

# ETHANOL PRODUCTION SYNERGY

## STARCH AND BIOMASS ?

### BIOENERGY 2000

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*PROCESS SOLUTIONS*

# INTRODUCTION

- **Biomass Conversion**
  - **Where is it?**
  - **What took so long?**
- **The Synergies Between Grain and Biomass Processes**
  - **What are they?**
  - **Advantages?**
- **Barriers to Synergy Exploitation**
  - **Industry mindset, Perceived competition**
  - **Research focus**
  - **Current technology**
- **Strategies to Overcome the Barriers**
  - **Focused pragmatic research**
  - **Intra-industry esprit de corps**
  - **Commitment**
- **The Crystal Ball**
  - **What's next?**
- **Policy Implications**

# BIOMASS CONVERSION

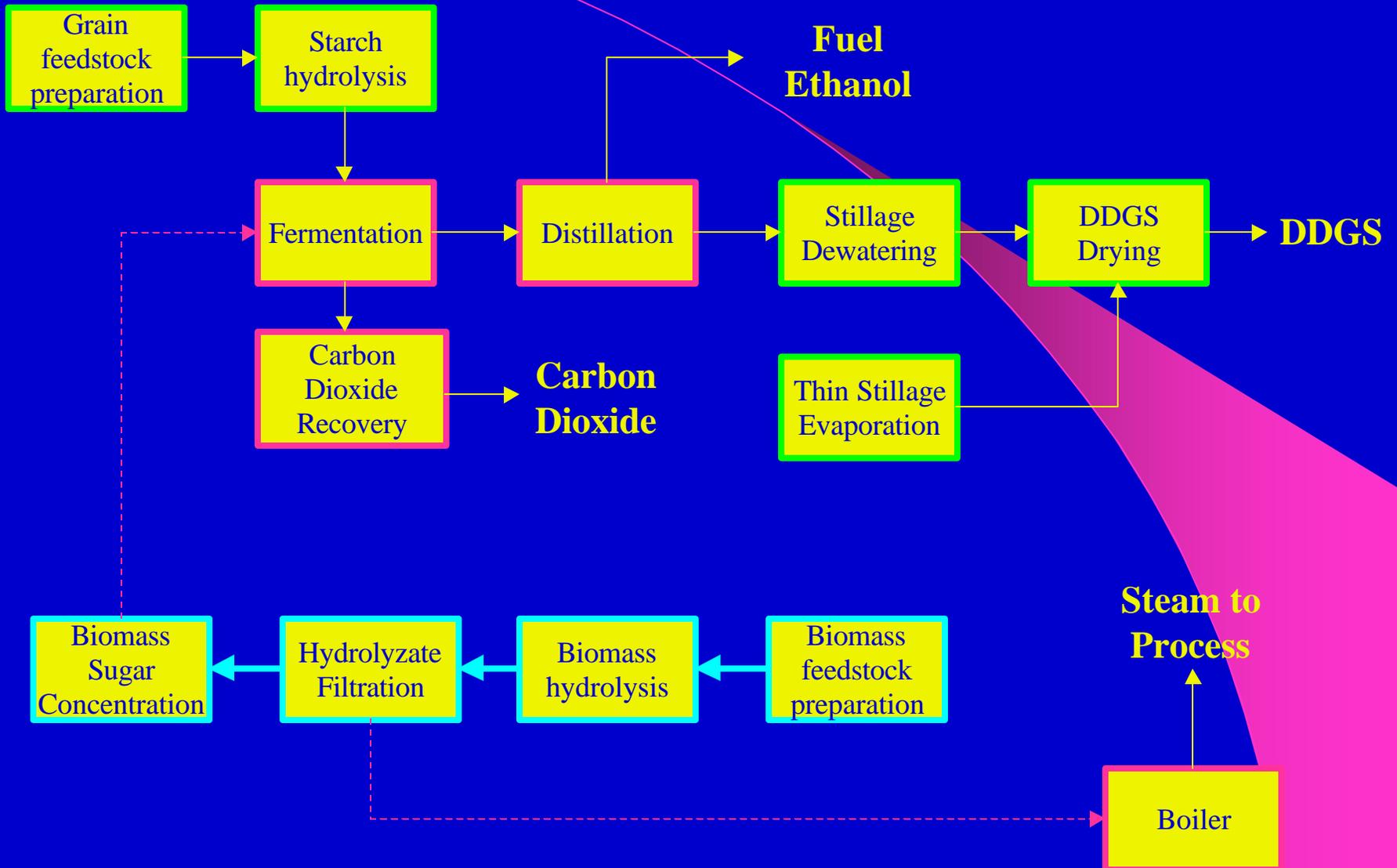
## ENZYMATIC HYDROLYSIS

- **Commercialization Deterrents**
  - **High cost of enzymes**
  - **Not forgiving of feedstock variances**
  - **Pretreatment requirement**
  - **Hydrolysis slow**
  - **Past primary research focus on feedstocks with no existing infrastructure**
  - **Co-fermentative organisms?**
- **Successful Attempt – Example**
  - **BCI – Bagasse, Rice Hulls**
- **Key Components of Success**
  - **Feedstock is a waste stream**
  - **Existing infrastructure for feedstock**
  - **Focuses on solving and existing problem**

## ACID HYDROLYSIS

- **Commercialization Deterrents**
  - **Acid Recovery and/or disposal**
  - **Expensive materials of construction**
  - **Stream clean-up needed before fermentation**
  - **Past primary research focus on feedstocks with no existing infrastructure**
  - **Co-fermentative organisms?**
- **Successful Attempt – Example**
  - **Masada – MSW, Sewage Sludge**
- **Key Components of Success**
  - **Feedstock is a waste stream**
  - **Existing infrastructure for feedstock**
  - **Focuses on solving and existing problem**

# SYNERGISTIC FLOW SHEET



# THE ADVANTAGES OF SYNERGISM

- **Lowers the Entry Cost for Biomass Conversion**
  - Lower capital cost due to shared unit operations
  - Likely to eliminate fermentation nutrient needs for bio-based sugars
  - Would likely use locally available feedstock at low or negative cost
  - Lowers risk associated with proving technology
  - Potential of tapping into existing feedstock delivery infrastructure
  - Product markets and conduits already established
- **Lowers Grain Conversion Risks**
  - Provides a hedge against grain price volatility
  - Potential of acquiring revenue from supplemental feedstock
  - Ultimately energy crops could be integrated – allowing farmers crop rotation alternatives
- **First Step to a Fully Integrated Facility**
- **Research Credibility Boost**
  - Utilization of world class shelved research at low risk
  - Revitalization and refocus of research efforts

# SYNERGY BARRIERS

- **Industry Mindset**
  - **Grain to ethanol industry routed in established agriculture infrastructure**
  - **Biomass research focus originally relegated to non-established “energy crops”**
  - **Biomass perceived as competitive and not complimentary**
  - **Treated by all players as two separate segregated industries**
  - **Due to weak interaction with industry research efforts seen as “blue sky”**
  - **Many identified feedstocks had no collection, storage, or delivery infrastructure**
- **Technological Barriers**
  - **Enzymatic processes require more TLC than industry standard**
  - **Acid processes require either removal or recovery of acid**
  - **SSF process significantly longer than conventional grain processes**
  - **Biomass processes produce much lower sugar concentrations**
  - **Biomass processes require more dilution water which must ultimately be removed**
  - **C5's require either two fermentations, co-fermentations or must be disposed**
  - **Lignin residue handling and disposal**
- **Past Lack of a Unified Commitment From and Between Research Groups, Industry, and Agriculture Groups – No Line Crossing**

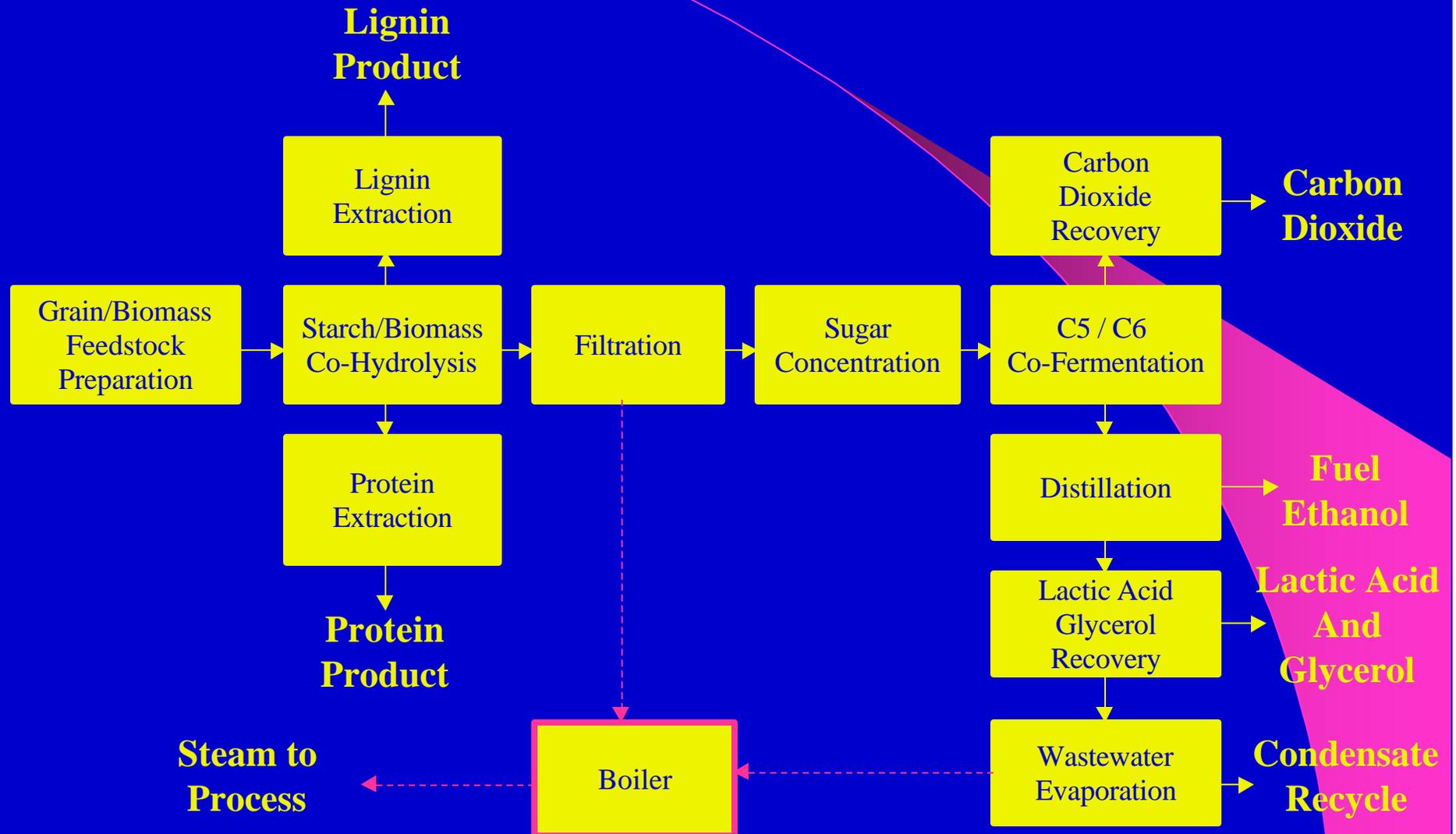
# RESEARCH FOCUS

- **Advancement of Co-Fermentative Organisms**
  - Higher sugar and subsequent ethanol concentrations
  - Higher tolerance to potential inhibitors
  - Hasten Fermentation Times
  - Acceptability of grain co-product in feed market
- **Improve Enzymatic Conversion Technology**
  - Lower enzyme costs
  - Improve conversion efficiency
  - Higher tolerance for sugar concentrations
  - Higher tolerance to potential inhibitors
- **Improve Acid Conversion Technology**
  - Improve conversion efficiency
  - Develop internal use of acidified stream
  - Develop gypsum markets and recovery techniques
  - Engineer milder conditions to lessen material costs

# BUSINESS FOCUS

- Cross Educate Biomass and Grain Groups
- Illustrate of Both Similarities and Differences
- Identify of Potential Synergisms
- Establish and Maintain an Intra/Inter-Industry Esprit de Corp
- Continue to Emphasize and Perform Cross Platform Pragmatic Research
- Develop Joint Ventures and Cooperative Agreements

# THE CRYSTAL BALL PROCESS



# POLICY IMPLICATIONS

## HOW DO WE GET THERE FROM HERE?

- Continue to Fund and Support **Targeted** Pragmatic Research
  - Improve conversion technologies
  - Further develop co-fermentative organisms
  - Switch focus to using “energy crops” to supplement existing feedstocks
  - Implement programs to focus research on commercialization barriers
  - Key Players: DOE, USDA, NREL, TVA, Academia
- Promote Partnerships and Joint Ventures
  - Provide forum and incentives for grain and biomass synergism
  - Key Players: Current grain to ethanol industry, Current biomass to ethanol industry
- Establish a Grain/Biomass Task Force
  - Identify research focus
  - Pilot promising strategies
  - Develop implementation plans
  - Key Players: Industry, DOE, USDA, NREL, TVA, Ethanol Research Center

# POLITICAL STATEMENT

Due to the unfortunate circumstances in the Middle East and the rising cost of Petroleum the Ethanol Industry is faced with the same motive forces responsible for its conception. It is now the industry's responsibility to Refocus, and rededicate itself to solving our nation's energy crises while cleaning our nation's air. The synergies are ours to exploit and the market is ours to expand.