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2016 Billion-Ton Report Briefing

July 19, 2016

Environmental and Energy Study Institute

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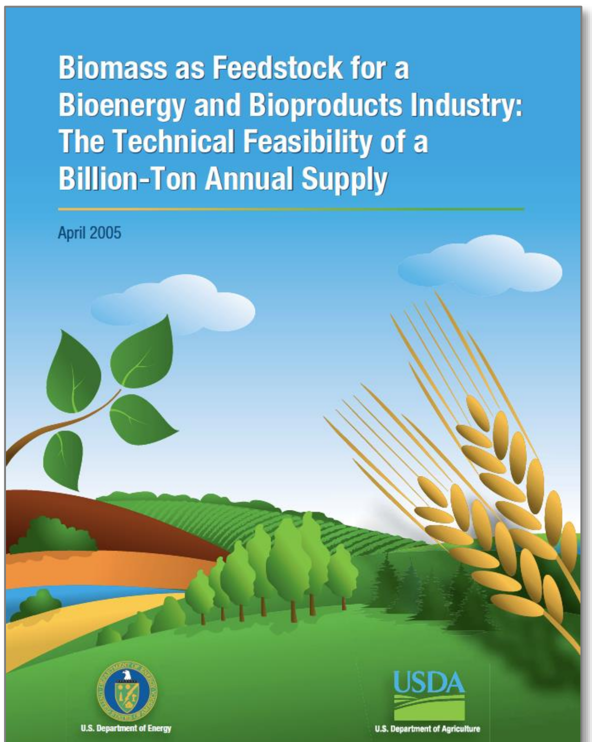
Office of Energy Efficiency and Renewable Energy

U.S. Department of Energy

* On behalf of the entire team

2016 Billion-Ton Report: Advancing Domestic Resources for a Thriving Bioeconomy

- A follow-up from the original 2005 *Billion-Ton Study* and 2011 *Billion-Ton Update*
- Technical resource assessment to verify one billion tons of biomass is available, and under which scenarios



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Motivation Behind *2016 Billion-Ton Report*

- Enormous U.S. domestic biomass potential
  - 2005 and 2011 reports identified > 1 billion ton annual supply
- Understanding and quantifying biomass supply fosters commercialization to increase
  - Energy security,
  - Energy independence, and
  - Environmental stewardship
- Sustainable production is critical to long-term viability of technology for clean energy

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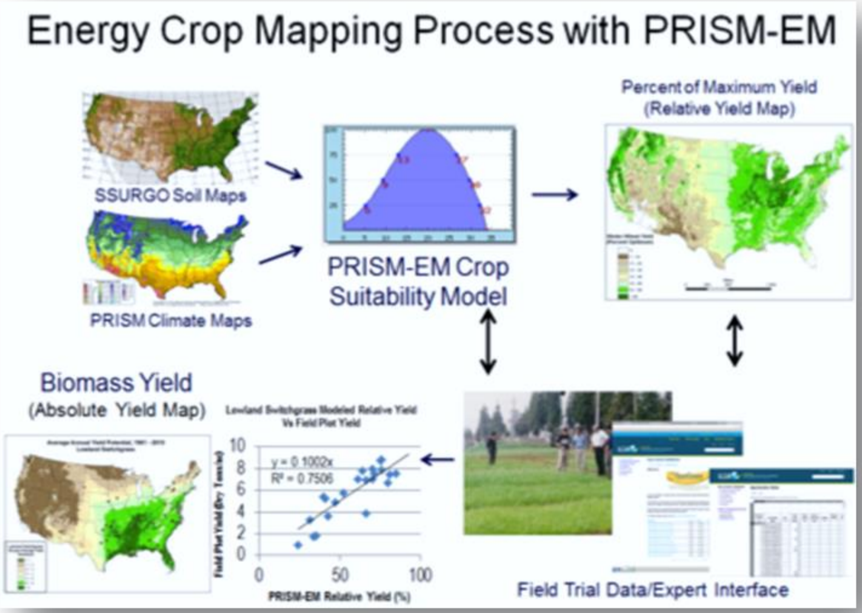
Research Questions: *2016 Billion-Ton Report*

- What is the potential economic availability of biomass resources at roadside, assuming latest-available yield and cost data?

- What is the economic availability of feedstocks delivered to the biorefinery?



- How does the addition of algae, miscanthus*, energy cane, and eucalyptus affect potential supply?

*Miscanthus invasiveness is limited by sterile seed cultivars and containment of rhizomes.

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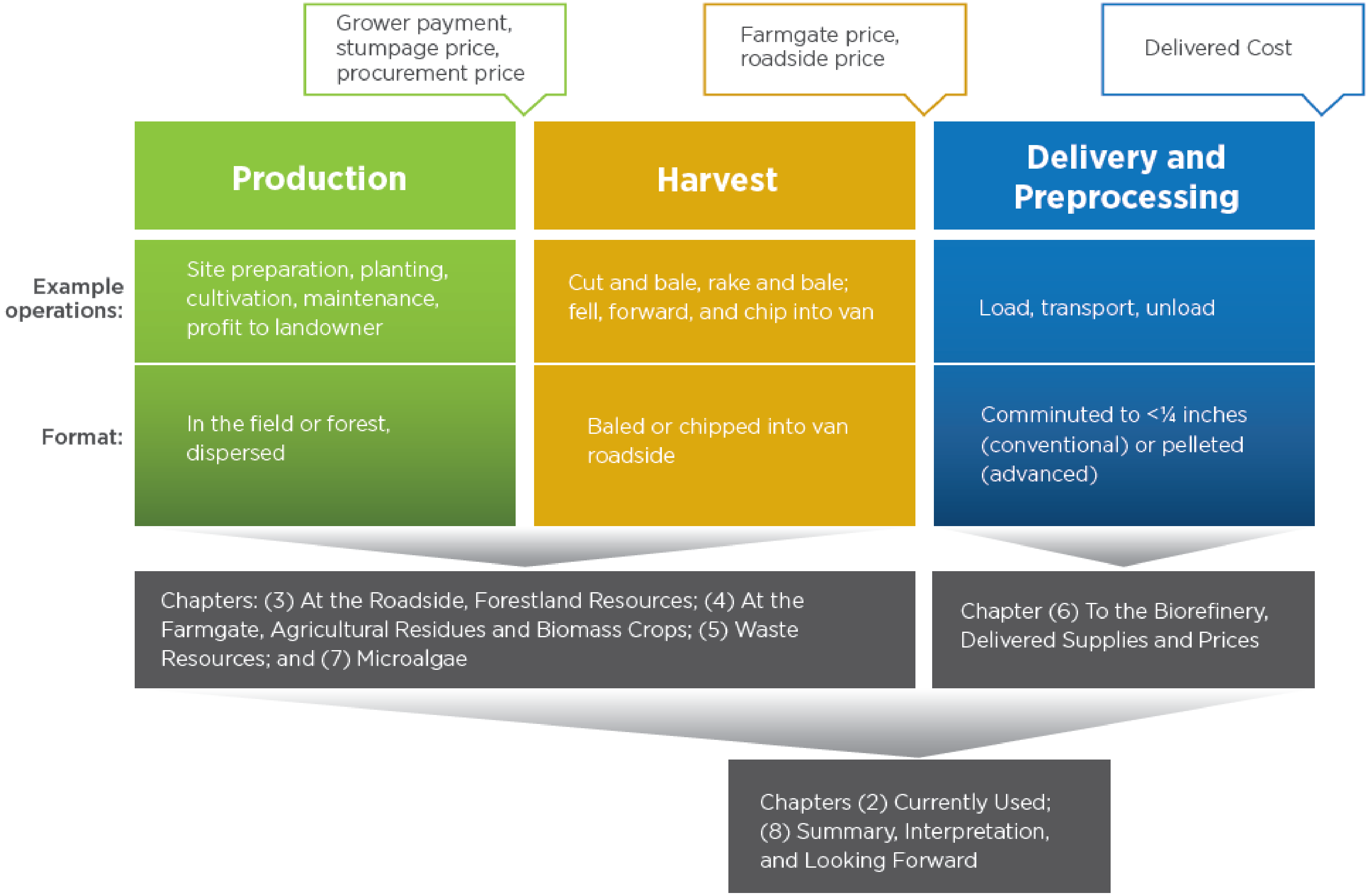
Schematic of biomass supply chain



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2016 Billion-Ton Report

- Potential new feedstocks exclude policy and end use
- Prioritizes food, forage, feed, fiber, and export to ensure social sustainability
- Current uses are estimated, then become part of the potential
- Economic supply curve approach
- Underlying conservative assumptions with environmental sustainability considerations
- Two volumes: resource assessment and environmental sustainability effects of select scenarios
- Multi-lab/agency effort

Contributors

Multiple Reviewers (28) attended volume 1 workshop

Government	Academia	Non-Government Organizations	Industry
• Environmental Protection Agency • Federal Aviation Administration • USDA Agricultural Research Service	• University of California - Davis • University of Georgia • North Carolina State University • University of Arizona • University of Minnesota • Iowa State University • University of Illinois	• National Council for Air & Stream Improvement • Union of Concerned Scientists • Pinchot Institute	• Shell • Forest Concepts • Mater Engineering • GreenWood Resources • AGCO Corp. • Antares • Resource Dynamics • Sapphire Energy • Qualitas Health • Algenol Biotech LLC

Models/Data Used in BT16 Volume 1

Models

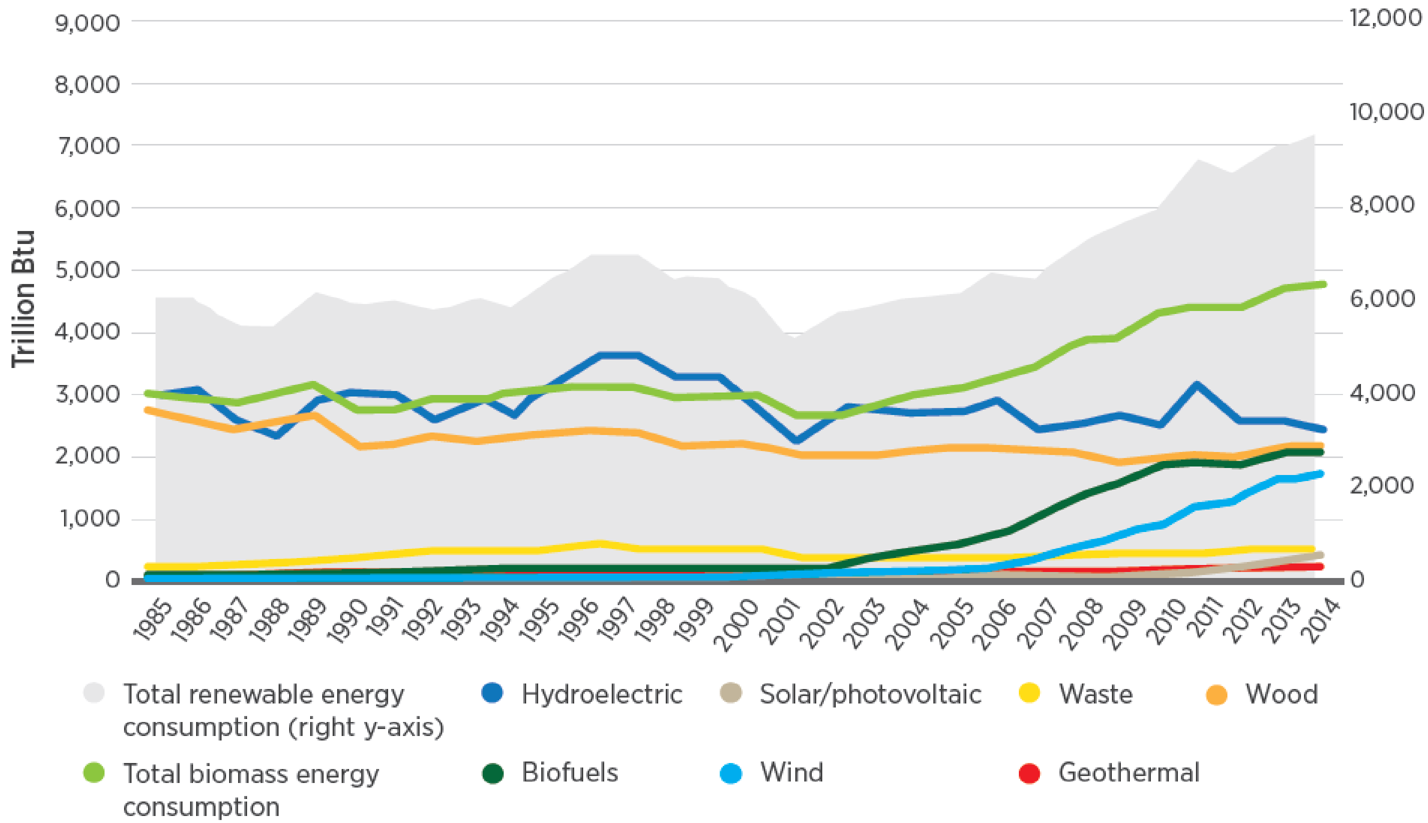
- POLYSYS: Policy Analysis System
- ForSEAM: Forest Sustainable and Economic Analysis Model
- SRTS: Subregional Timber Supply Model
- USFPM/GFPM: U.S. Forest Products Module/Global Forest Products Model
- PRISM-EM: Parameter-elevation Relationships on Independent Slopes Model
- SCM: Supply Characterization Model

Data

- USDA Long-Term Agricultural Projections (10 years extrapolated)
- U.S. Forest Service RPA (10-year forest assessment) and FIA
- EIA Monthly Energy Review, Annual Energy Outlook, Consumption Surveys and other data
- PRISM (climate) and SSURGO (soils) high resolution data
- Sun Grant Regional Feedstock Partnership and Historical Field Trial data of energy crops

Biomass is the largest source of domestic renewable energy

Figure 2.2 | Primary renewable energy consumption by source and total consumption (1985–2014)



Source: Data from EIA (2015d).

2016 Billion-Ton Report | 15

365 million dry tons per year (2014)

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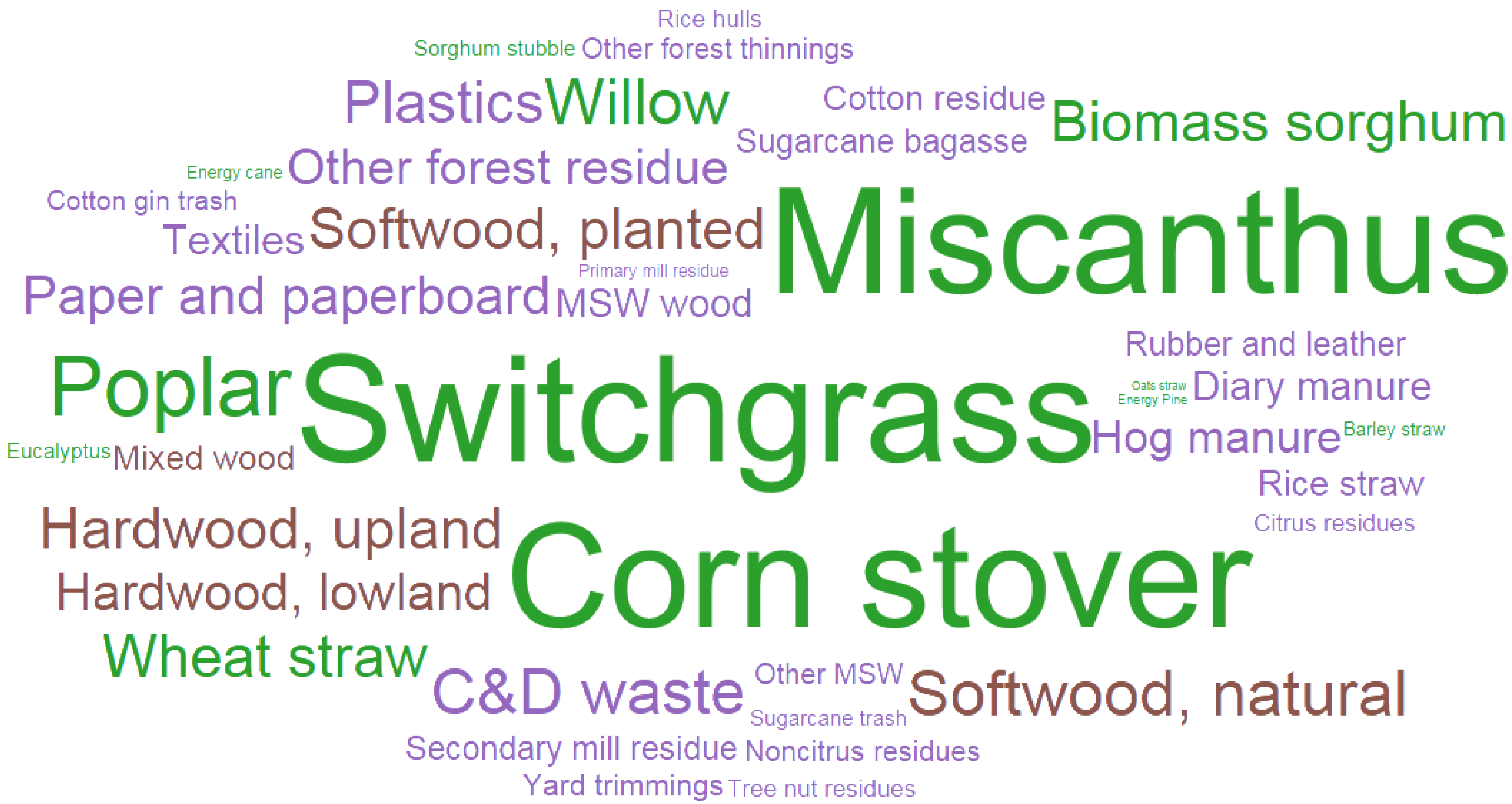
Major biomass sources, 2040



Base case scenario, 2040, $60 per dry ton or less

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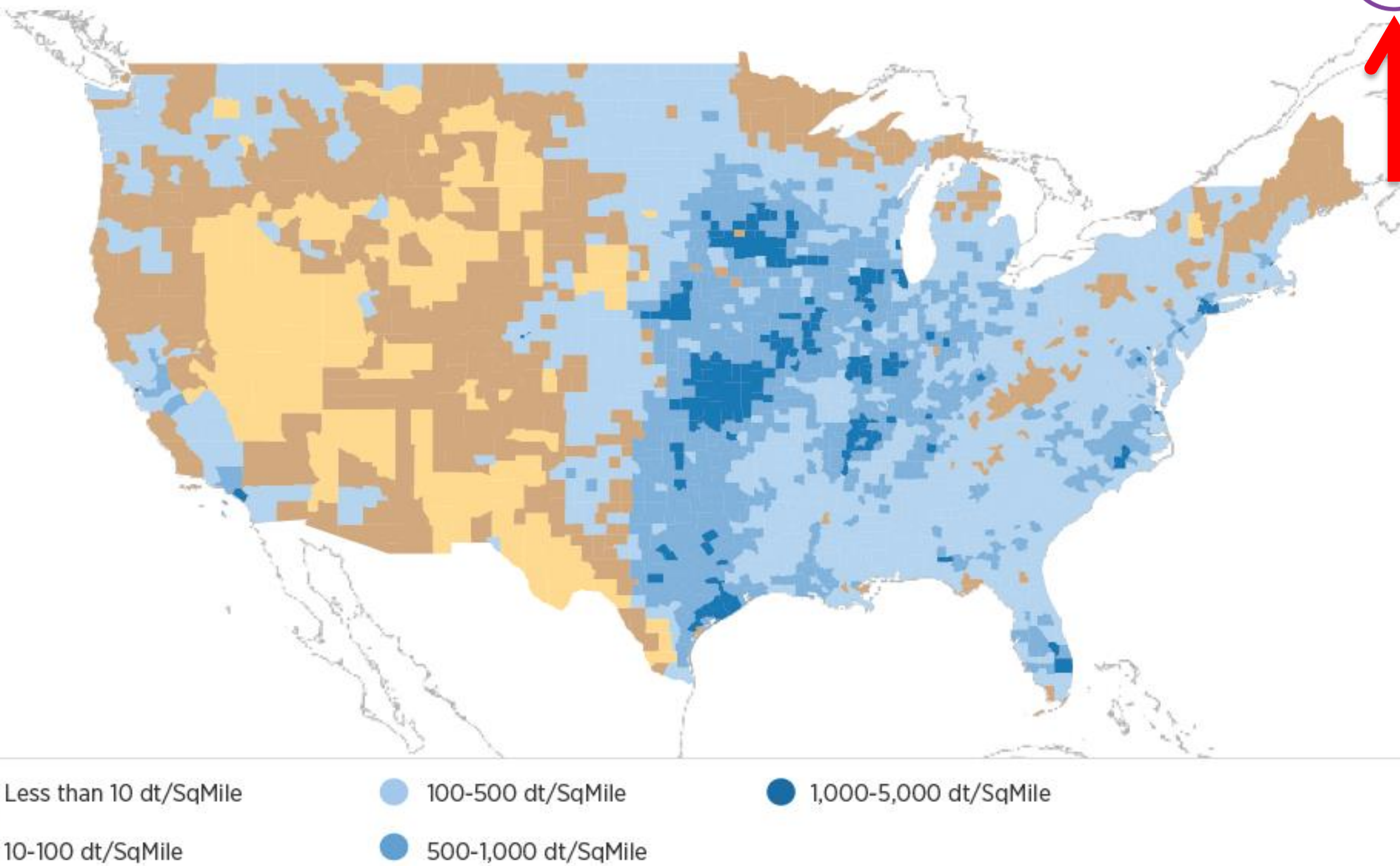
Figure ES.4 | Combined potential supplies from forestry, wastes, and agricultural resources, base case, 2040[10]



[10] Interactive visualization: https://bioenergykdf.net/billionton2016/1/2/tableau

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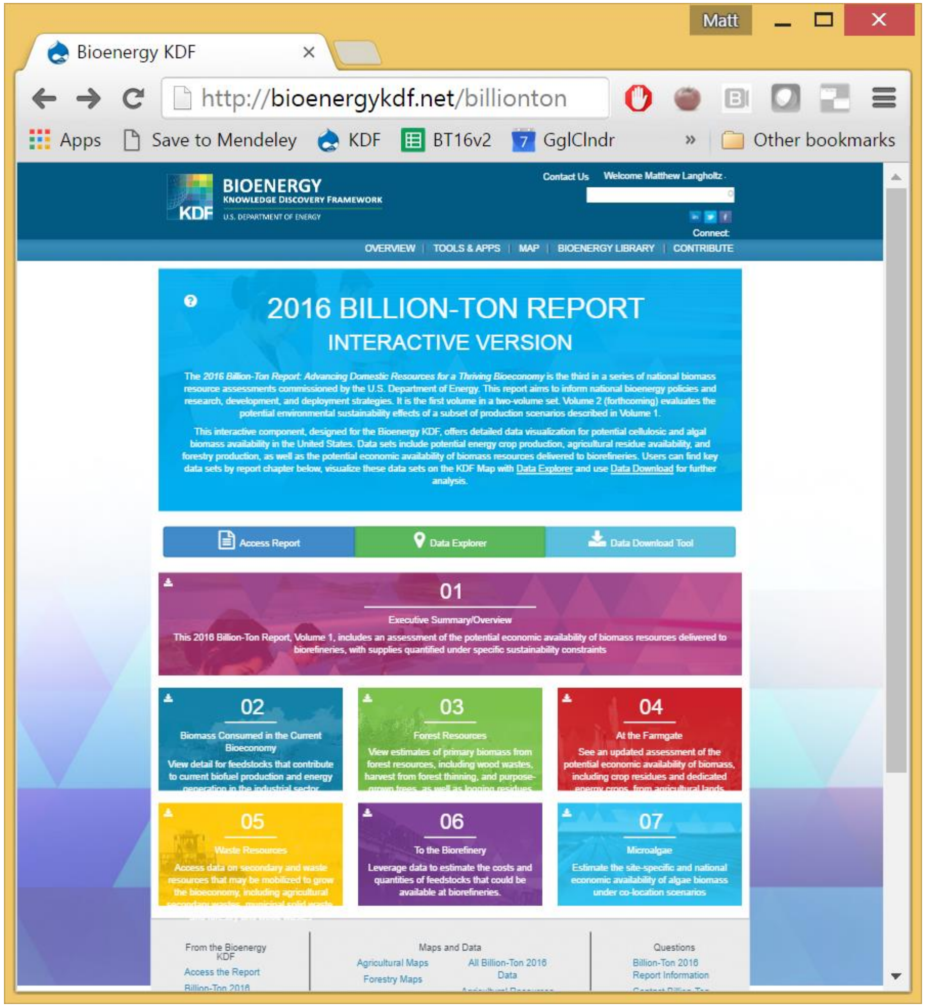
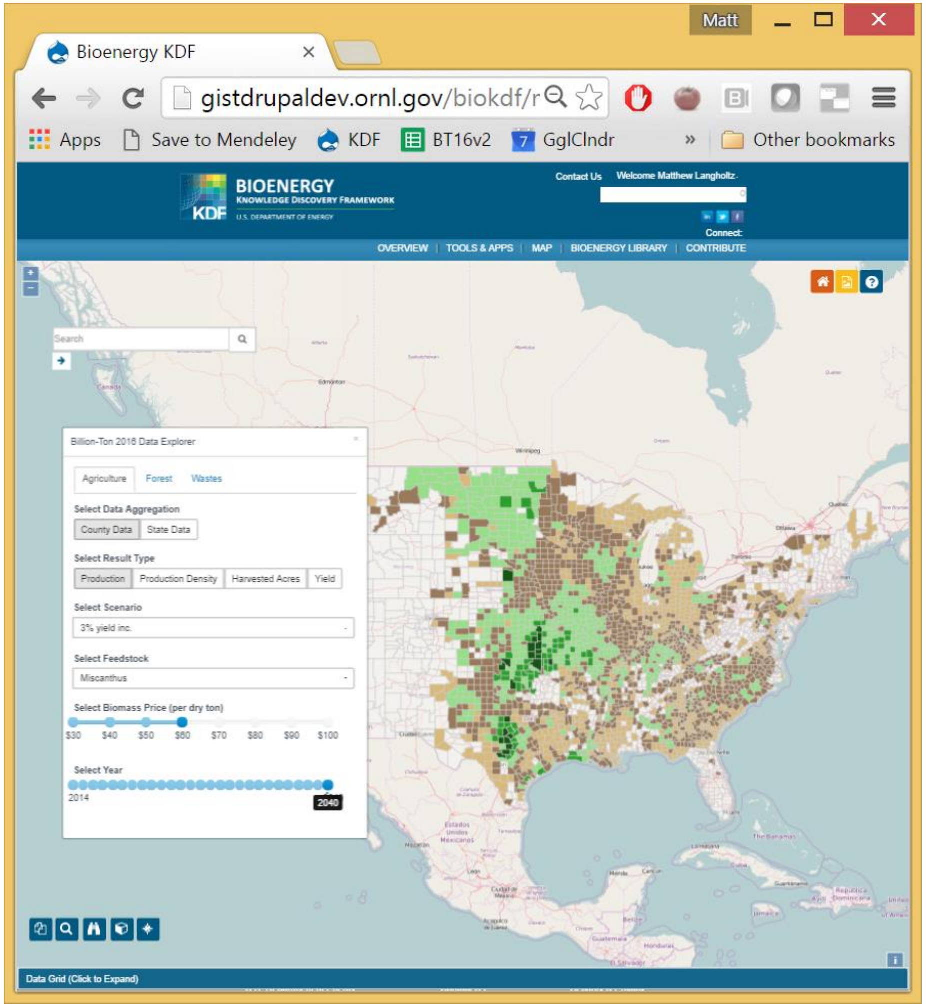
Interactive Resources

http://bioenergykdf.net/billionton





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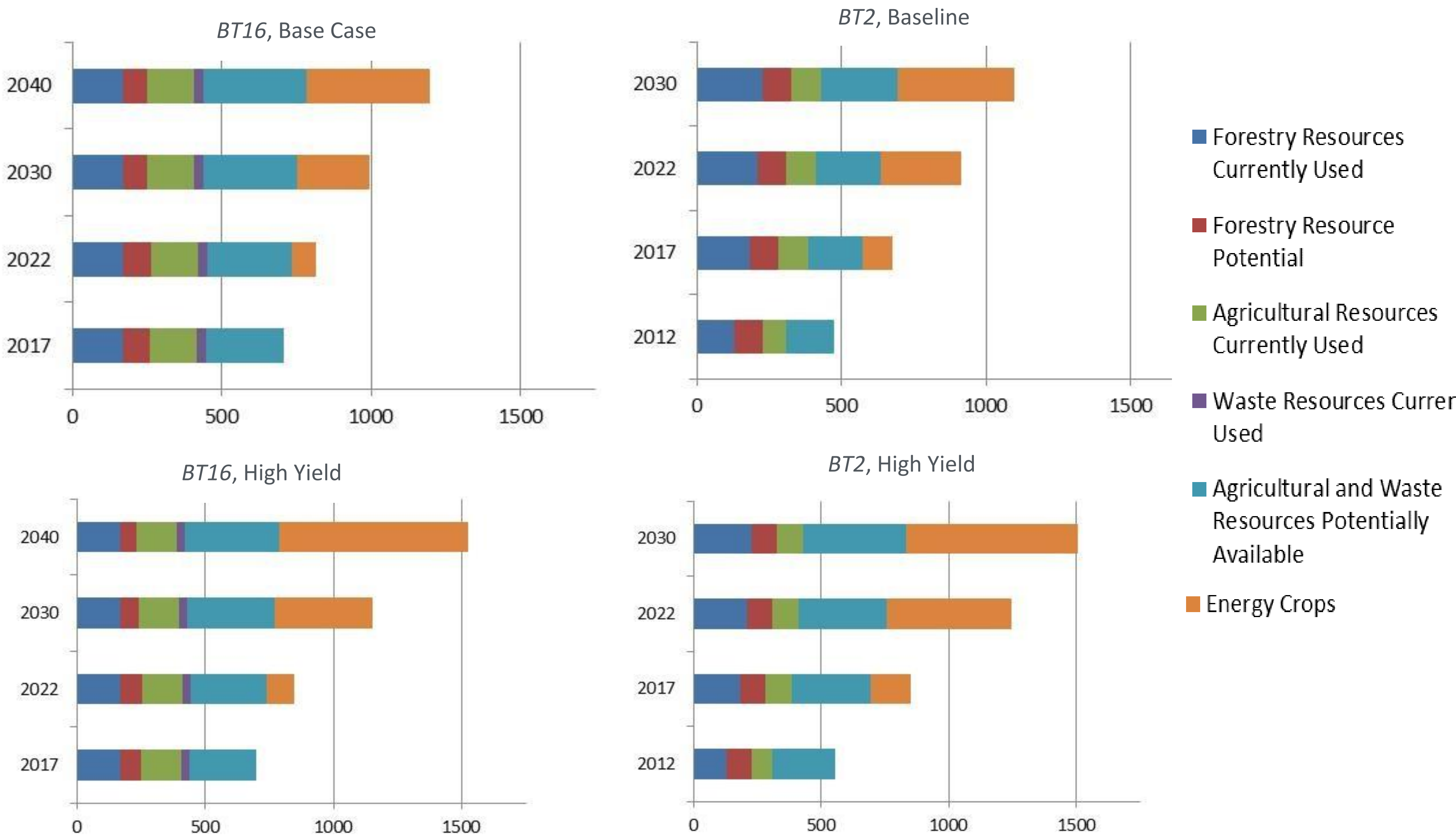
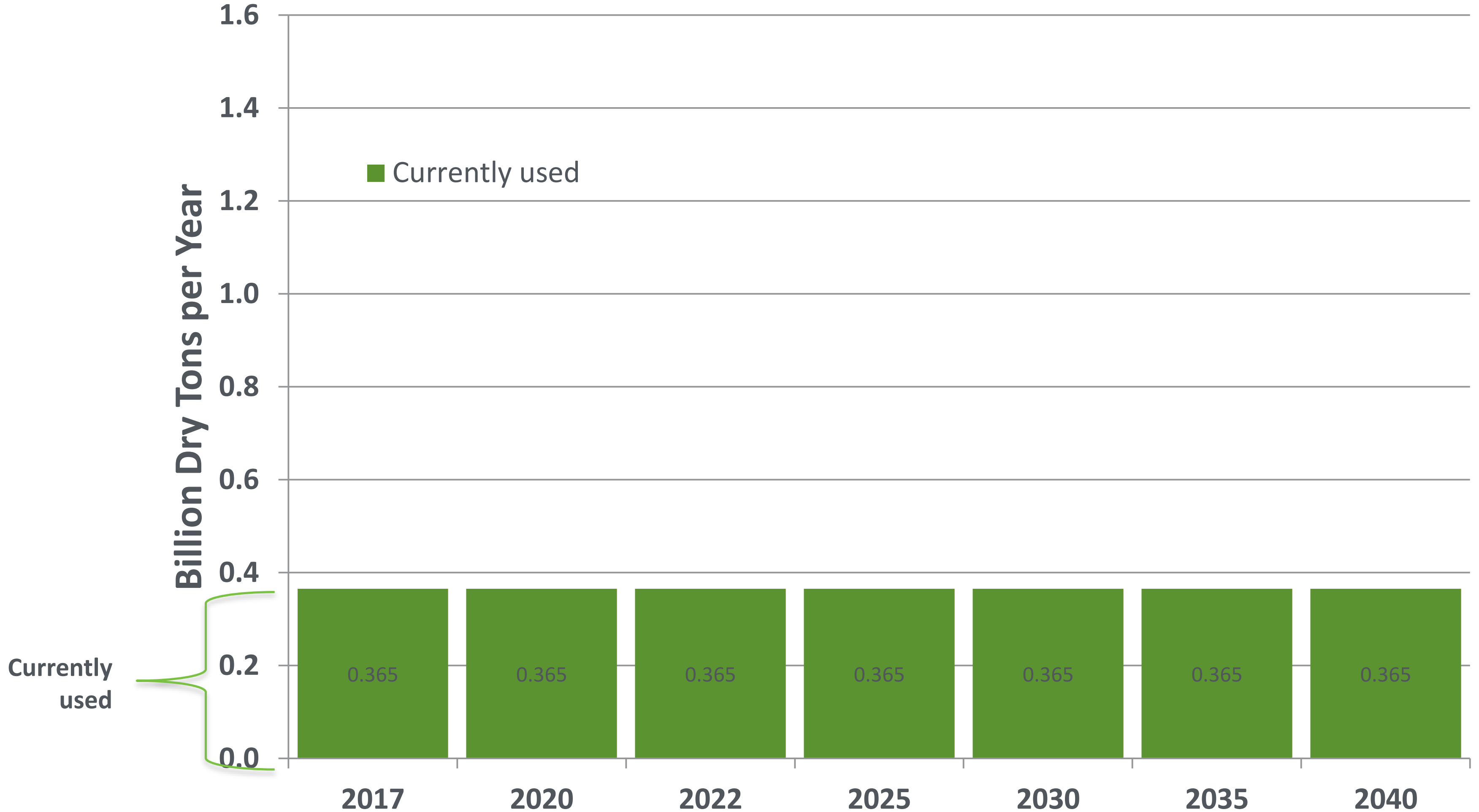
Similar potential as 2011 *BT2*

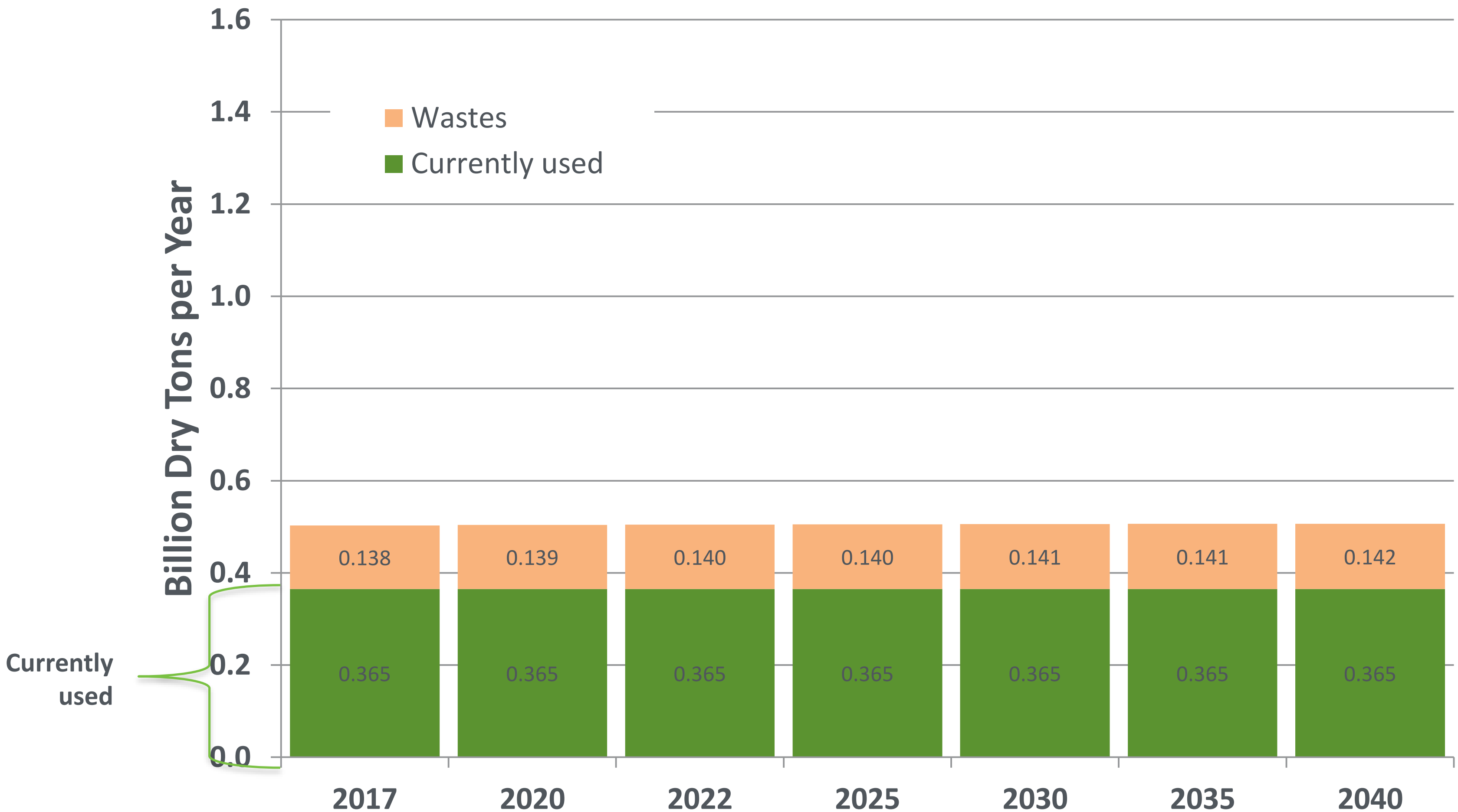


Current and Potential, Base Case



Currently used at market prices, potential supplies up to $60/dt (2014$)

Current and Potential, Base Case



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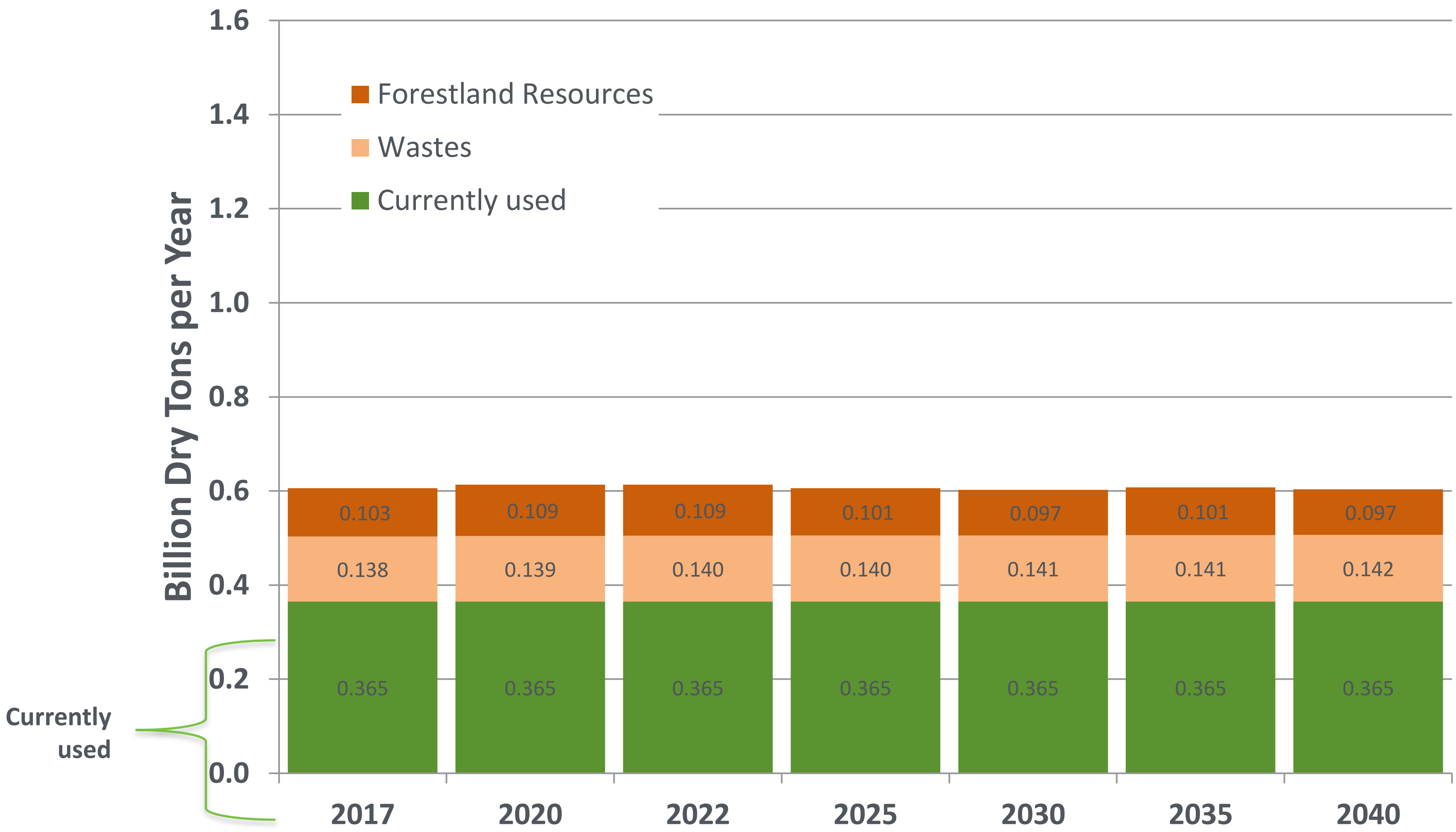

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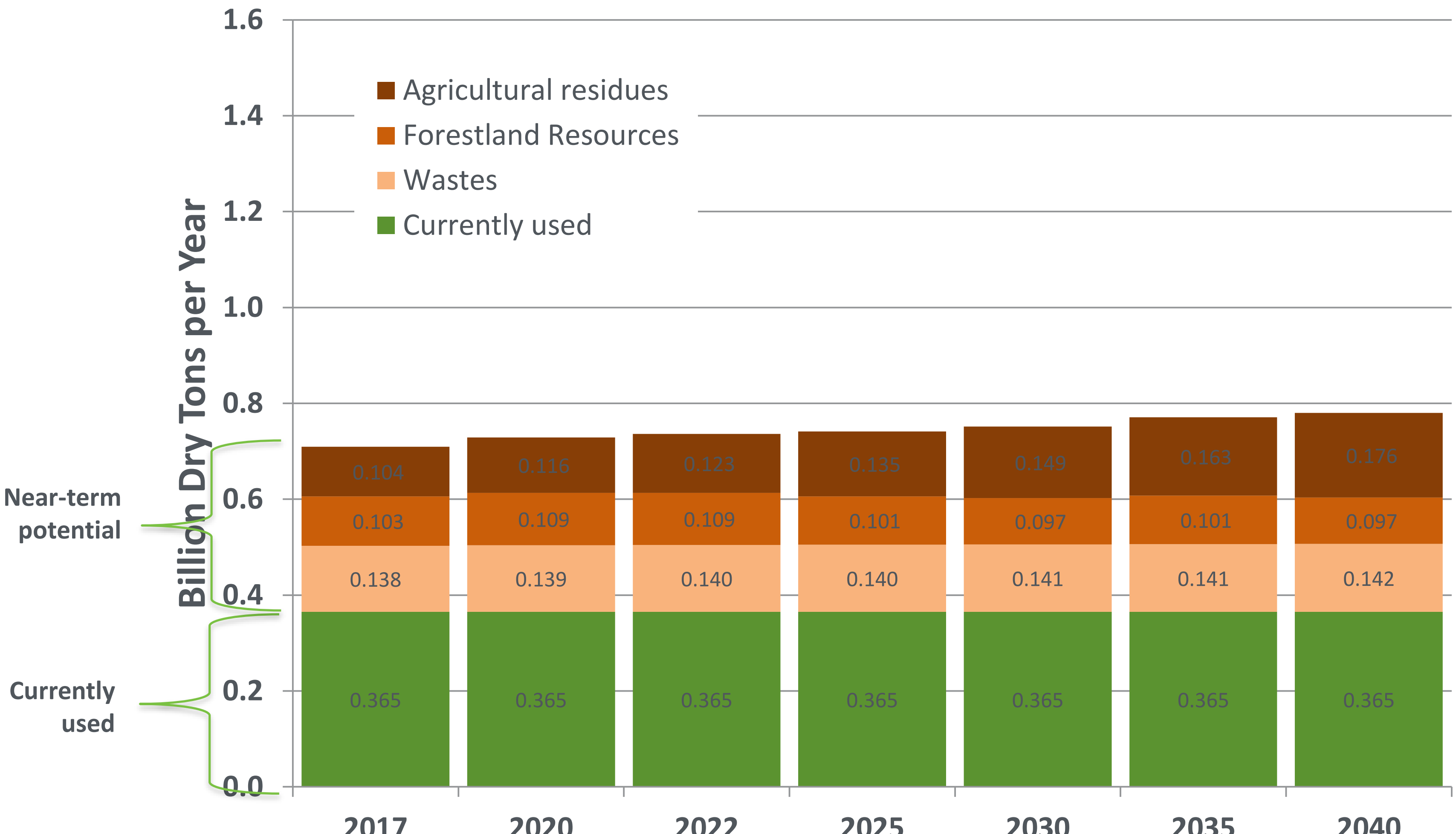

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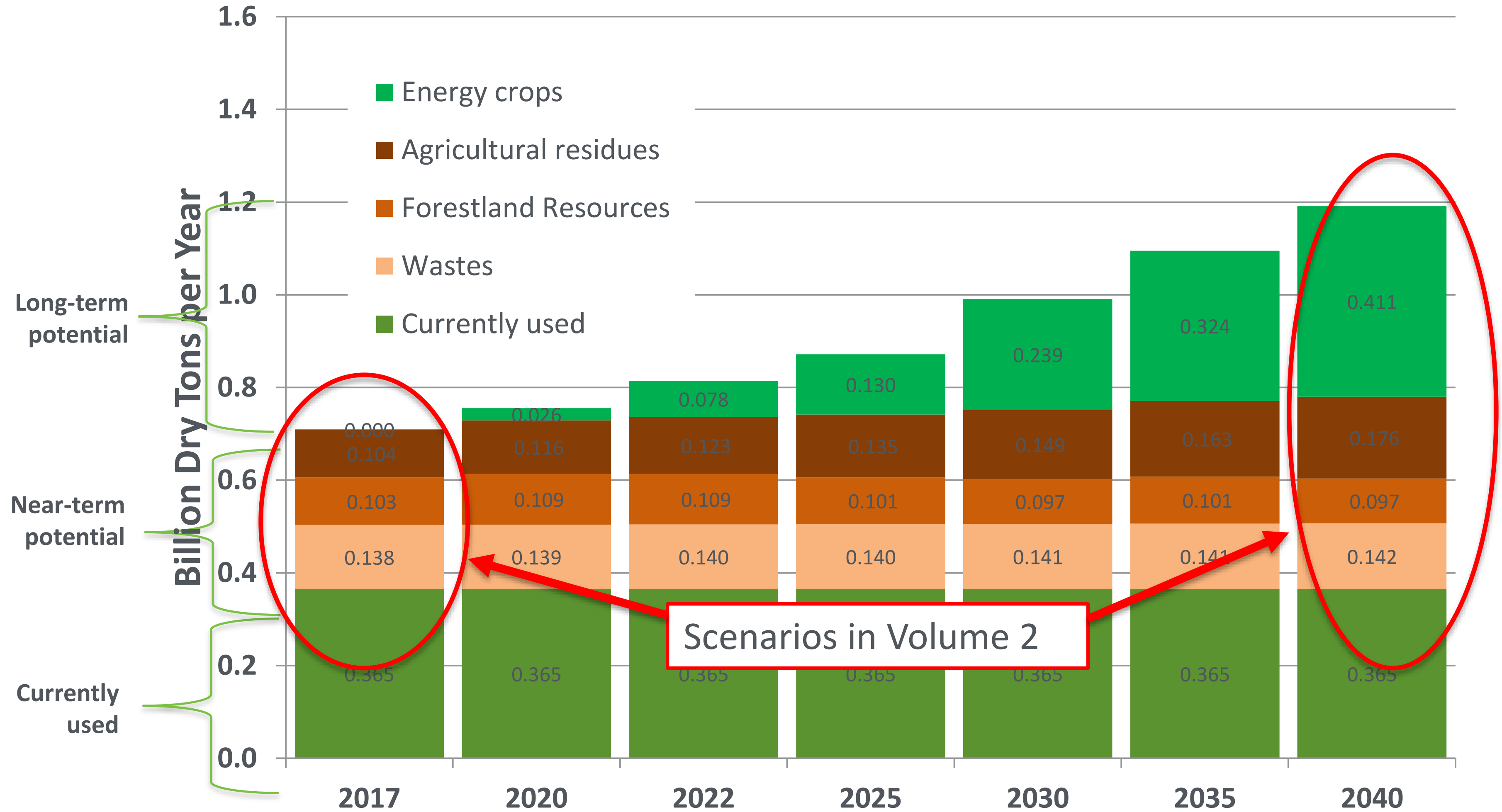
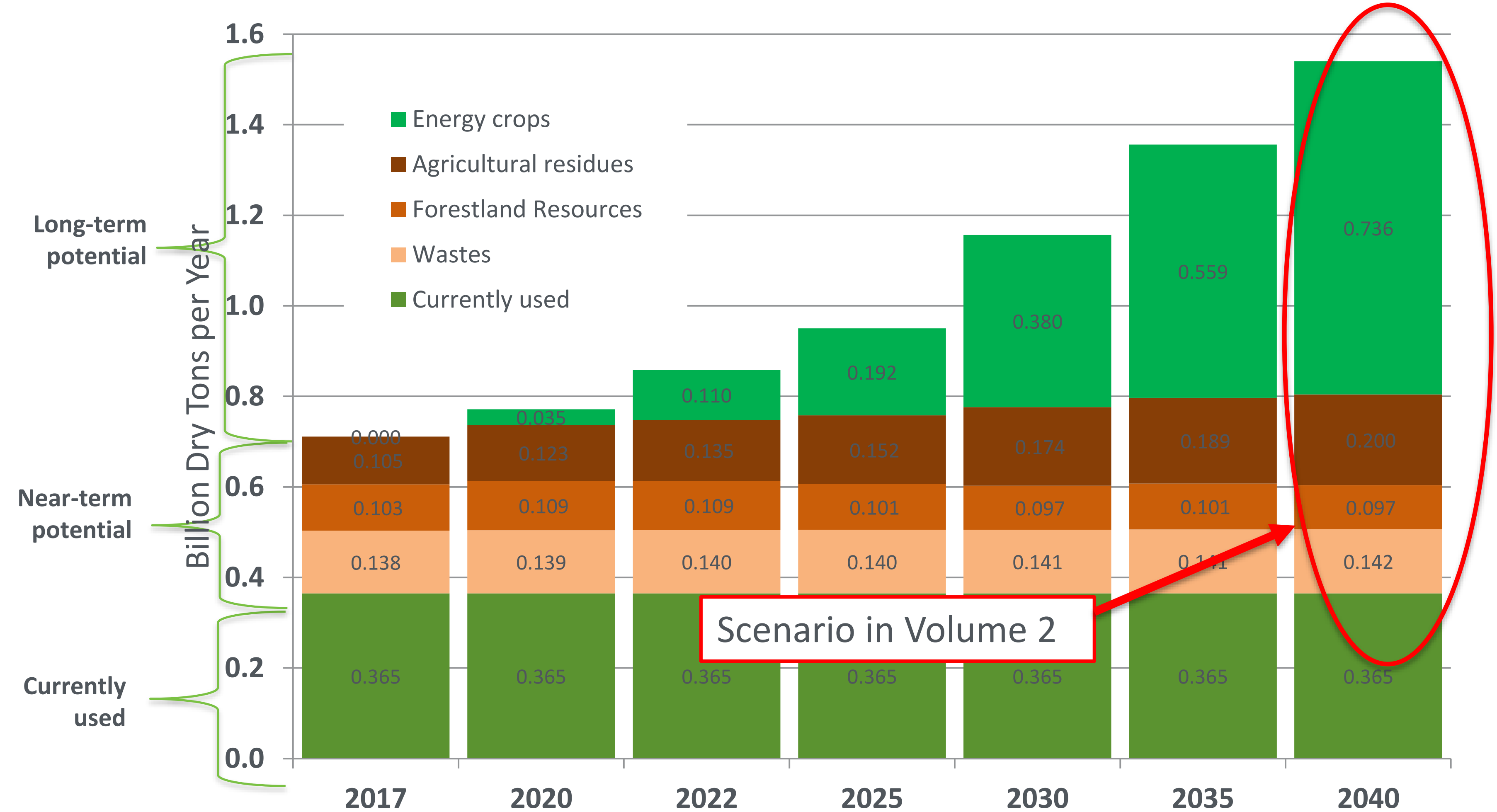


Currently used at market prices, potential supplies up to $60/dt (2014$)

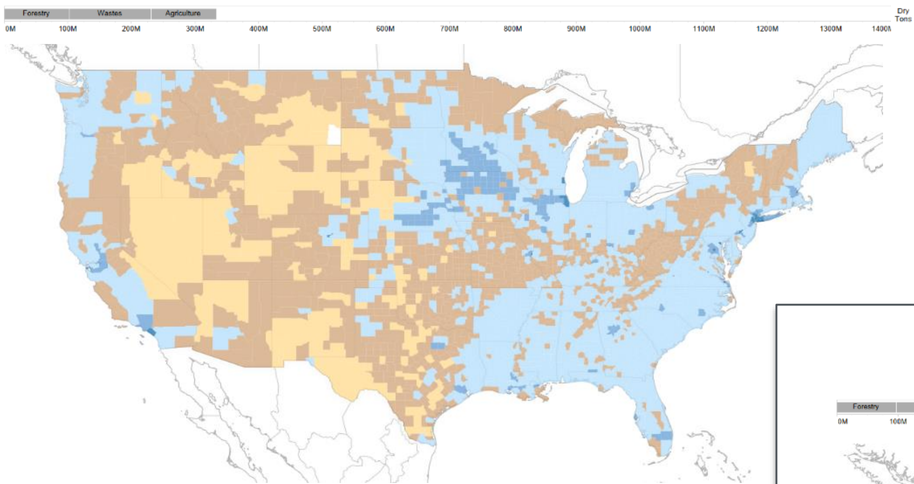
Current and Potential, High Yield Agriculture



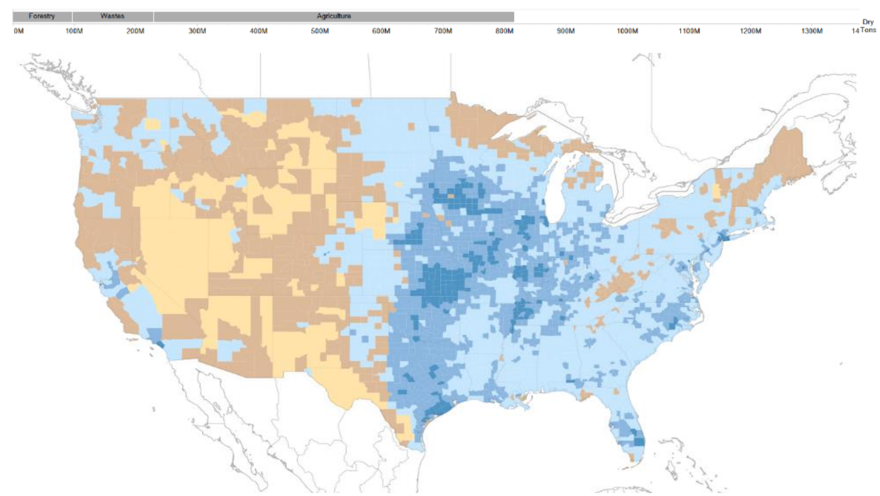
Currently used at market prices, potential supplies up to $60/dt (2014$)

Supplies vary spatially and temporally

Near-term potential (2017):



Long-term potential (2040, base case):



Dry tons/year

- Less than 10 dt/SqMile
- 10-100 dt/SqMile
- 100-500 dt/SqMile
- 500-1000 dt/SqMile
- Greater than 1,000 dt/SqMile

https://bioenergykdf.net/billionton2016/1/2/tableau

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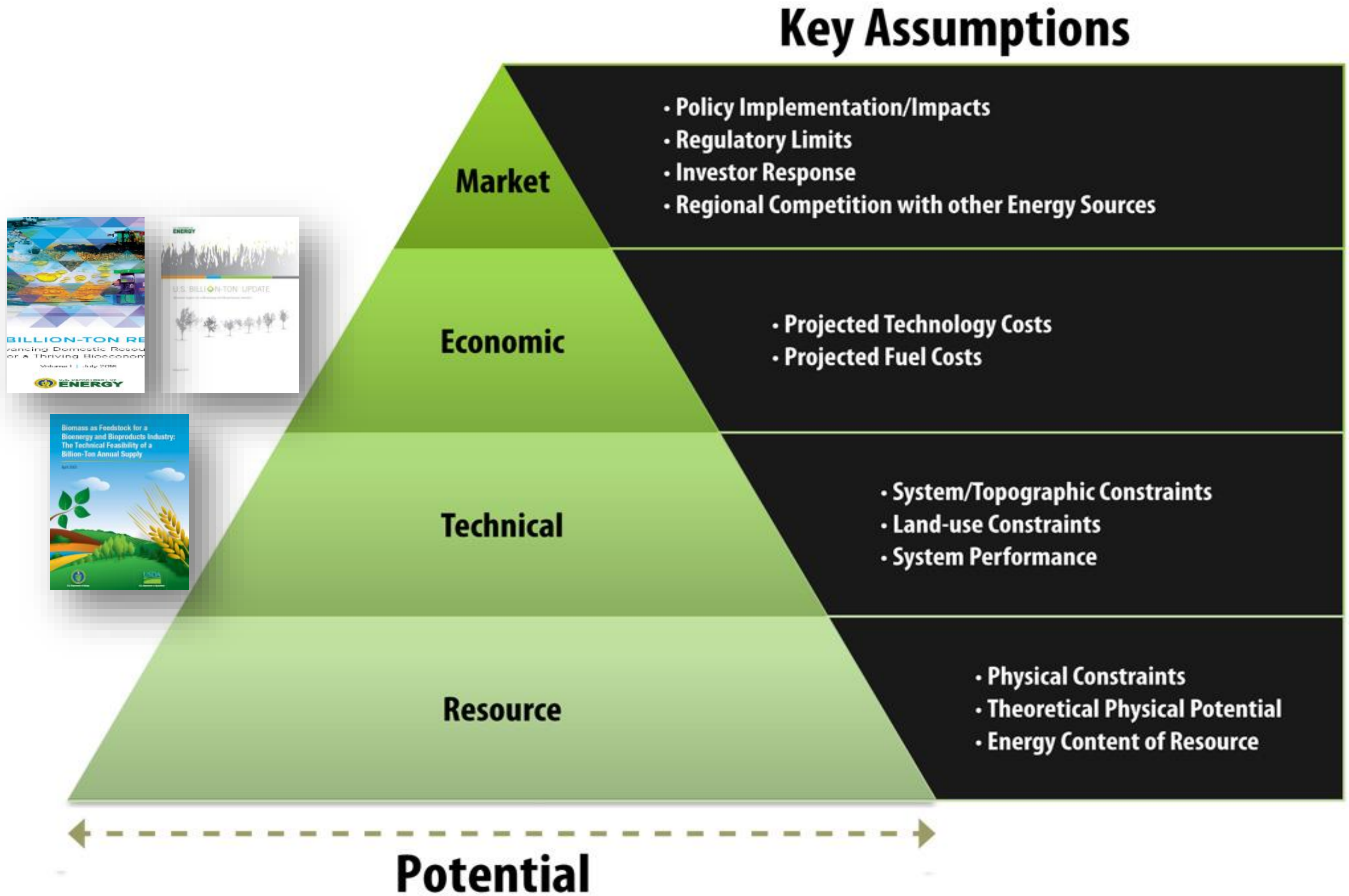
Advancing Resources



Adapted from DOE-EERE (2006) and NREL (2011). See also Batidzirai, Smeets, and Faaij (2012)

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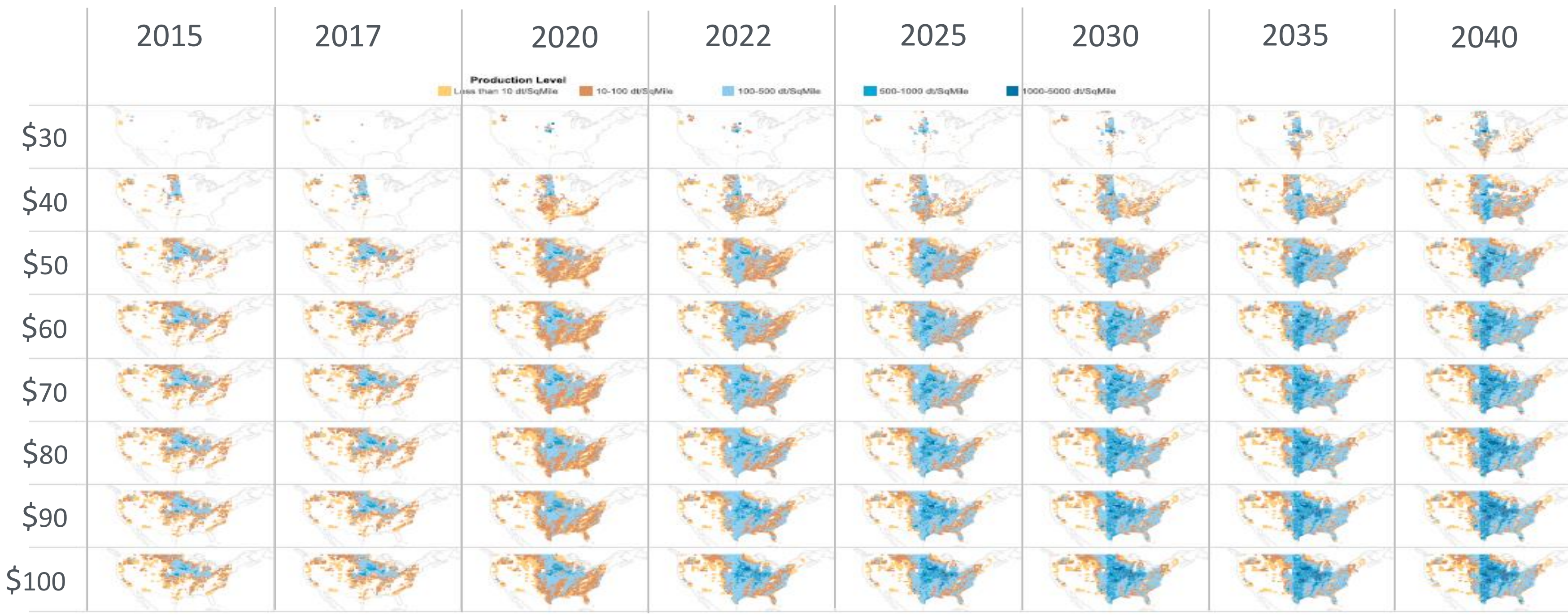
Advancing Resources

Supply push

Market pull



- Conversion
- Bioproducts
- International markets

- Crop improvement
- Advanced logistics
- Precision agriculture

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Volume 1 Key Conclusions

- Still have the potential for more than a billion tons of biomass available as early as 2030, and continues to increase to 2040
  - 1-1.2 billion tons in 2030 and 1.2-1.5 billion tons in 2040
- New insights into biomass accessibility, spatial and temporal distribution, and costs (to roadside/farmgate and to facility gate)
- About half of potential biomass can be produced and delivered at less than $84 per dry ton
- Forest resources are regionally specific, and subject to macroeconomic and local market forces
- Algae has substantial potential, but prices will need to decrease for that potential to be realized
- Potential biomass supply is contingent upon supply curve prices

Sustainability Constraints in BT16 - Agriculture

Sustainability assumption or constraint	Sustainability category	Implementation
Trend toward reduced till and no till for corn, wheat	Soil quality, water quality	Management assumptions
High fraction of crop acres no-till		Management assumptions
Residue removal prohibited on conventionally tilled acres		Management assumptions
Crop residue removal based on wind and water erosion estimates and soil carbon loss (nutrient replacement)		Residue removal tool used to estimate retention coefficients
No residue removal for soy		Management assumption
Acceptable residue removal different for reduced and no till		Residue removal tool to estimate retention coefficients
Multi-county NRCS crop management zones (e.g., tillage assumptions)		Spatially explicit rotation and management assumptions
Annual energy crops on land with low erosion potential and assumed part of multi-crop rotation		Excluded land area
Irrigated cropland or pasture excluded	Water quantity	Excluded land area
No supplemental irrigation of energy crops		Management assumptions
No use of pastureland in counties west of 100th meridian		Excluded land area
No transition of non-agricultural lands to energy crops	Greenhouse gas emissions	Excluded land area

Sustainability Constraints in BT16 - Forestry

Sustainability assumption or constraint	Sustainability category	Implementation
No road building – all stands had to be within half mile of low-grade logging road	Soil quality, water quality	Management assumptions
Acceptable residue removal for logging residues (70%)	Soil quality, water quality	Management assumptions
No biomass removal in wet areas to avoid soil compaction	Soil quality	Excluded land area
No production in administratively reserved forestlands, such as wilderness areas, National Parks, or roadless areas	Biodiversity	Excluded land area
Annual harvest can not exceed annual growth	Biodiversity	Excluded land area
Best management practices were assumed to be used by adding costs for compliance	Several, but primarily water quality	Management

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BT16 Volume 2 Outline

Volume 2

- Soil Carbon and Greenhouse Gas Emissions (Agriculture and Forestry)
- Water Quantity for Forestry
  Water Quality for Forestry
  Water Quality for Agriculture
- Biodiversity for Agriculture and Forestry
- Air Quality (Agriculture and Forestry)
- Climate Variability and Climate Change Impacts on Feedstock Productivity
- Land Use Change and Indirect Effects
- Strategies to Enhance Environmental Sustainability
- Qualitative Analysis of Environmental Sustainability of Algae

Volume 2 – Main Objective and Research Questions

Main Objective: Assess environmental effects of potential agricultural and forest biomass produced in select 2017 and 2040 scenarios from volume 1

- Potential availability in 2017
- Potential availability in 2040 (base case scenario)
- Potential availability in 2040 (high yield scenario)

Research questions

- What are the simulated values of environmental indicators and how do those compare among the above scenarios?
- What environmental benefits are possible from expansion of biomass for energy, and under what conditions do they occur?
- What are the potential negative effects, and how might they be managed or mitigated?
- Where is more research needed with regard to quantifying effects, enhancing benefits, and preventing negative consequences?

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Summary

- Resource assessments indicate vast national sustainable potential, over 1 billion tons/yr.
- Future biomass utilization is a function of supply and demand interactions.
- Resource assessments can help evaluate impacts of supply push and market pull and inform strategies to increase biomass utilization.
- Future research should advance from “how much is there” to “how can it happen”.

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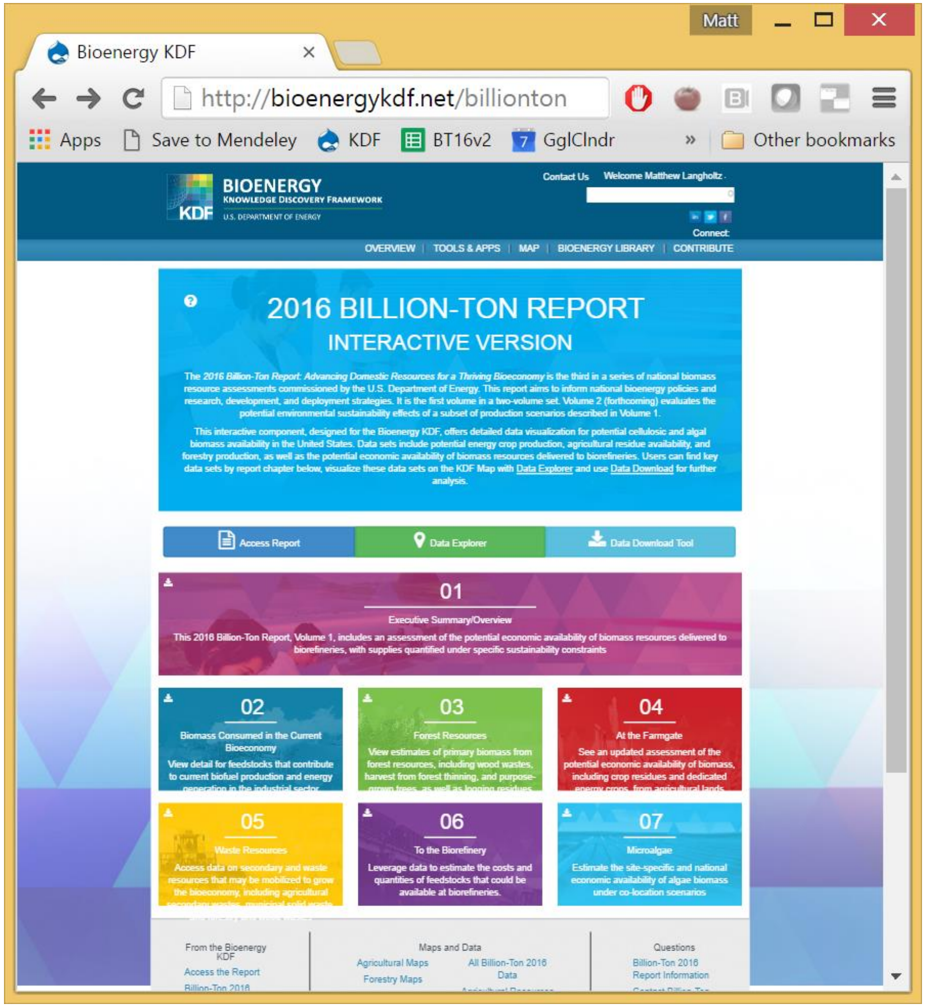

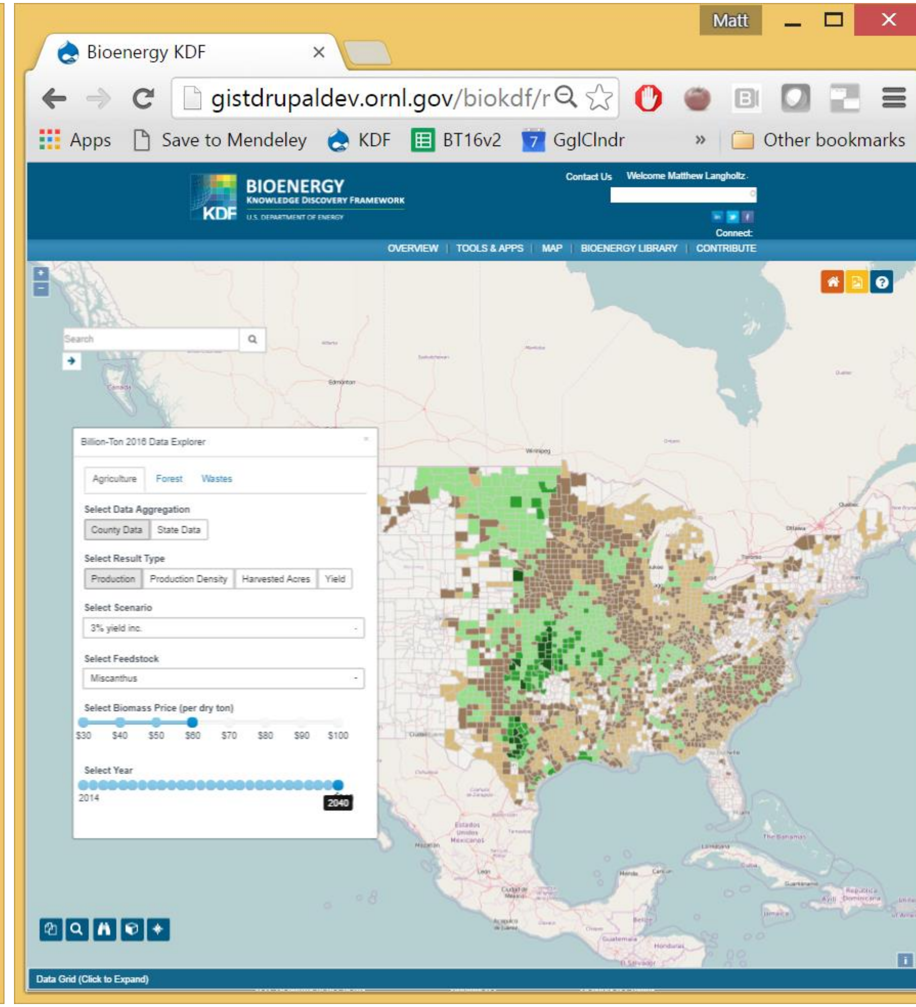

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Contact Information

Questions?

Contact EERELegAffairs@ee.doe.gov

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