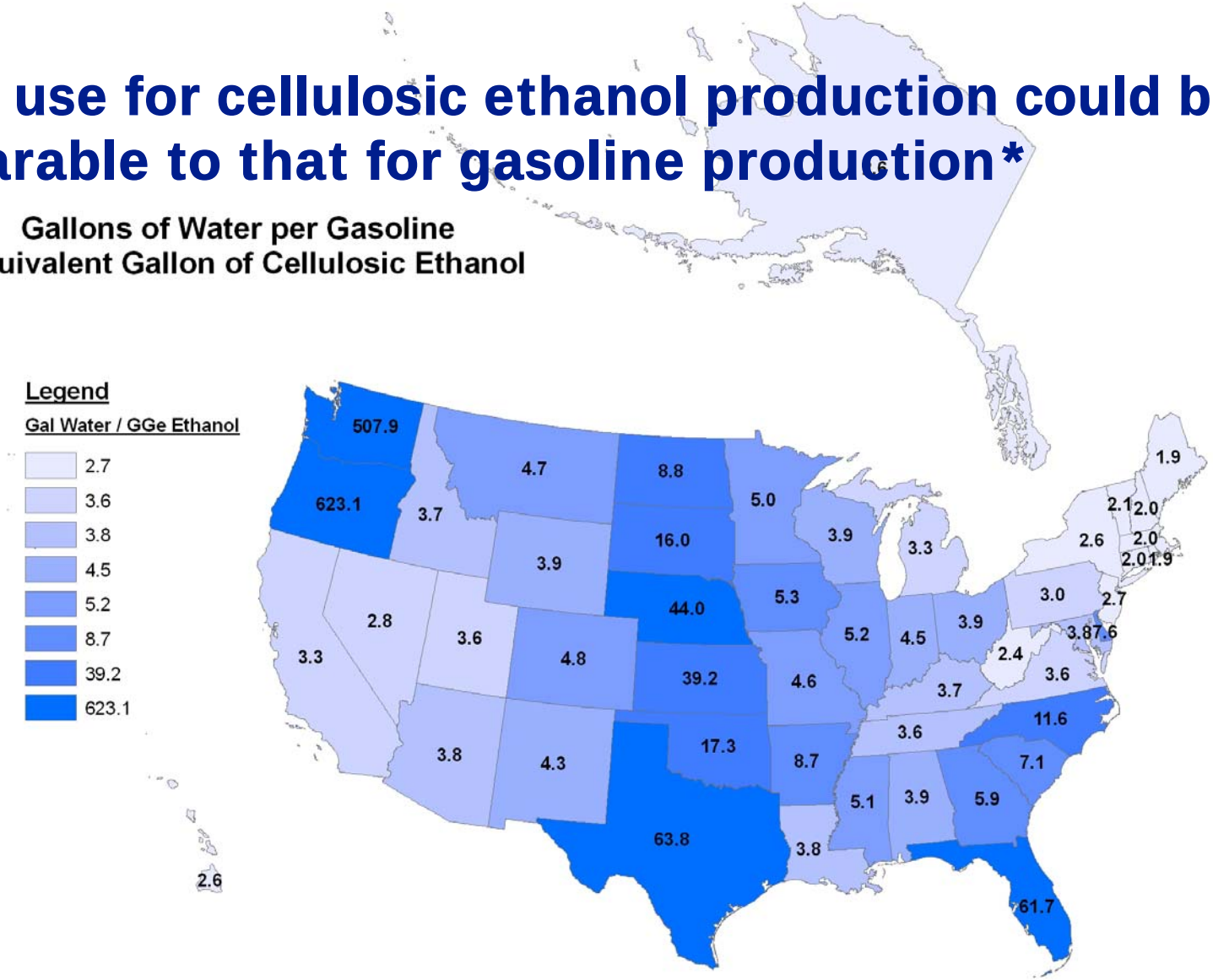
What is required for cellulosic ethanol to be cost competitive with gasoline?

- **Cellulosic biofuels can compete with oil at $90/bbl assuming:**
  - Average conversion yield of 95 gallons per dry ton of biomass
  - Average conversion plant capital expenditure of $3.60 per installed gallon of nameplate capacity
  - Average delivered feedstock cost of $52 per dry ton

- **Sensitivity analyses varying these assumptions individually gave potential cost-competiveness with oil priced at $70/bbl to $120/bbl**

Water use for cellulosic ethanol production could be comparable to that for gasoline production*

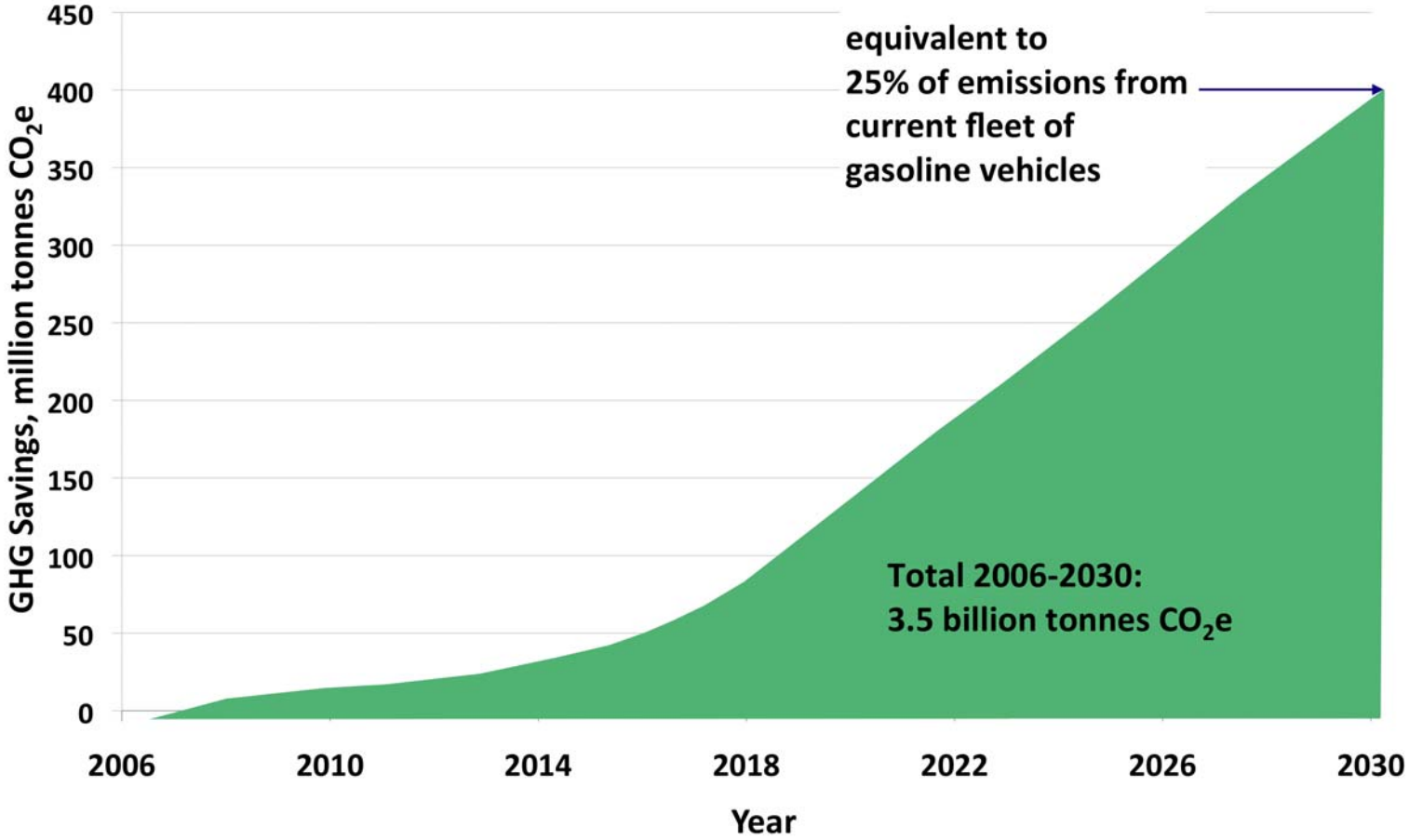
Gallons of Water per Gasoline Equivalent Gallon of Cellulosic Ethanol



50B gallons of cellulosic ethanol could be produced in states requiring little or no irrigation. Additional ethanol could be produced in low-irrigation areas of high water use states.

***Gasoline production uses 3-7 gallons water per gallon gasoline.**

Greenhouse gas savings estimates for 90 billion gallons of ethanol are significant



Excluding GHG emissions from land use change – a current topic of intense research