Biomass for bioenergy: Outline

- What?
- Why?
- Which crops preferable?
- Current sources?
- Future sources?
- Examples
- **Discussion**
- Resources for more information

"You can't know where you're headed if you don't know where you've been"

And it helps to understand where you are right now.

"Prediction is very difficult, especially about the future"

-Niels Bohr, Danish physicist.

Thoughts for discussion

- Many studies of global biomass potential begin with assumed limitations of land. Is land the primary constraint to biomass production? - No -
  - Social, political, economic/market issues
  - Institutions, governance, water…
- Needed: Incentives for improved soil/water (resource) management
  - Increase carbon and nutrient retention
  - And capacity to store carbon
- On the sustainability radar:
  - Integrated land-use plans and production systems (ILUP)
  - Urban food-energy systems for nutrient, water and energy recycling

Source: Kline presentation to "Pathways to Climate Solutions: Assessing Energy Technology and Policy Innovation" Workshop organized by the Aspen Global Change Institute; 24-28 February, 2014. Aspen CO.

Conclusions – we have no shortage of biomass

Different places, contexts, needs and goals require unique solutions.

We need to

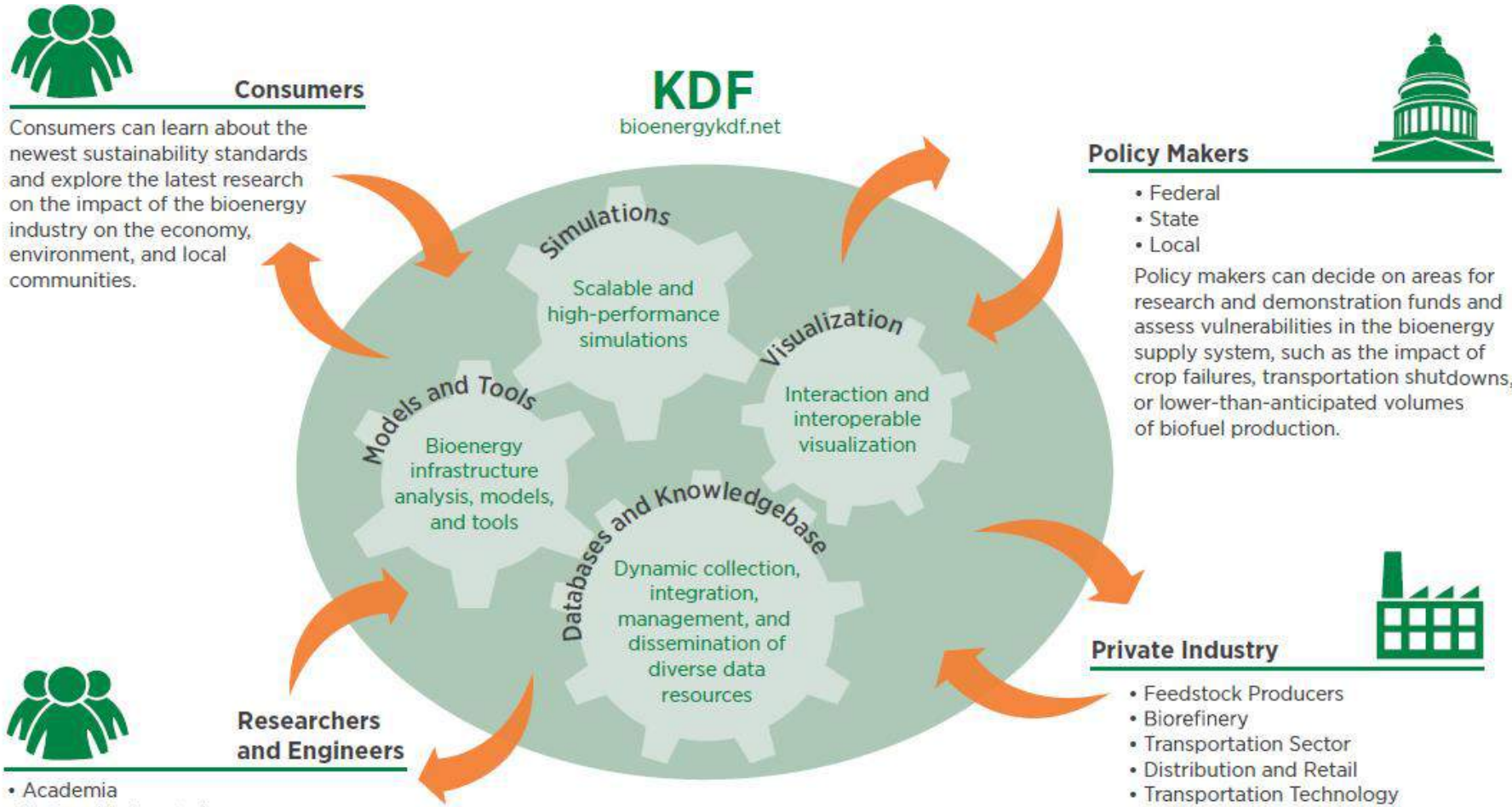
- Learn from experiences
- Build partnerships
- Develop and apply a suite of metrics that reflect local stakeholder priorities for “sustainability”

Thank you!

http://www.ornl.gov/sci/ees/cbes/

For more information: Bioenergykdf.net

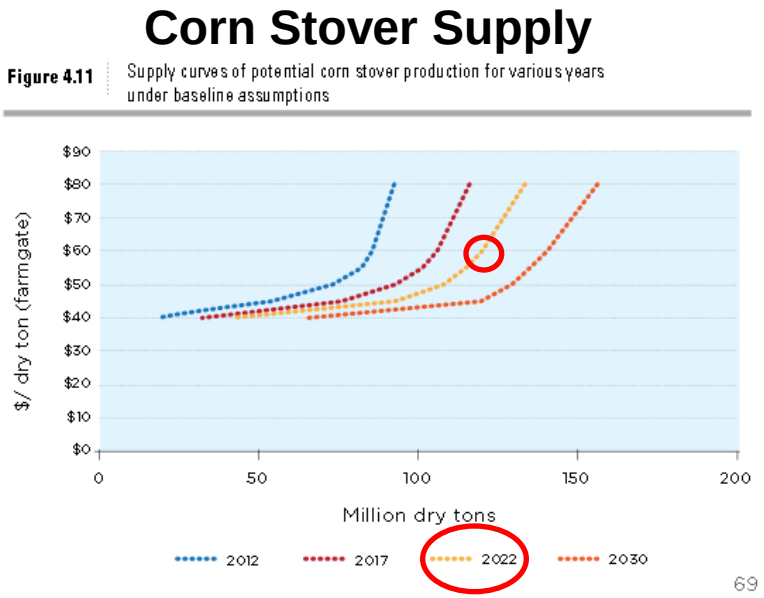
BIOENERGY KNOWLEDGE DISCOVERY FRAMEWORK
KDF
U.S. DEPARTMENT OF ENERGY



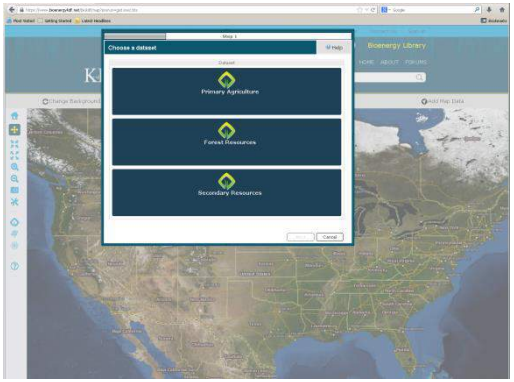
For video, see: https://www.youtube.com/watch?v=sm1Yt-kPZpE&list=UUSRLqX2RF5hWFxb2AY891wg

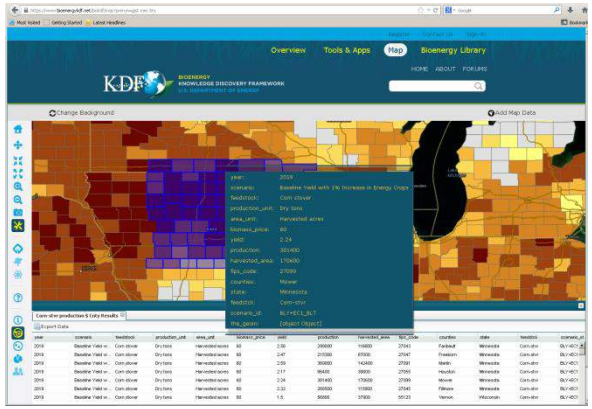
Bioenergy KDF Resources

- Billion Ton Data Explorer
  - Visualize custom supplies from the BT2 findings
  - Available for all potential resources identified as new biomass sources



Online Tool Workflow





https://bioenergykdf.net/

Thank you

Center for Bioenergy Sustainability

http://www.ornl.gov/sci/ees/cbes/

See the website for

- Reports
- Forums
- Other presentations
- Recent publications

- Bibliography and extra slides follow

CBES
Center for BioEnergy Sustainability

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The views in this presentation are those of the author/presenter who is responsible for any errors or omissions.

OAK RIDGE National Laboratory

Further reading on bioenergy and sustainability:

- Dale VH, KL Kline, LL Wright, RD Perlack, M Downing, RL Graham. 2011. Interactions among bioenergy feedstock choices, landscape dynamics and land use. *Ecological Applications* 21(4):1039-1054.
- Dale, VH, RA Efroymson, KL Kline, MH Langholtz, PN Leiby, GA Oladosu, MR Davis, ME Downing, MR Hilliard. 2013. Indicators for assessing socioeconomic sustainability of bioenergy systems: A short list of practical measures. Ecological Indicators 26: 87-102.
- Oladosu D, KL Kline, P Leiby, R Martinez, M Davis, M Downing, L Eaton. 2012. Global economic effects of the US biofuel policy and the potential contribution from advanced biofuels. Biofuels 3(6):703-723. http://www.future-science.com/doi/pdfplus/10.4155/bfs.12.6
- USDOE 2011. U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry. ORNL. http://www1.eere.energy.gov/bioenergy/pdfs/billion_ton_update.pdf
- USDoe State of Technology updates: http://www1.eere.energy.gov/bioenergy/key_publications.html
- Dornburg et al. 2010. Bioenergy revisited: Key factors in global potentials of bioenergy. Energy Environ. Sci., 2010,3, 258-267..
- Efroymson, R. A., V. H. Dale, K. L. Kline, A. C. McBride, J. M. Bielicki, R. L. Smith, E. S. Parish, P. E. Schweizer, D. M. Shaw. 2012. Environmental indicators of biofuel sustainability: What about context? Environmental Management DOI 10.1007/s00267-012-9907-5
- Giglio L., J. T. Randerson, G. R. van derWerf, P. S. Kasibhatla, G. J. Collatz, D. C. Morton, and R. S. DeFries. Assessing variability and long-term trends in burned area by merging multiple satellite fire products. Biogeosciences, 7, 1171–1186, 2010.
- IPCC 2012 Special Report on Renewables and Climate Change Mitigation.
- Kline KL, Dale VH, Lee R, Leiby P. 2009. In Defense of Biofuels, Done Right. Issues in Science and Technology 25(3): 75-84. http://www.issues.org/25.3/kline.html
- Langholtz M, Eaton L and Turhollow A. (in press). 2013 Feedstock Supply and Price Projections and Sensitivity Analysis. (BioFPR 2014).
- McBride A, VH Dale, L Baskaran, M Downing, L Eaton, RA Efroymson, C Garten, KL Kline, H Jager, P Mulholland, E Parish, P Schweizer, and J Storey. 2011. Indicators to support environmental sustainability of bioenergy systems. *Ecological Indicators* 11(5) 1277-1289.
- Parish ES, M Hilliard, LM Baskaran, VH Dale, NA Griffiths, PJ Mulholland, A Sorokine, NA Thomas, ME Downing, R Middleton. 2012. Multimetric spatial optimization of switchgrass plantings across a watershed. *Biofuels, Bioprod. Bioref*. 6(1):58-72.
- Strassburg BBN, Latwiec AE, et al., 2014. When enough should be enough. Improving the use of current agricultural lands could spare natural habitats in Brazil. Glob.Env.Change 28 84-97.

Bibliography and references (continued)

- Arezki et al. 2014. Understanding international commodity price fluctuations. Journal of International Money and Finance 42 (2014) 1–8
- Babcock, B. A. (2011 June). The impact of US biofuel policies on agricultural price levels and volatility. International Centre for Trade and Sustainable Development (35)
- Charles, C. (2012 April). Should we be concerned about competition between food and fuel? International Institute for Sustainable Development.
- de Gorter, H., & Just, D. R. (2010). The social costs and benefits of biofuels: The intersection of environmental, energy and agricultural policy. Applied Economic Perspectives and Policy.
- Economic Research Service, Amber Waves, 10(2 (June)), 2012.
- Durham, C., Davies, G., & Bhattacharyya, T. (2012, June). Can biofuels policy work for food security? Department for Environment Food and Rural Affairs.
- FAO, IFAD, IMF, OECD, UNCTAD, WFP, the World Bank, the WTO, IFPRI, and the UN HLTF. (2011, June 2). Price volatility in food and agricultural markets: Policy responses. Policy Report for the G-20 .
- King R (Oxfam), Kelbert A (IDS), Chisholm N (University College Cork), Hossain N (IDS). 2014. Help Yourself - Food Rights and Responsibilities: Year 2 findings from Life in a Time of Food Price Volatility. Joint Agency Research Report. www.ids.ac.uk and www.oxfam.org
- Locke, A., Wiggins, S., Henley, G., & Keats, S. (2013 April). Diverting grain from animal feed and biofuels. London : Overseas Development Institute.
- McPhail, Lihong Lu, & Du, X. (2012). Ethanol Strengthens the Link Between Agriculture and Energy Markets.
- Peterka, A. (2012 31-July). Livestock groups urge EPA to waive ethanol mandate. Governors' Biofuels Coalition.
- Schafer, E. (2012 8-March). Proposed RFS changes spark food vs. fuel debate. Feed & Grain.
- Sepp S. 2014. Multiple-household fuel use; a balanced choice between firewood, charcoal and LPG. Published by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (www.giz.de/hera), Eschborn, Germany, on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ). http://www.eco-consult.com/fileadmin/user_upload/pdf/Multiple-Household_Fuel_Use.pdf
- Tyner, W. E., Taheripour, F., & Hurt, C. (2012 16-August). Potential impacts of a partial waiver of the ethanol blending rules. Farm Foundation and Purdue University.
- Wright, B. (2011, February). Biofuels and food security: Time to consider safety valves? . IPC Policy Focus, International Food and Agricultural Trade Policy Council.

References Used in the Global Carbon Project Analysis

Global Carbon Budget (2014) More information, data sources and data files at http://www.globalcarbonproject.org/carbonbudget/

C. Le Quéré, R. Moriarty, R.M. Andrew, G.P.Peters, P. Ciais, P. Friedlingstein, S.D. Jones, S. Sitch, P.Tans, A. Arneth, T.A. Boden, L. Bopp, Y. Bozec, J.G. Canadell, F. Chevallier, C.E. Cosca, I. Harris, M. Hoppema, R.A. Houghton, J.I. House, J.K Jain, T. Johannessen, E. Kato, R.F. Keeling, V. Kitidis, K. Klein Goldewijk, C. Koven, C. Landa, P. Landschützer, A. Lenton, I.D. Lima, G. Marland, J.T. Mathis, N. Metzl, Y. Nojiri, A. Olsen, T. Ono, W. Peters, B. Pfeil, B. Poulter, M.R. Raupach, P. Regnier, C. Rödenbeck, S. Saito, J.E. Salisbury, U. Schuster, J. Schwinger, R. Séférian, J. Segschneider, T. Steinhoff, B.D. Stocker, A.J. Sutton, T. Takahashi, B. Tilbrook, G.van der Werf, N. Viovy, Y.P. Wang, R. Wanninkhof, A. Wiltshire, N. Zeng (2014) "Global Carbon Budget 2014", *Earth System Science Data Discussions* (in review), http://dx.doi.org/10.5194/essdd-7-521-2014

R. Andrew, G.P. Peters, S. Davis (2013) "Climate Policy and Dependence on Traded Carbon" *Environmental Research Letters*, http://dx.doi.org/10.1088/1748-9326/8/3/034011, DOI:10.1088/1748-9326/8/3/034011

T. Boden, G. Marland, R. Andres (2013) "Global, Regional, and National Fossil-Fuel CO_2 Emissions in Trends", Carbon Dioxide Information Analysis Center **(CDIAC)**, http://cdiac.ornl.gov/trends/emis/meth_reg.html

E. Dlugokencky and P. Tans (2013) "Trends in Atmospheric Carbon Dioxide", National Oceanic & Atmosphere Administration, Earth System Research Laboratory **(NOAA-ESRL)**, http://www.esrl.noaa.gov/gmd/ccgg/trends/

L. Giglio, J.T. Randerson, G.R. van der Werf (2014) "Analysis of daily, monthly, and annual burned area using the fourth-generation global fire emissions database (GFED4)", Journal Geophysical Research Biogeosciences, 118, TS10, 2013, http://onlinelibrary.wiley.com/doi/10.1002/jgrg.20042/abstract, DOI:10.1002/jgrg.20042

R.A. Houghton, J.I. House, J. Pongratz, G.R. van der Werf, R.S. DeFries, M.C. Hansen, C. Le Quéré, N. Ramankutty (2012), "Carbon emissions from land use and land-cover change", http://www.biogeosciences.net/9/5125/2012/bg-9-5125-2012.html, DOI:10.5194/bg-9-5125-2012

F. Joos, R. Roth, J.Fuglestvedt, G. Peters, I. Enting, W. von Bloh, V. Brovkin, E. Burke, M. Eby, N. Edwards, T. Friedrich, T. Frölicher, P. Halloran, P. Holden, C. Jones, T. Kleinen, F. Mackenzie, K. Matsumoto, M. Meinshausen, G.-K. Plattner, A. Reisinger, J. Segschneider, G. Shaffer, M. Steinacher, K. Strassmann, K. Tanaka, A. Timmermann, and A. Weaver (2013) "Carbon dioxide and climate impulse response functions for the computation of greenhouse gas metrics: a multi-model analysis", *Atmospheric Chemistry and Physics*, http://www.atmos-chem-phys.net/13/2793/2013/acp-13-2793-2013.html, DOI: 0.5194/acp-13-2793-2013

S. Khatiwala, T. Tanhua, S. Mikaloff Fletcher, M. Gerber, S. Doney, H. Graven, N. Gruber, G. McKinley, A. Murata, A. Rios, C. Sabine (2013), "Global ocean storage of anthropogenic carbon", *Biogeosciences*, http://www.biogeosciences.net/10/2169/2013/bg-10-2169-2013.html, doi:10.5194/bg-10-2169-2013

G.P. Peters, J. Minx, C. Weber, O. Edenhofer (2011) "Growth in emission transfers via international trade from 1990 to 2008", *Proceedings of the National Academy of Sciences*, www.pnas.org/content/108/21/8903 DOI:10.1073/pnas.1006388108

G.P. Peters, S. Davis, R. Andrew (2012) "A synthesis of carbon in international trade", *Biogeosciences*, http://www.biogeosciences.net/9/3247/2012/bg-9-3247-2012.html, DOI:10.5194/bg-9-3247-2012

UN (2014) United Nations Statistics Division http://unstats.un.org/unsd/default.htm

Jobs are important for social and political sustainability – Fossil fuels = boom/bust cycles, while…

i - Employment information for large-scale hydropower is incomplete and not included.

Source: www.ren21.net

Win-Win LUC Opportunities

Improve soil & water management	• Precision management and nutrient recycling • Reduce disturbance/tillage intensity • Crop mix, rotations, cover crops • Land restoration • Technology (seed, microbe, equipment)
Increase Efficiency	• Reduce inputs/increase ***yields*** • Open, transparent markets • Minimize transaction costs • Prioritize, incentivize, measure
Diversify	• Uses and markets • Substitution options • Bases of production
Adopt Systems Perspective	• Multi-scale • Long term and adaptive • Integrated land-use plans

Source: K.Kline presentation to Coordinating Research Council CRC, Argonne IL, 13 Oct 2013

Research challenges to better address issues about food security and biofuels

- Accurate representations based on clear **definitions** for variables and conditions of concern:
  - land attributes
  - management practices
  - baseline trends and dynamics
- **"Causal analysis"** that can be validated at multiple scales
- Adequate empirical **data** to test models and hypotheses
- Multi-disciplinary, multi-institutional **learning** and problem-solving mechanisms

Source: adapted from K.Kline presentation to Coordinating Research Council CRC, Argonne IL, 13 Oct 2013