Biomass-based mitigation options for liquid fuel CO_2 emissions within an LCA policy framework

Presented at:

International Life Cycle Assessment and Management 2007

By:

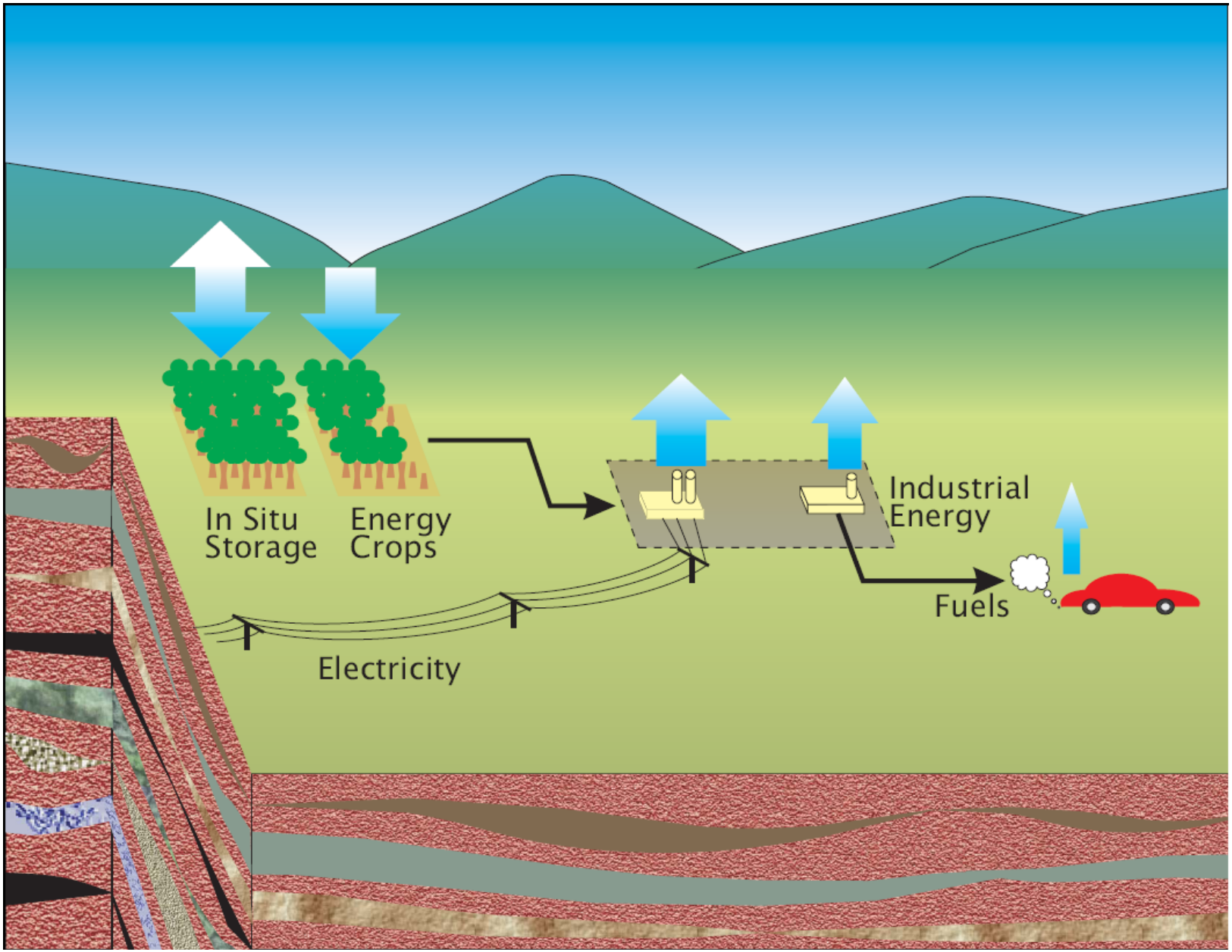
James S. Rhodes and David W. Keith[b]

[b] Institute for Sustainable Energy Environment and Economy at the University of Calgary.

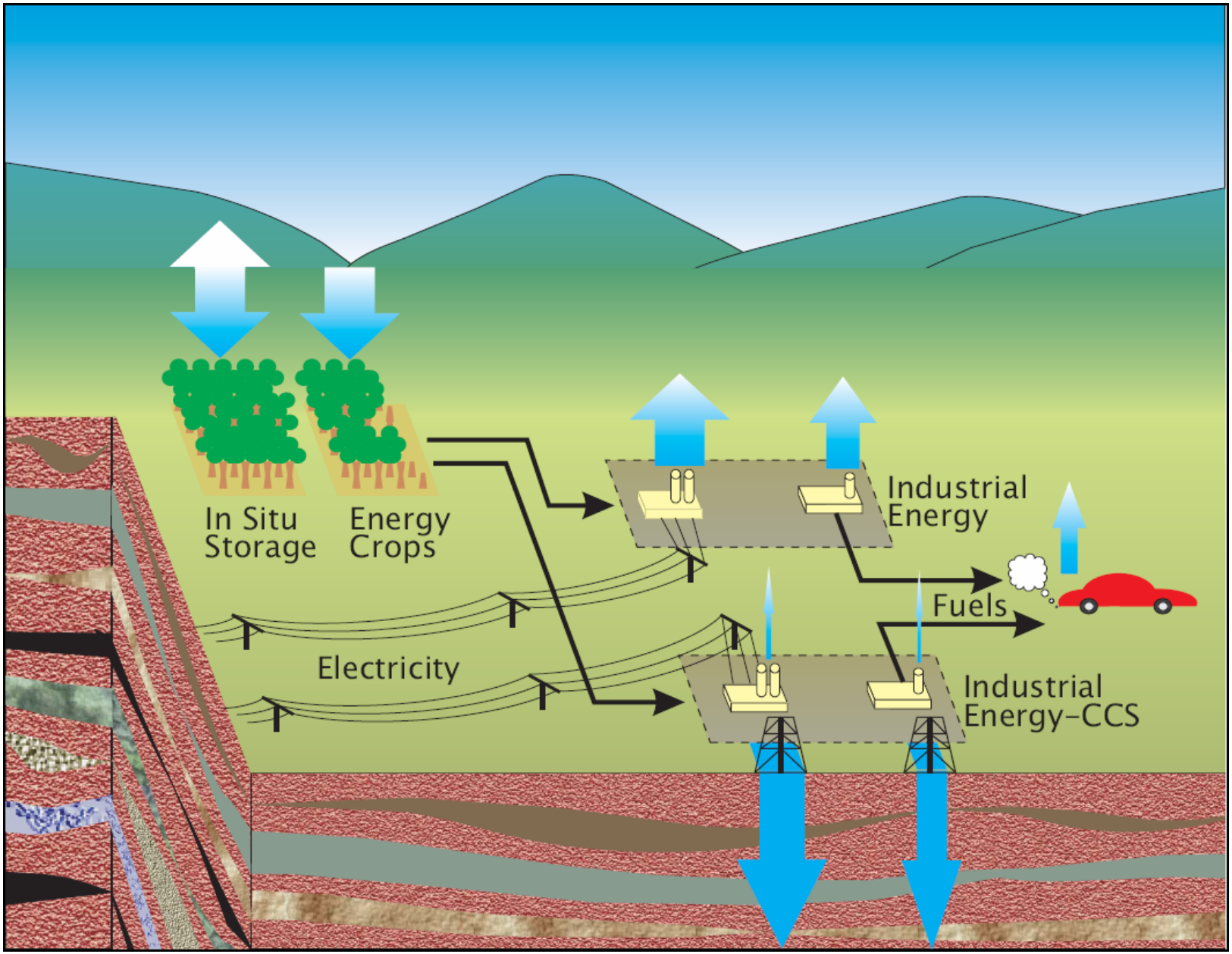
Outline

- Biomass-based CO_2 mitigation strategies
- Engineering-economic modeling
- Implications and potential contributions
- Conclusions and outstanding questions

Biomass-based mitigation



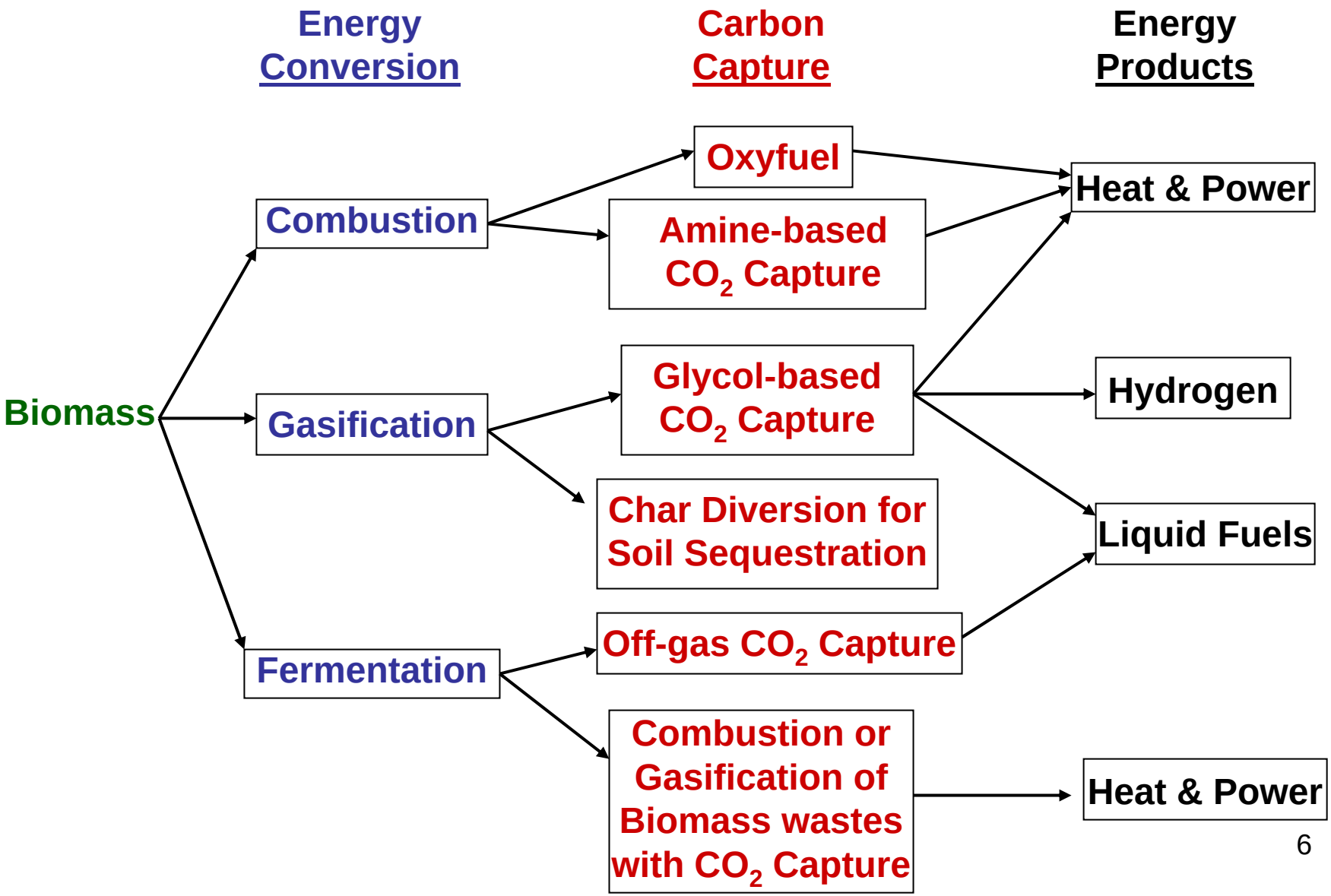
Biomass-based mitigation



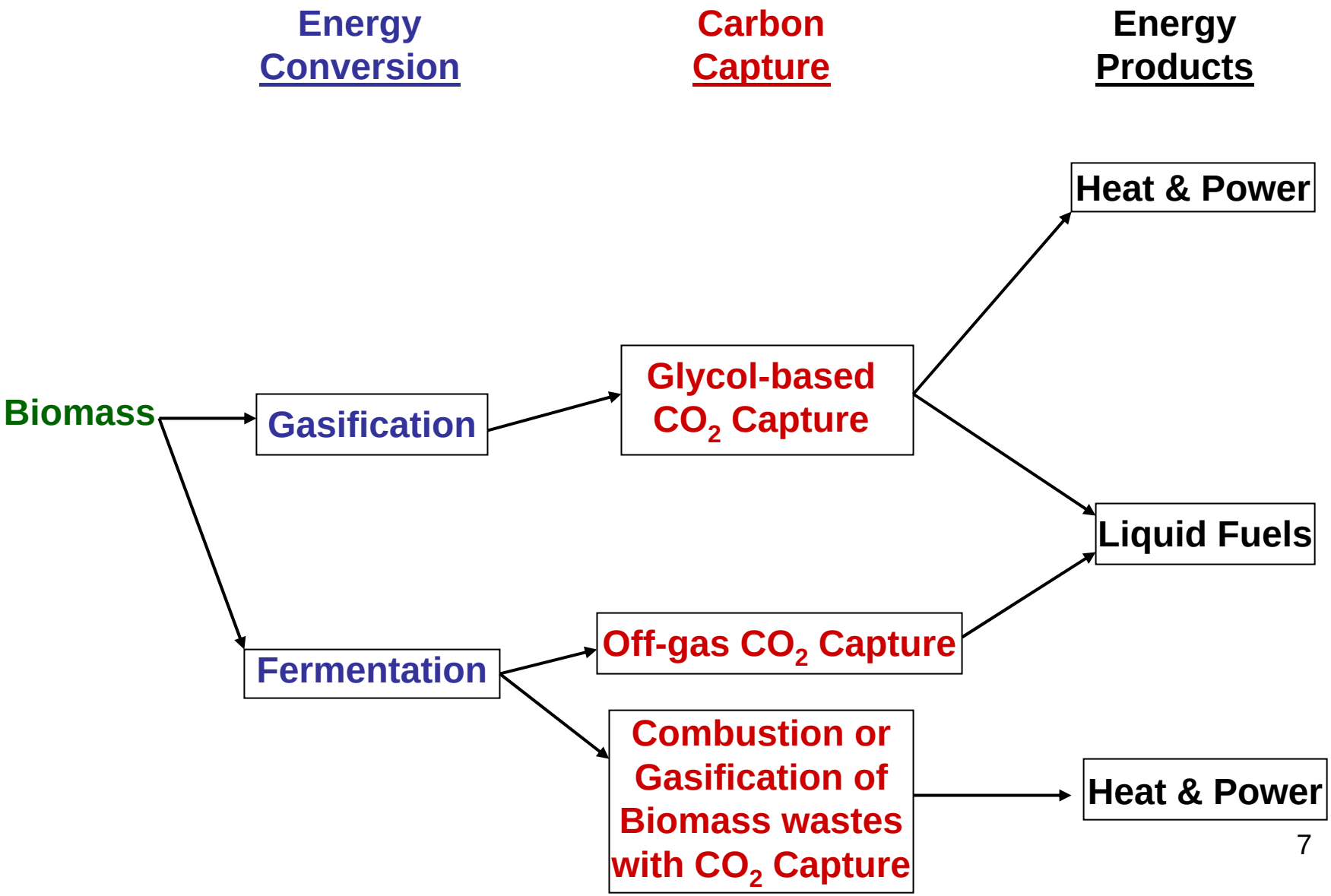
Implications (and assumptions) of biomass-CCS

- Increases the scope of mitigation with biomass
- Raises policy questions
  - Potentially decoupled mitigation
  - Transitional vs. long-term strategies
- Potential for long-term management of atmospheric concentrations
- Key assumptions:
  - Carbon-neutral biomass supply
  - Secure geological storage systems

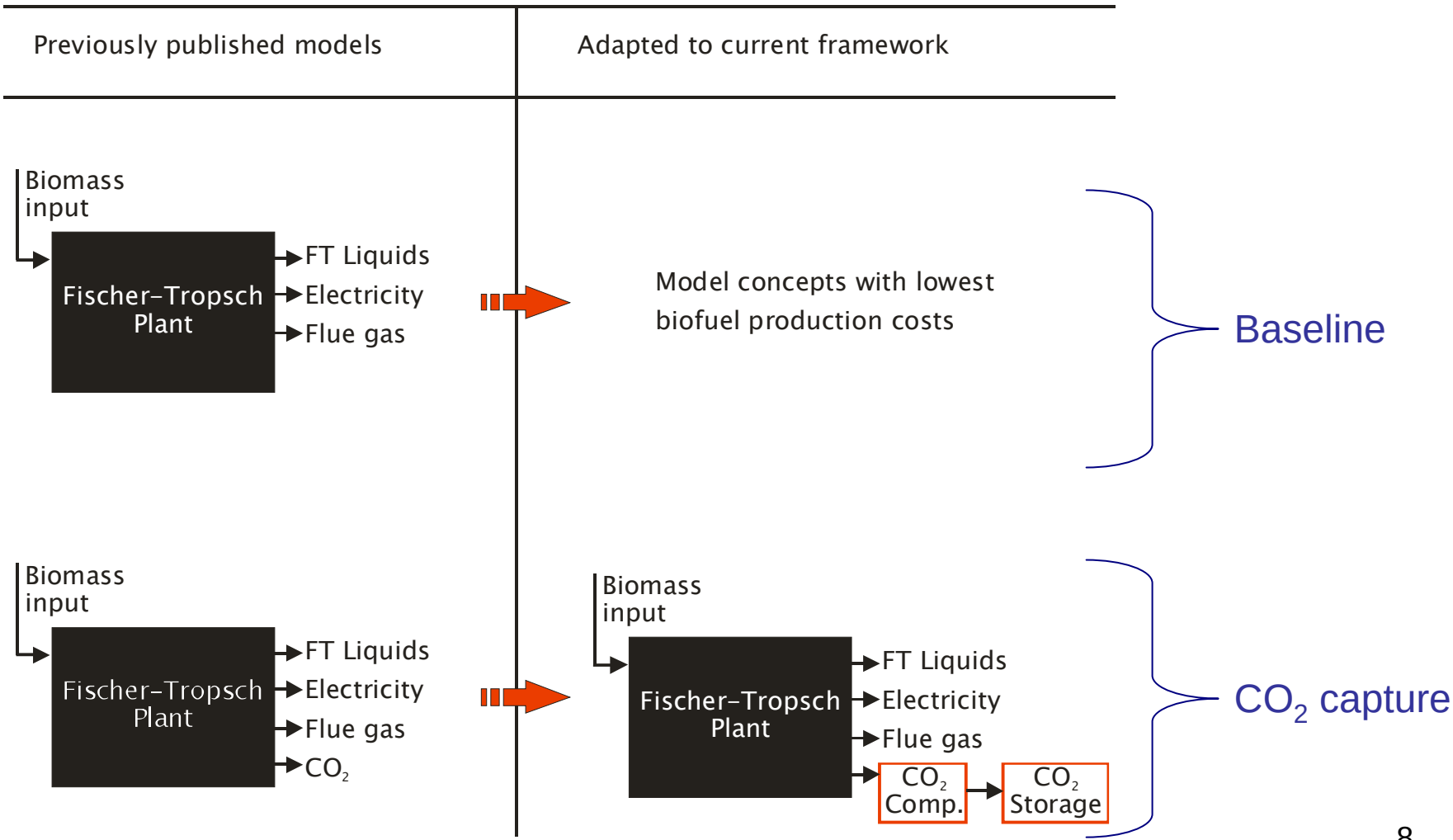
Pathways to biomass-CCS



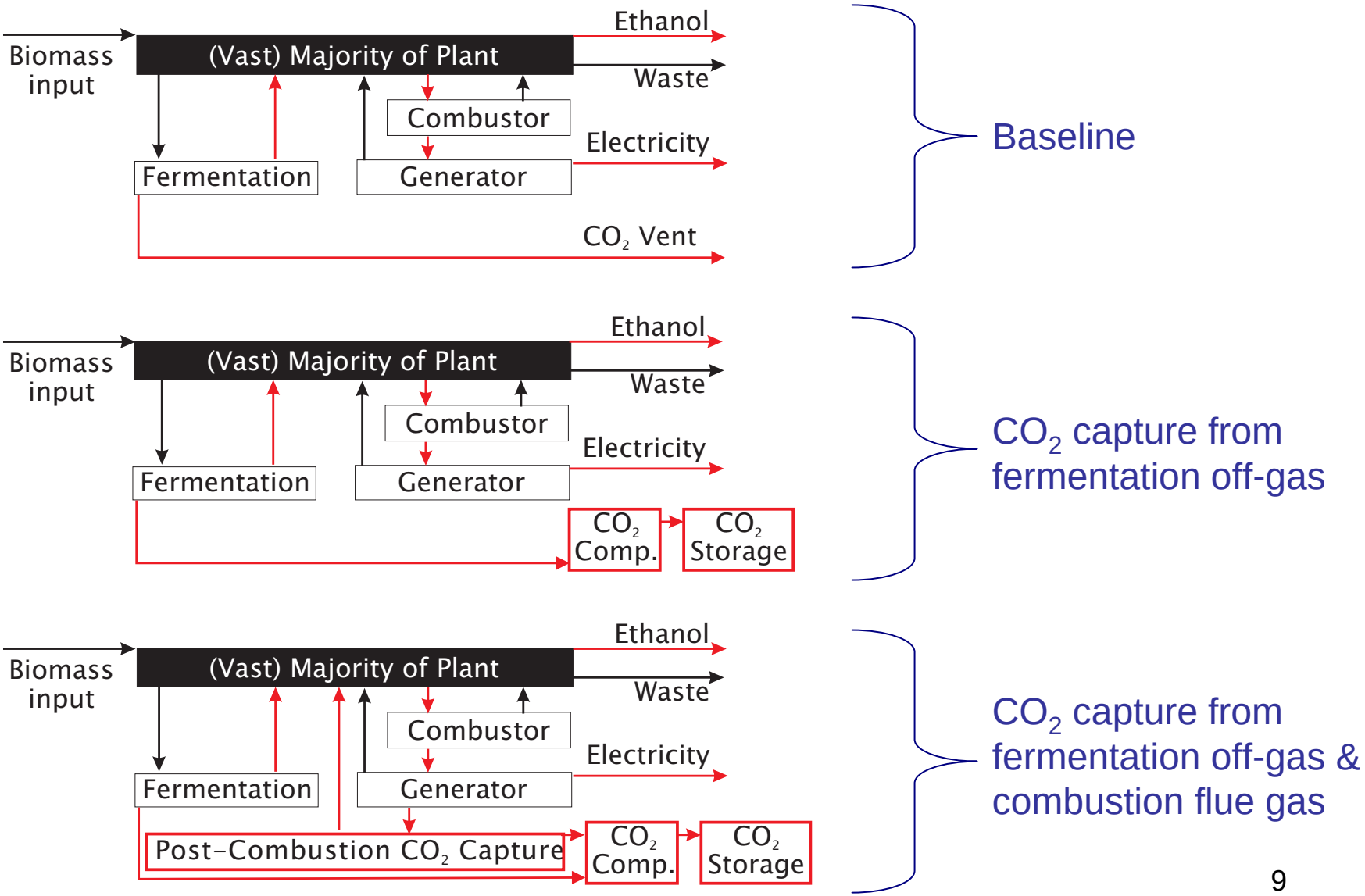
Pathways to biomass-CCS



Process block diagram: FT liquids



Process block diagram: Bio-ethanol



Key modeling references

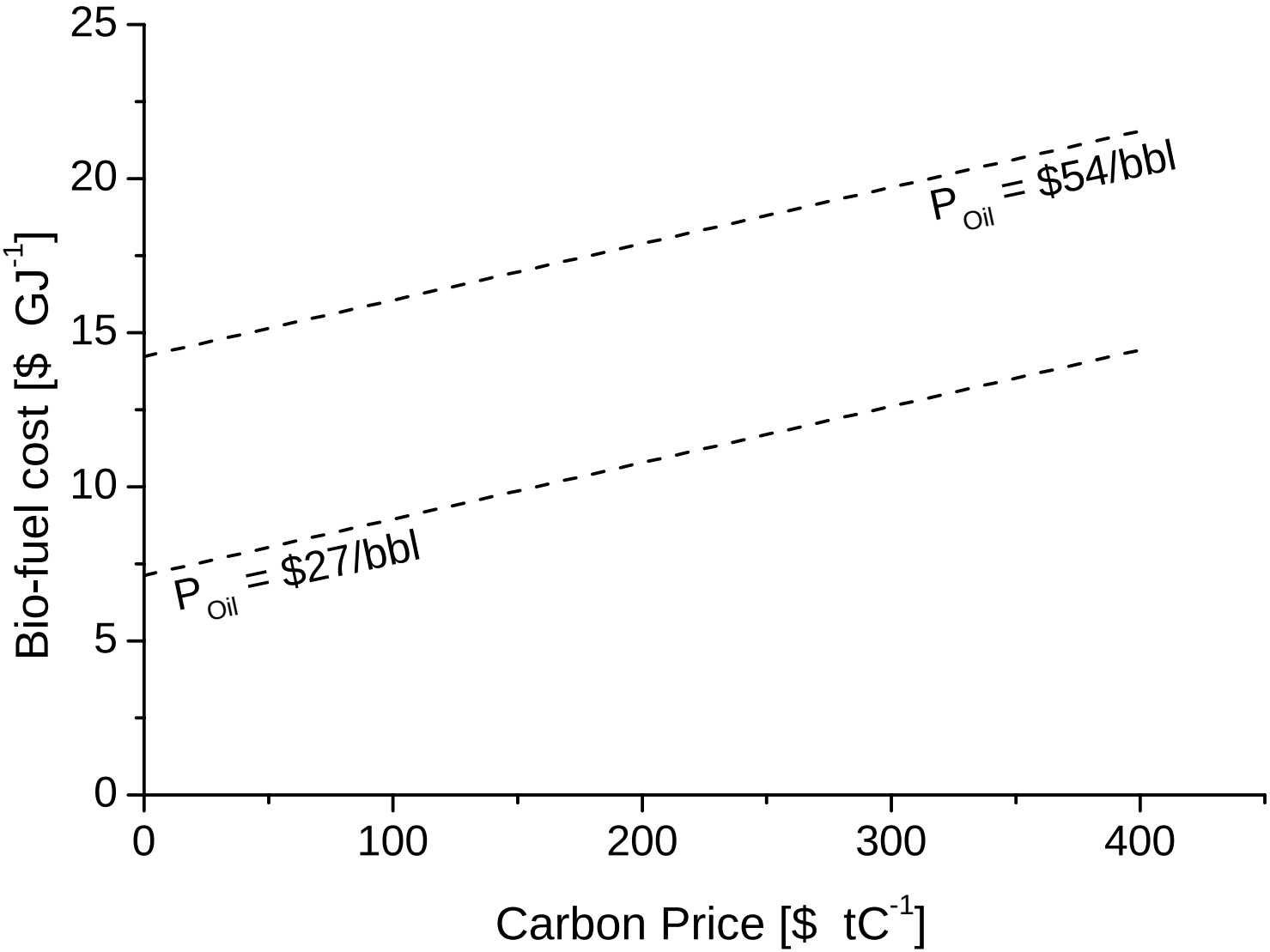
- Ethanol:
  - Wooley R., Ruth M., Sheehan J., Ibsen K., and Majdeski H. Lignocellulosic Biomass to Ethanol Process Design and Economics Utilizing Co-Current Dilute Acid Prehydrolysis and Enzymatic Hydrolysis Current and Futuristic Scenarios. 1999. U.S. Department of Energy, National Renewable Energy Laboratory, Golden, CO.

  - Aden A., Ruth M., Ibsen K., Jechura J., Neeves K., Sheehan J., Wallace B., Montague L., Slayton A., and Lukas J. Lignocellulosic Biomass to Ethanol Process Design and Economics Utilizing Co-Current Dilute Acid Prehydrolysis and Enzymatic Hydrolysis for Corn Stover. 2002. U.S. Department of Energy, National Renewable Energy Laboratory. p. 142.

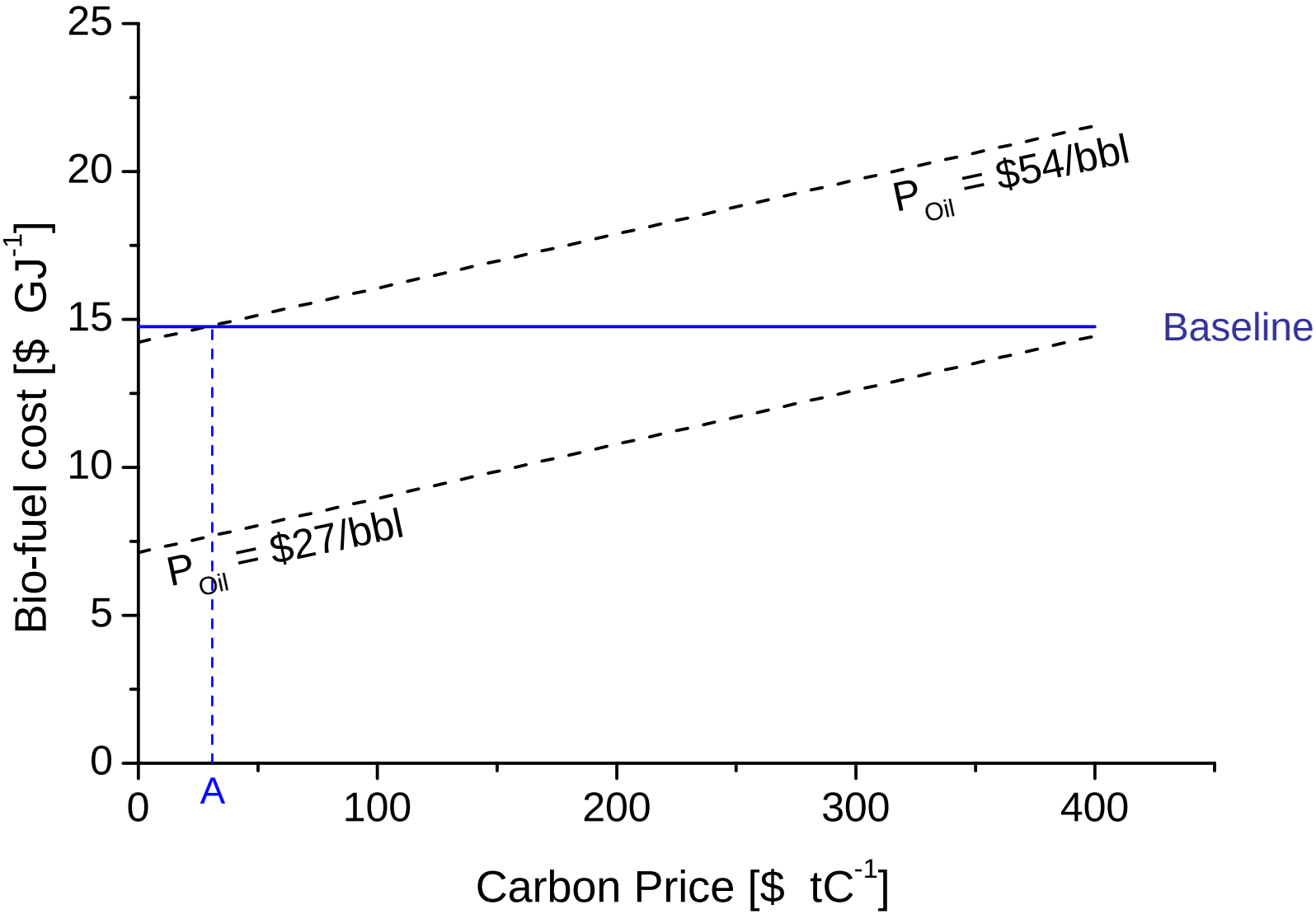
- F-T Liquids:
  - Hamelinck C.N., Faaij A.P.C., den Uil H., and Boerrigter H. Production of FT transportation fuels from biomass; technical options, process analysis and optimisation, and development potential. 2003. Utrecht: Copernicus Institute, Utrecht University.

- Carbon Capture and Storage:
  - Metz B., Davidson O., de Coninck H., Loos M., and Meyer L. eds. Working Group I of the Intergovernmental Panel on Climate Change. IPCC Special Report on Carbon Dioxide Capture and Storage. 2005, Cambridge University Press: New York, NY. 431.

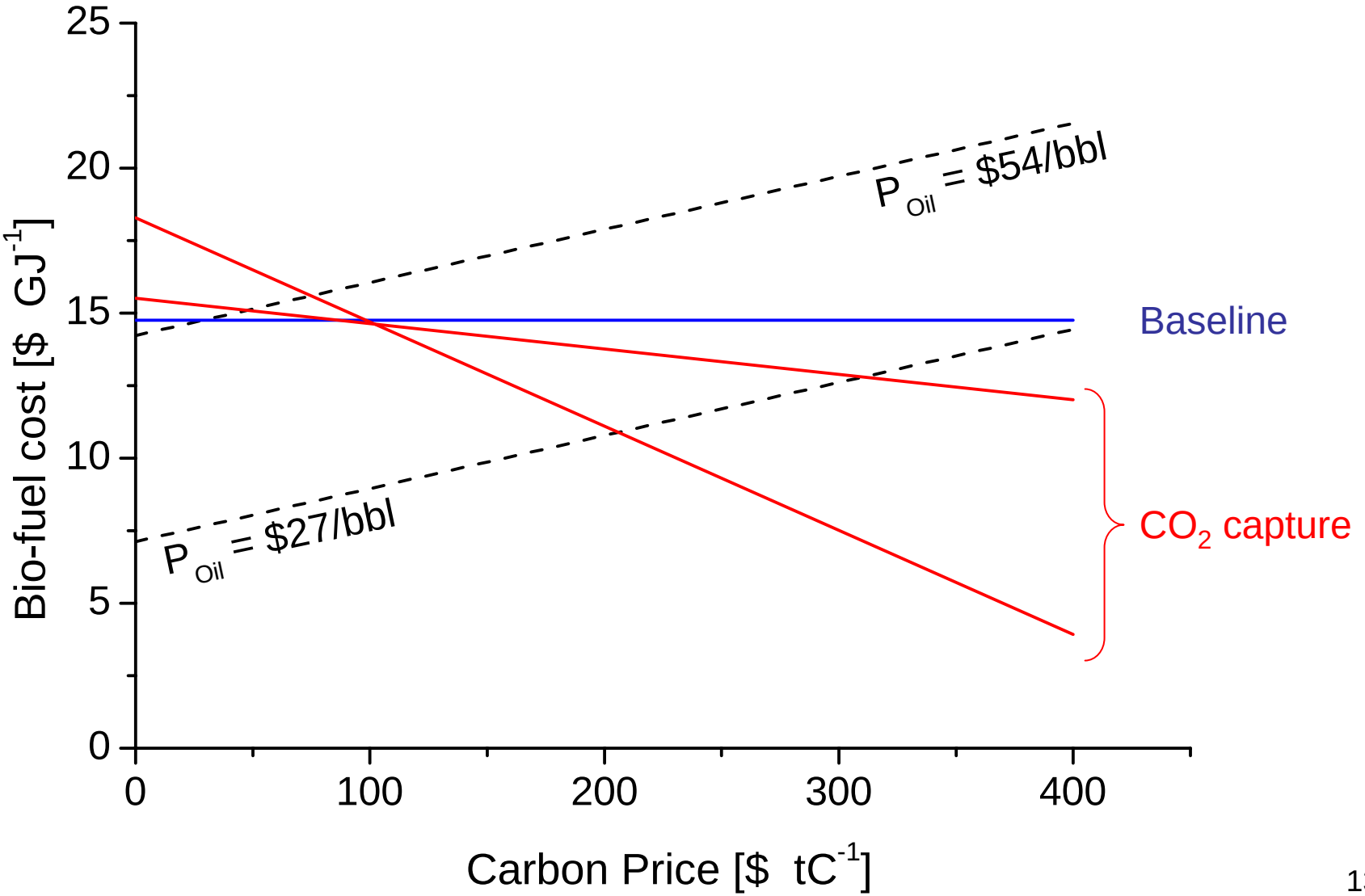
Cost of Ethanol as a Function of Carbon Price



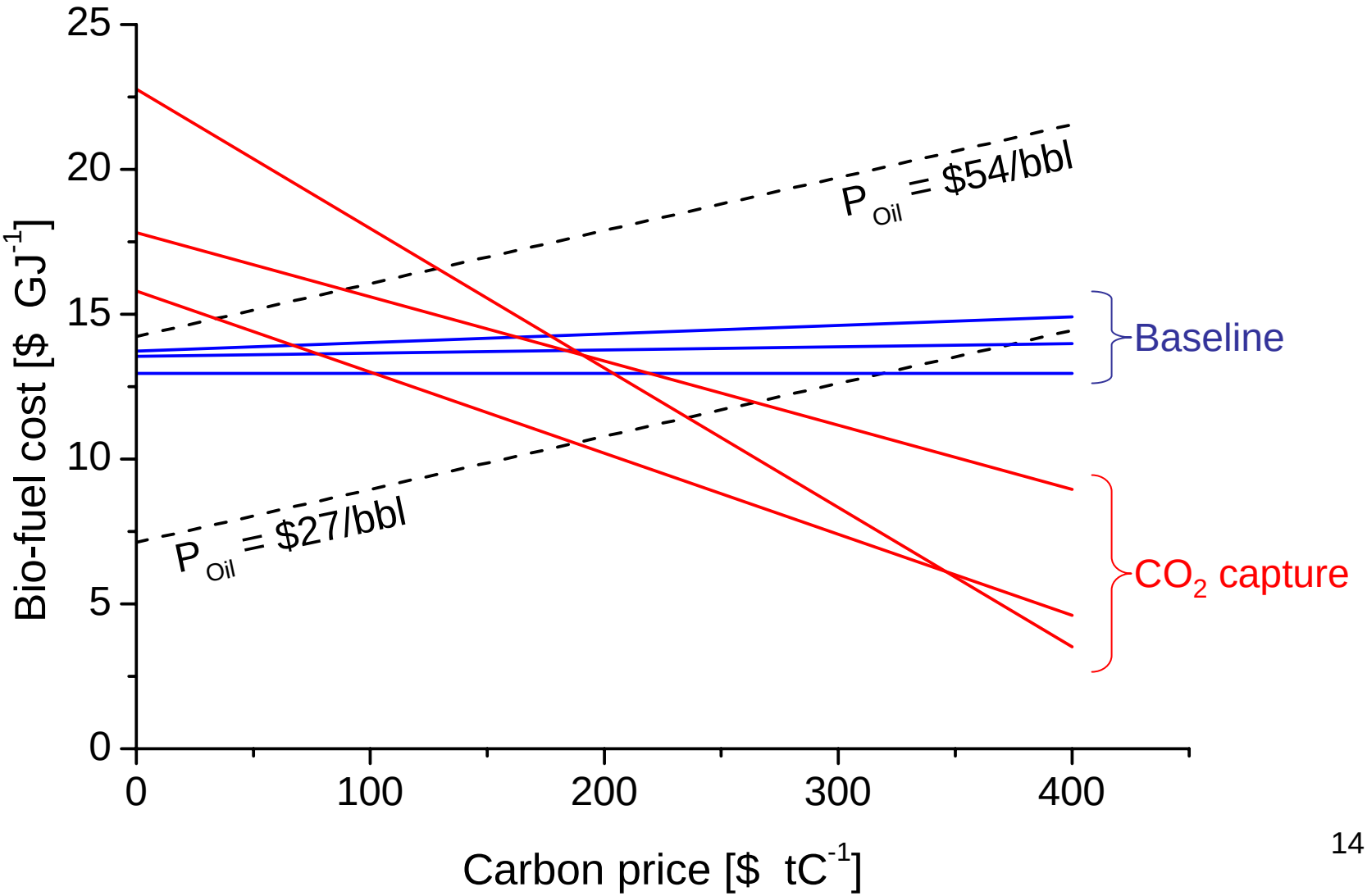
Cost of Ethanol as a Function of Carbon Price



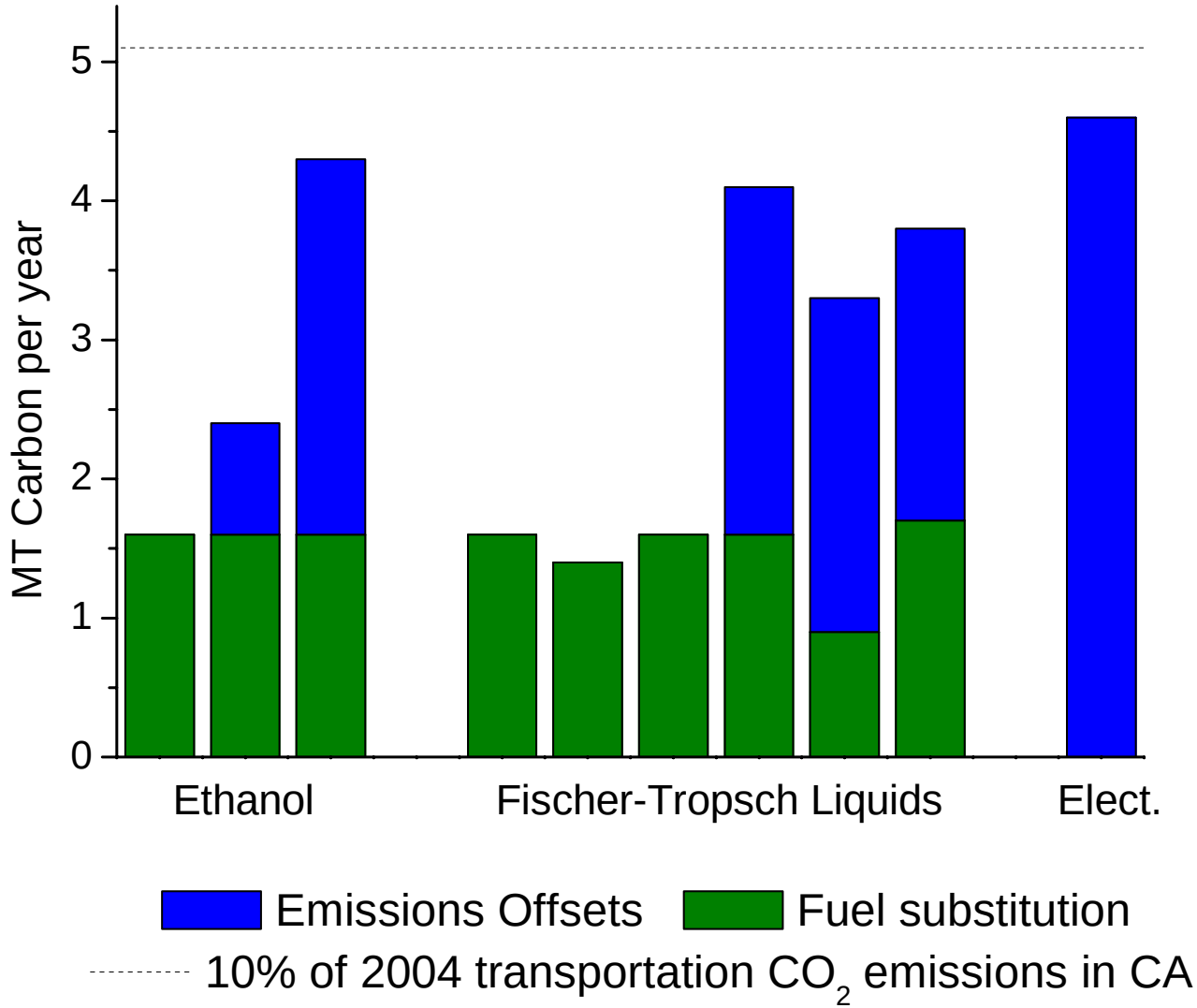
Cost of Ethanol as a Function of Carbon Price



Cost of FT liquids as a Function of Carbon Price



Potential contributions toward CA's LCFS target (w/biomass residues)



Conclusions

- LCA frameworks support biomass-based strategies.
- Potential contributions from biomass hinge on supply. (technical, social, and environmental constraints)
- Biomass-CCS (greatly) increases mitigation potential.

  Technically feasible (by many routes) and may be economically efficient.

  Potentially important implications, but…

Questions:

- Carbon accounting for biomass supply?
- Carbon accounting for geologic storage?
- Carbon accounting for emissions offsets? (Policy question)
- Economically efficient use of available biomass? A: Depends on issues above and on future oil prices and energy security.

Acknowledgments

- We gratefully acknowledge thoughtful comments and input on this work from Gregg Marland, Allen Robinson, and Edward Rubin.

- This research was made possible through support from the Climate Decision Making Center. This Center has been created through a cooperative agreement between the National Science Foundation (SES-034578) and Carnegie Mellon University.