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The Joint Global Change Research Institute and The GCAM Integrated Assessment Model

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(and the GCAM modeling team)

Joint Global Change Research Institute
College Park, MD

3rd Annual BA-UMD Fall Symposium Trends in Agriculture

January 20, 2014

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UNIVERSITY OF MARYLAND

The Joint Institute

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- Established in 2001 as joint venture between Pacific Northwest National Laboratory (PNNL) and the University of Maryland.
  - JGCRI staff are mostly PNNL- Battelle Memorial Institute employees. Battelle is a 501(c)(3) organization.
  - JGCRI is part of the Atmospheric Sciences and Global Change Division (ASGC) at PNNL.
  - About 50 people– roughly 1/3 are students, associates with UMD, visiting scientists, or post-docs
  - Research staff with terminal degrees in more than 10 different disciplines.
- JGCRI is funded through a competitive proposal process with DOE, EPA, other agencies, and some private sector funding.
- Co-located with Earth System Science Interdisciplinary Center near the UMD Campus in College Park
- Focused on studies of global change – emissions mitigation, energy technologies, biogeochemical cycles of the major greenhouse gases, impacts, adaptation and vulnerability
- Major emphasis on the development of integrated assessment models; one of only 5 such centers in the world

JGCRI Major Research Areas

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- **Integrated Assessment Modeling**
  - Global Technology Strategy
  - Future Scenarios (CCSP, CCTP, IPCC SRES, RCP)
  - Linking with climate, hydrology models
  - Incorporating interactions among land-use/energy/water/climate
  - Global and Regional Analysis
- **Resource Modeling and Assessment**
  - Agro-ecosystem model development and application
  - Links and development with ecosystem and hydrologic models
  - Sustainability and climate impacts
  - Integration with IAM and Climate Models
- **Understanding the Details of Energy Technologies**
  - Performance characteristics of Energy Supply Technologies: e.g., CCS, Nuclear, Wind, Solar, etc.
  - Descriptions and performance characteristics of end-use technologies: e.g., Transportation, Buildings
- **International Clean Energy Implementation**
  - Analyze and understand opportunities, successful approaches, market conditions and barriers
  - Focus on policy options, new technology development, financing and institutional approaches to promoting clean energy
- **Vulnerability, Security, R&D trends**
  - Vulnerability-Resilience Indicators Model (VRIM)
  - Connections between climate change impacts and national security
  - Understanding the interplay between climate change, human decisions and adaptation

What is an Integrated Assessment Model (IAM)?

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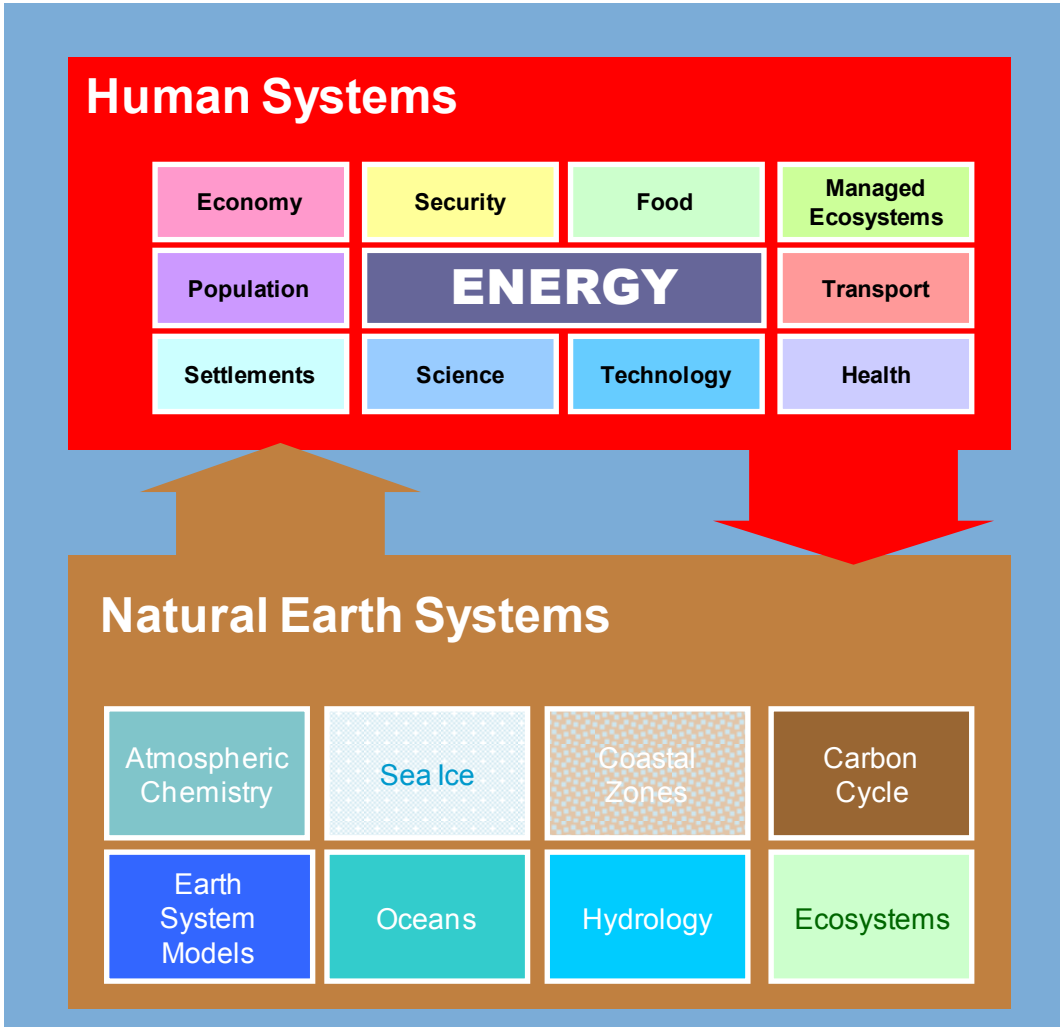
IAMs integrate human and natural Earth systems.

- IAMs provide insights that would be otherwise unavailable from disciplinary research.
- IAMs capture interactions between complex and highly nonlinear systems.
- IAMs provide natural science researchers with information about human systems such as GHG emissions, land use and land cover. (e.g. RCP and SSP scenarios)

IAMs provide important, science-based decision support tools.

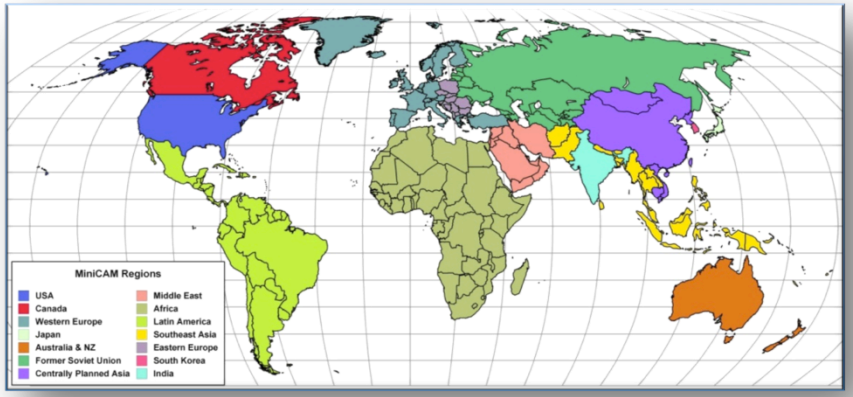
- IAMs support national, international, regional, and private-sector decisions.



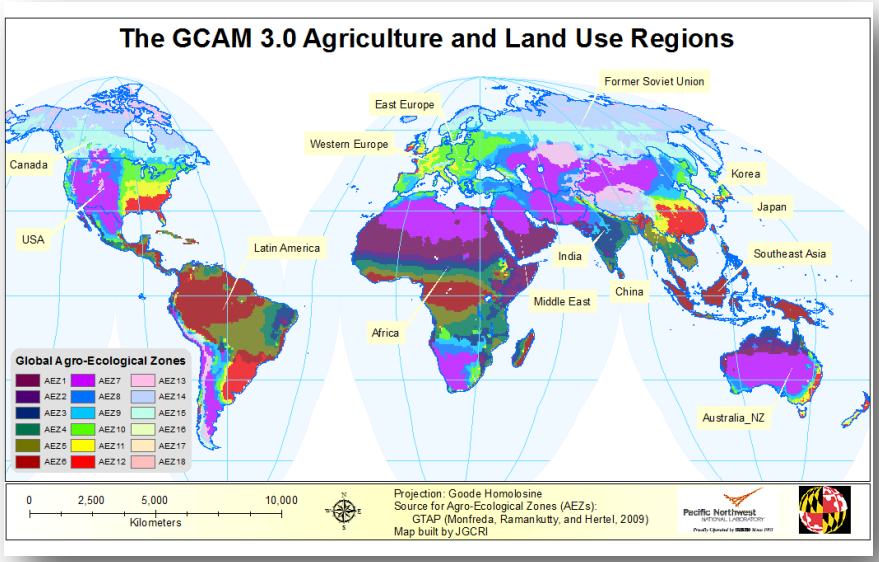
The Global Change Assessment Model

Ongoing developments:
Disaggregating to 30+ geopolitical regions

14 Region Energy/Economy Model



151 Agriculture and Land Use Model



- GCAM is an open source **global integrated assessment model**
- GCAM links **Economic**, **Energy**, **Land-use**, and **Climate** systems
- Typically used to examine the effect of technology and policy on the economy, energy system, agriculture and land-use, and climate
- Technology-rich model
- Emissions of 16 greenhouse gases and short-lived species: CO_2, CH_4, N_2O, halocarbons, carbonaceous aerosols, reactive gases, sulfur dioxide.
- Runs through **2100** in **5-year time-steps.**
- Documentation available at: **wiki.umd.edu/gcam**
- There is also a GCAM Community Listserve.

The Global Change Assessment Model

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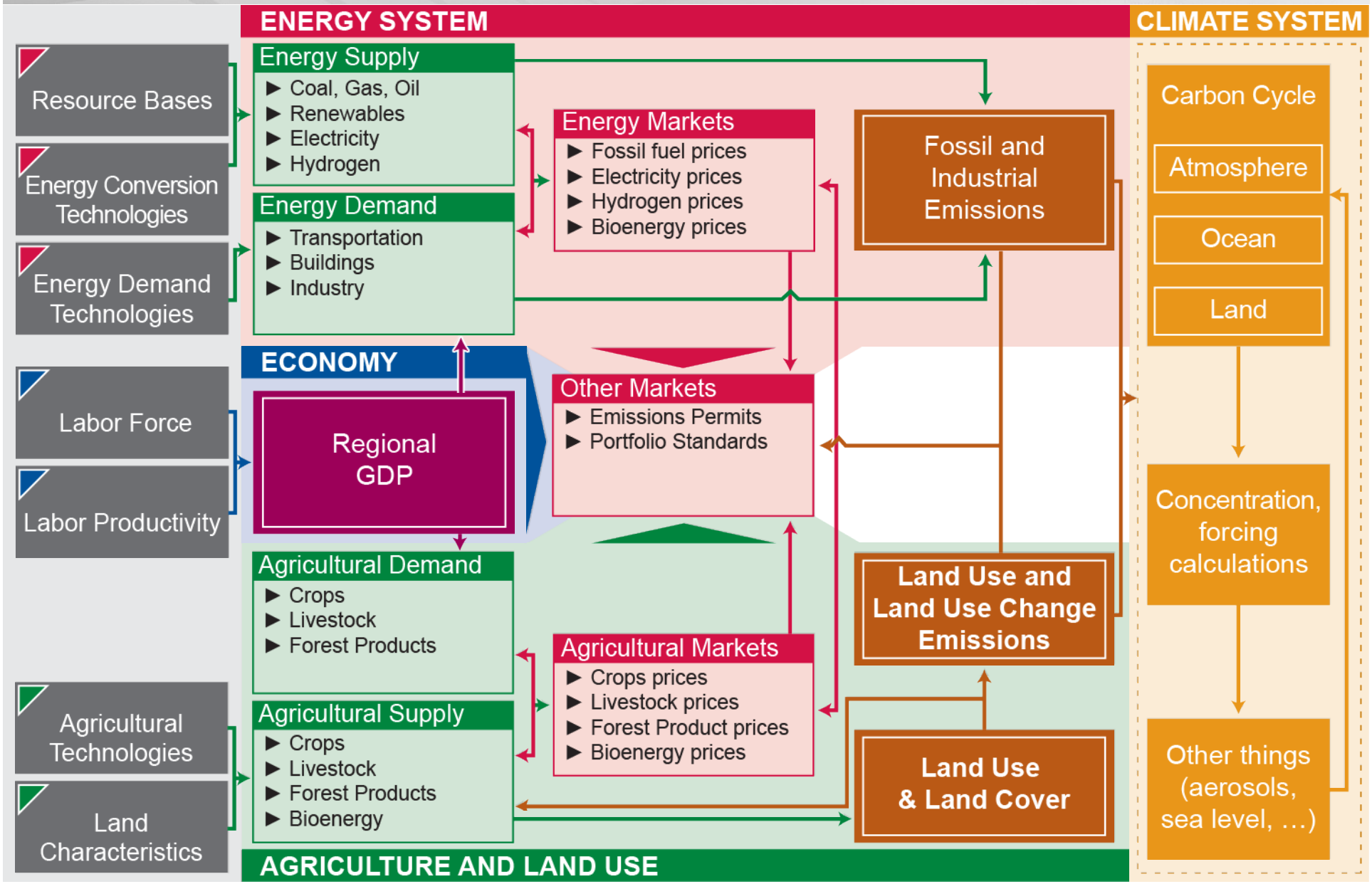

Intersection of land-use and climate policies

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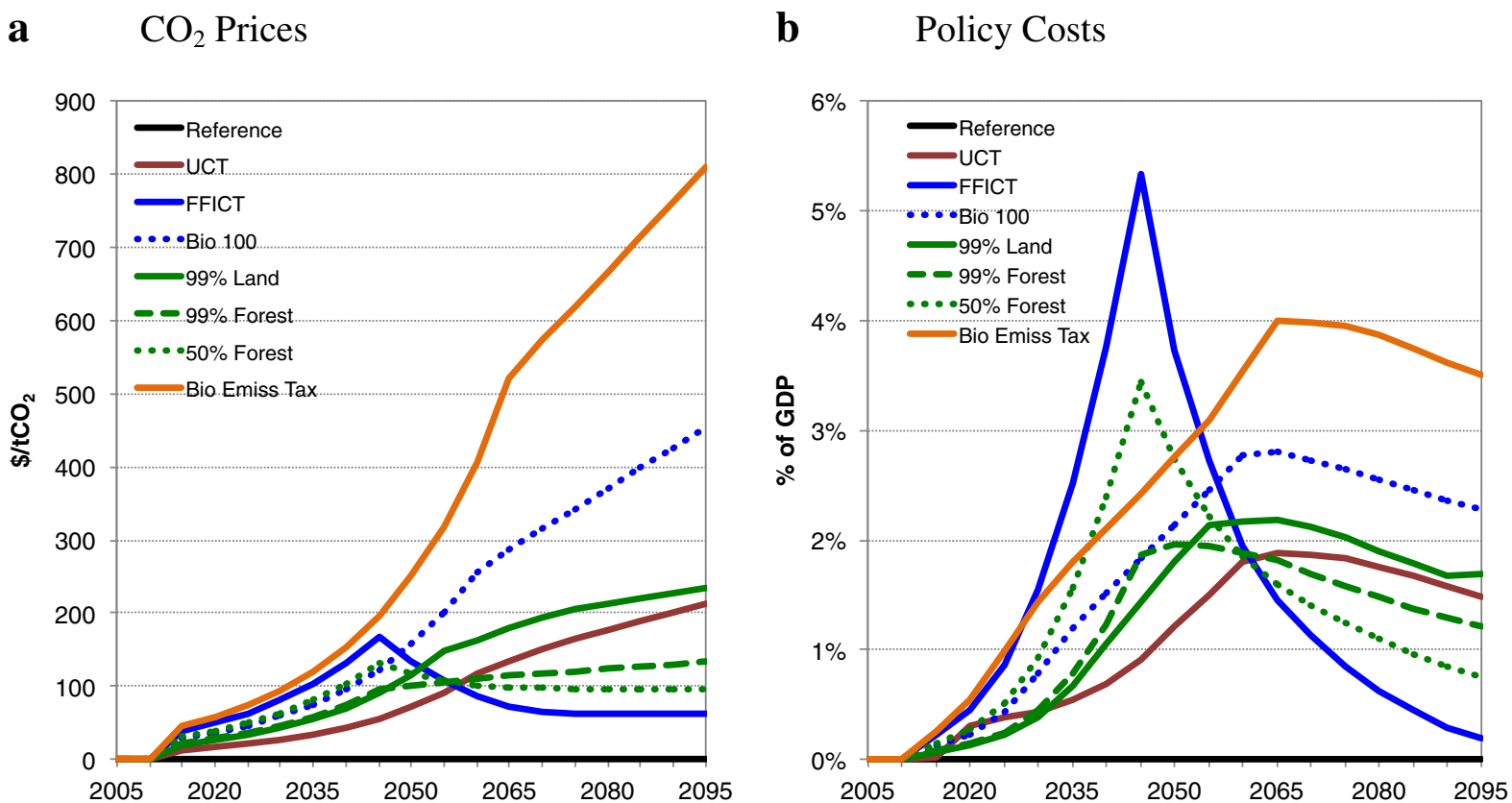
Cost of a global climate policy to limit total radiative forcing to 3.7 W/m²



Land-use policies can make a large difference in costs!

And also on land-use, agricultural prices, etc. (see paper)

Fig. 5 CO_2 prices and policy costs (Area under MAC curve) across bioenergy and land policy scenarios

Calvin et al. (2014) Trade-offs of different land and bioenergy policies on the path to achieving climate targets Climatic Change DOI 10.1007/s10584-013-0897-y

Biomass consumption: technology & policy

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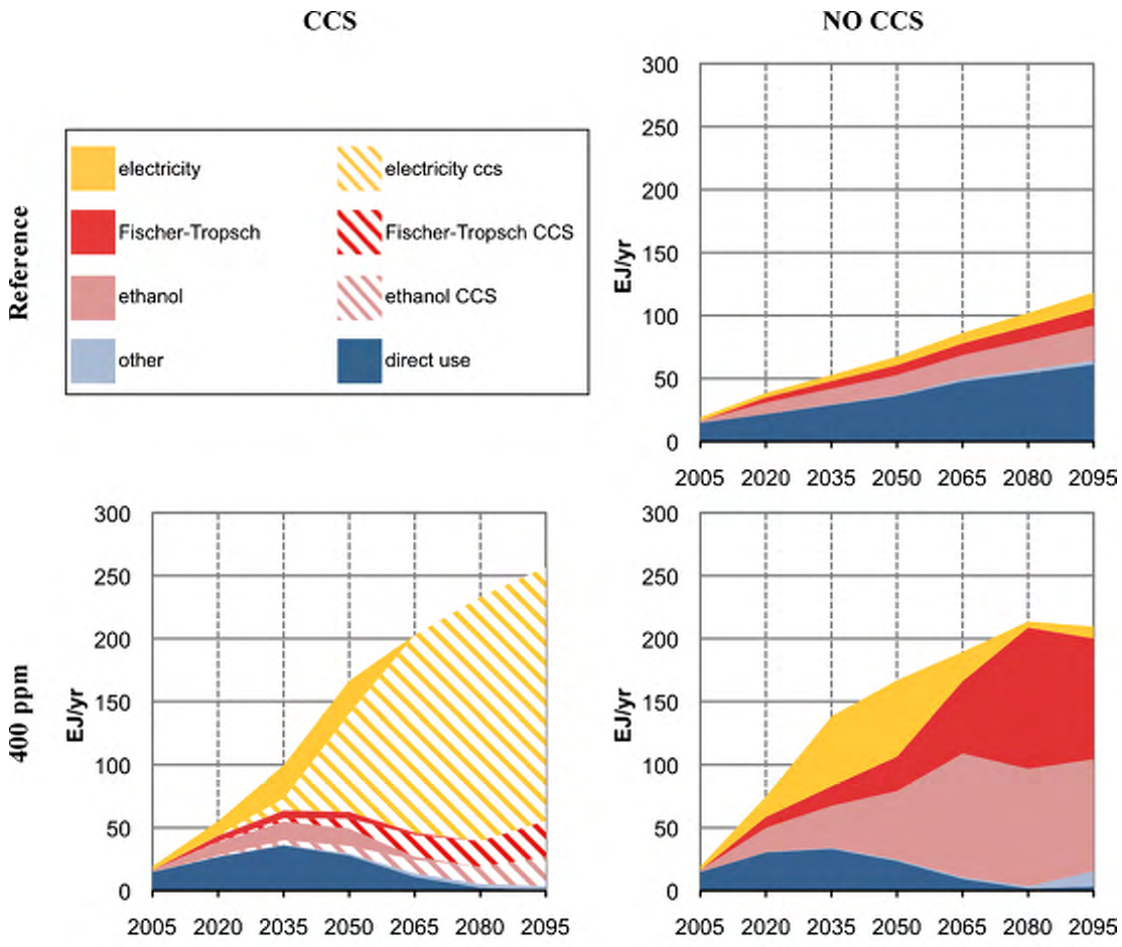
Where is biomass best used in the energy system?

- *Depends on the time period and the technological options available.*



- Without a climate policy, biomass is used across the energy system *(upper left)*
- Under a comprehensive climate policy, consumption of biomass (waste/residue + dedicated crops) increases.
- If CCS (CO2 capture & storage) is available, this becomes the preferred options.
- Without CCS, biomass ultimately is used largely for liquid fuels.

Luckow P, MA Wise, JJ Dooley, and SH Kim. 2010. "Large-Scale Utilization of Biomass Energy and Carbon Dioxide Capture and Storage in the Transport and Electricity Sectors under Stringent CO2 Concentration Limit Scenarios." International Journal of Greenhouse Gas Control 4(5):865-877. doi:10.1016/j.ijggc.2010.06.002

Biomass consumption: technology & policy

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If CCS is available, biomass with CCS quickly becomes the preferred use of biomass feedstock.

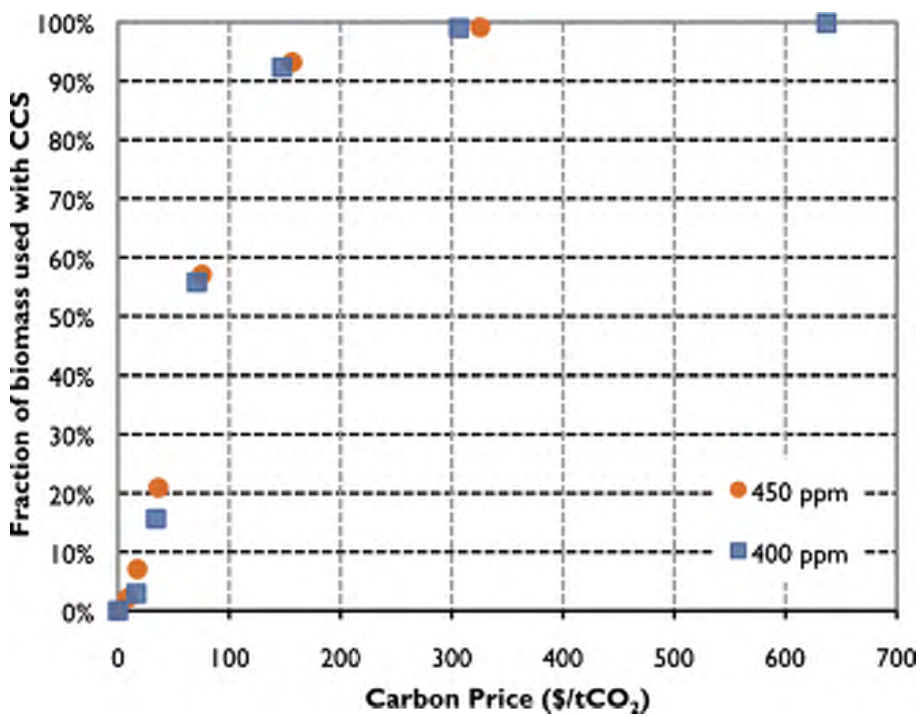

Fig. 9. Percentage of energy-system biomass used in combination with CCS, as a function of carbon price.

- Once the carbon price rises above $100/tCO2, the vast majority of biomass is used in technologies that also employ CO2 capture and storage (CCS).
- This generates net negative CO2 emissions, which is economically very valuable.

Luckow P, MA Wise, JJ Dooley, and SH Kim. 2010. "Large-Scale Utilization of Biomass Energy and Carbon Dioxide Capture and Storage in the Transport and Electricity Sectors under Stringent CO2 Concentration Limit Scenarios." International Journal of Greenhouse Gas Control 4(5):865-877. doi:10.1016/j.ijggc.2010.06.002

For Further Information

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- GCAM web site

  http://www.globalchange.umd.edu/models/gcam/

  Links here to the GCAM Wiki on-line documentation

- GCAM Community web site

  http://www.globalchange.umd.edu/models/gcam/gcam-community/

  Including presentations from the 2013 GCAM community meeting.

- Published journal papers and reports

  Partial list on the GCAM Wiki.

  See also individual GCAM integrated assessment group staff pages (updated within about a month of publication)

  http://www.pnnl.gov/atmospheric/staff/stfsrchresults.asp?id=763