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

MGA Webinar

July 20, 2017

OAK RIDGE National Laboratory

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

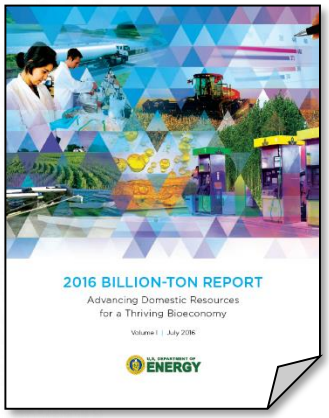
Outline

- Currently used resources
- Additional available and potentially available resources
- Advancing resources
- Environmental effects and Bioenergy KDF online data discovery tools

Contributors

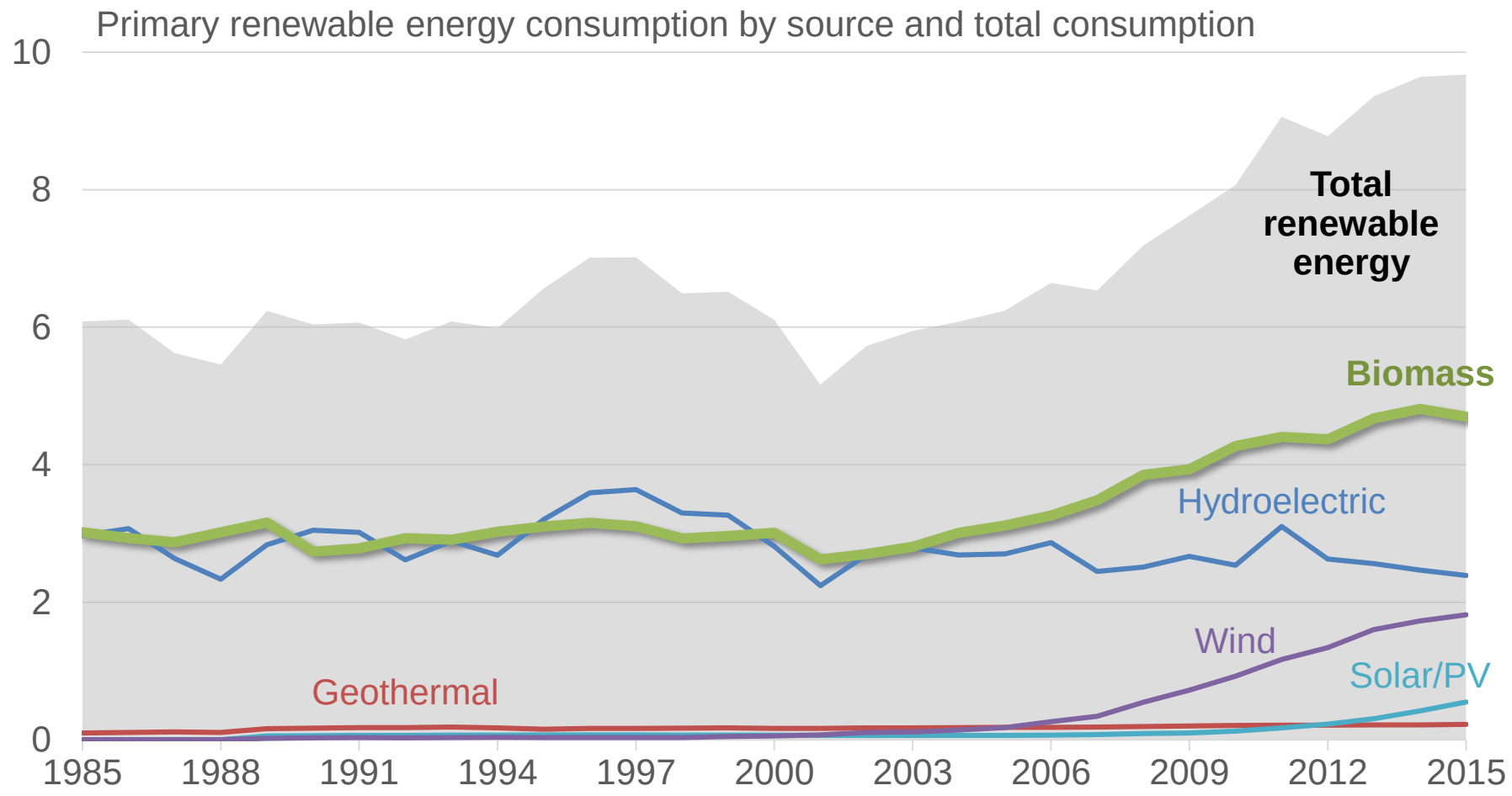
Why a third assessment?

- Update to latest available economic and agricultural baseline
- Expand to new feedstocks
- Examine availability of delivered feedstocks

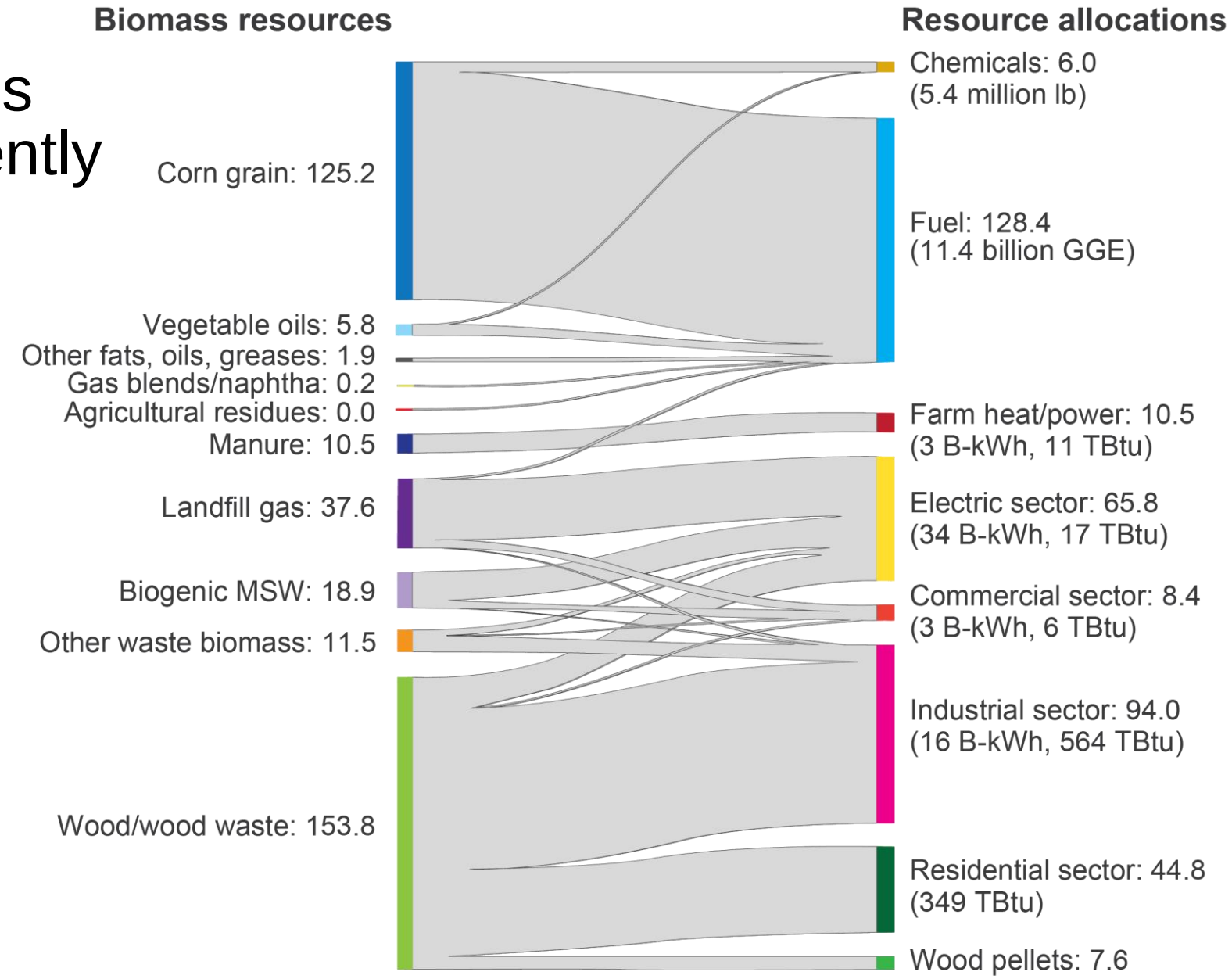


BT16

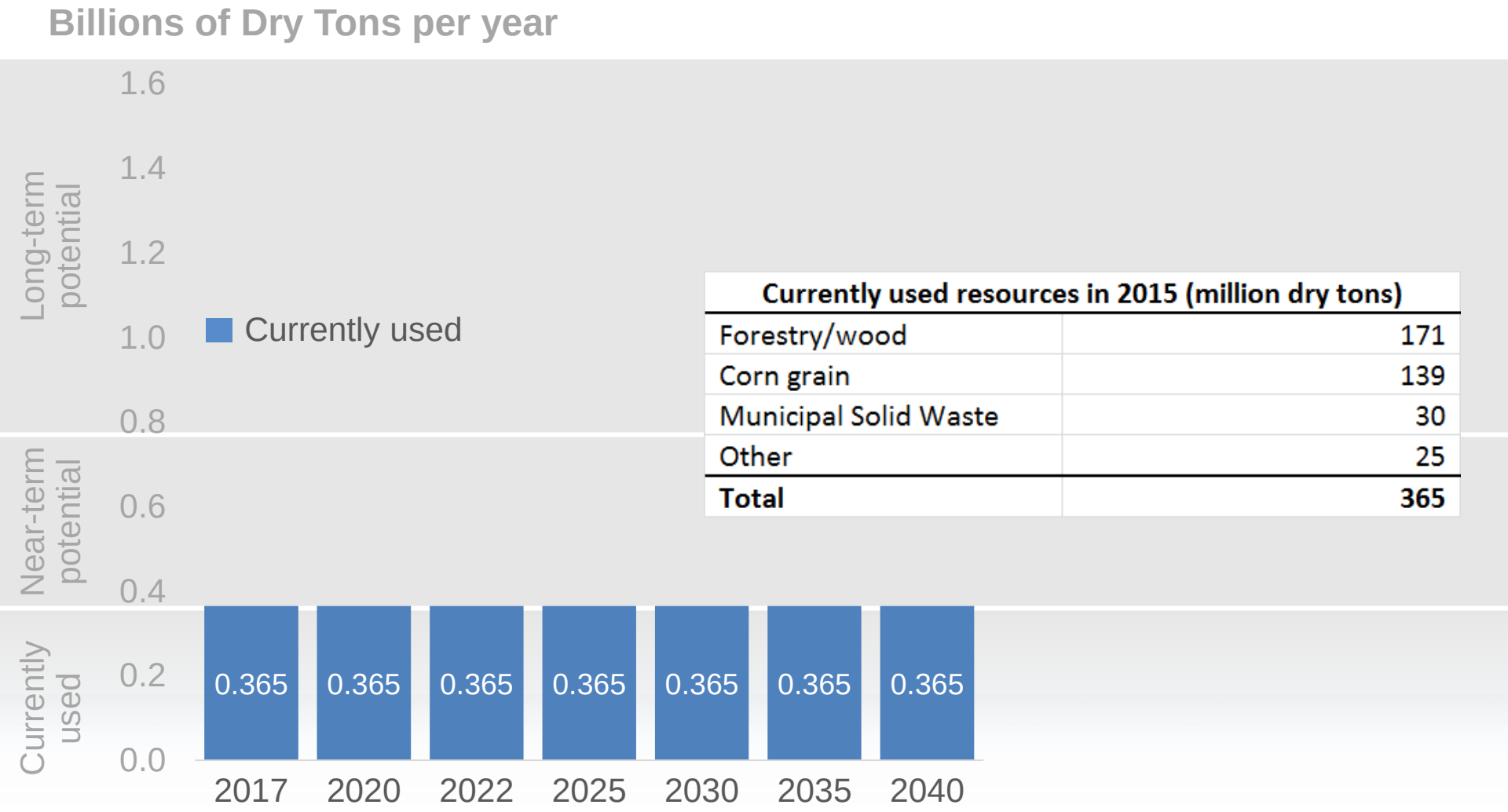
Biomass is our largest source of domestic renewable energy



How biomass is currently used

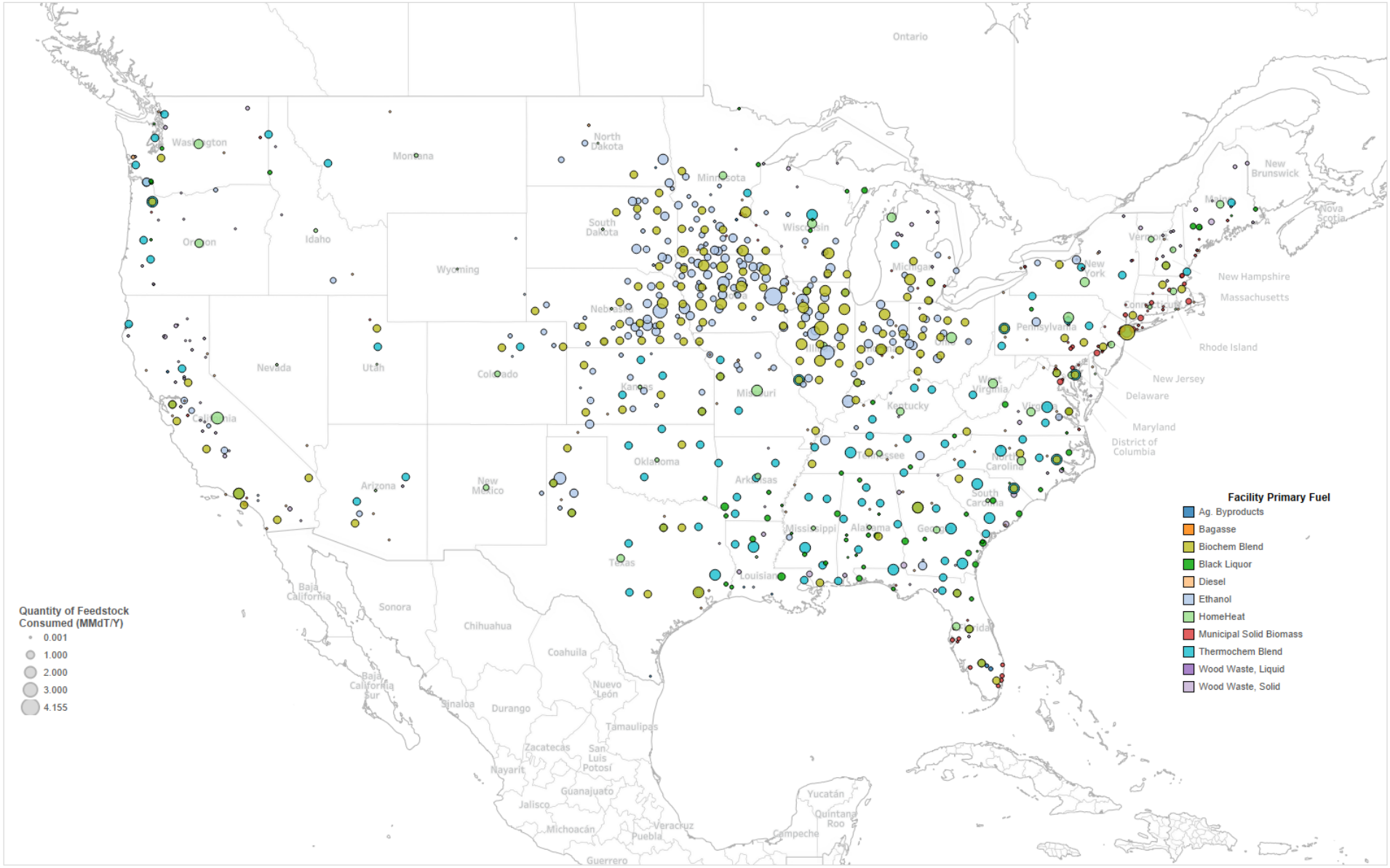


Current and Potential, Base Case



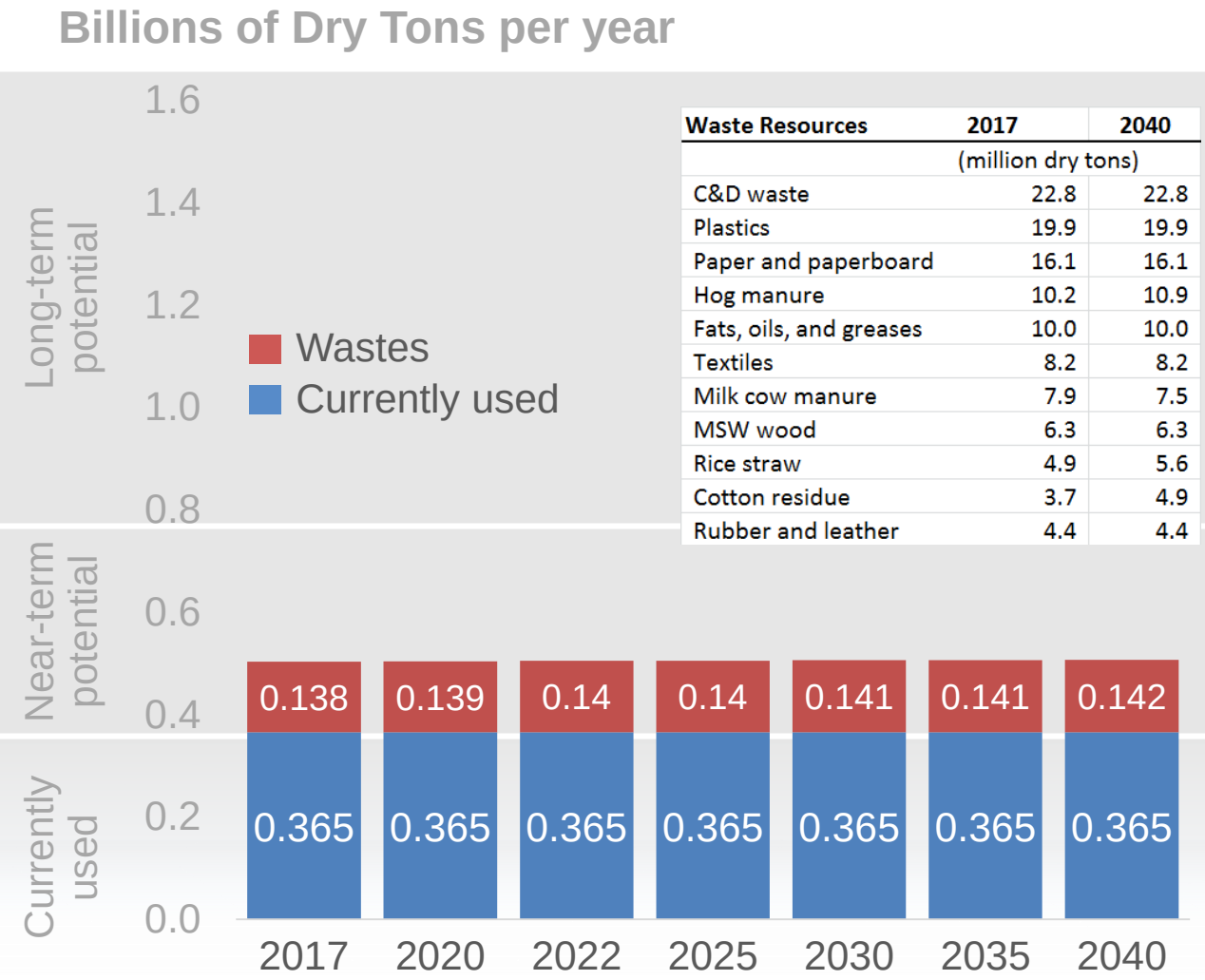
Currently used resources in 2015 (million dry tons)	
Forestry/wood	171
Corn grain	139
Municipal Solid Waste	30
Other	25
Total	**365**

Biomass-to-Energy Facilities (2014)



Please cite as: U.S. Department of Energy. 2016. 2016 Billion-Ton Report: Advancing Domestic Resources for a Thriving Bioeconomy, Volume 1: Economic Availability of Feedstocks. M. H. Langholtz, B. J. Stokes, and L. M. Eaton (Leads), ORNL/TM-2016/160. Oak Ridge National Laboratory, Oak Ridge, TN. 448p. doi: 10.2172/1271651.

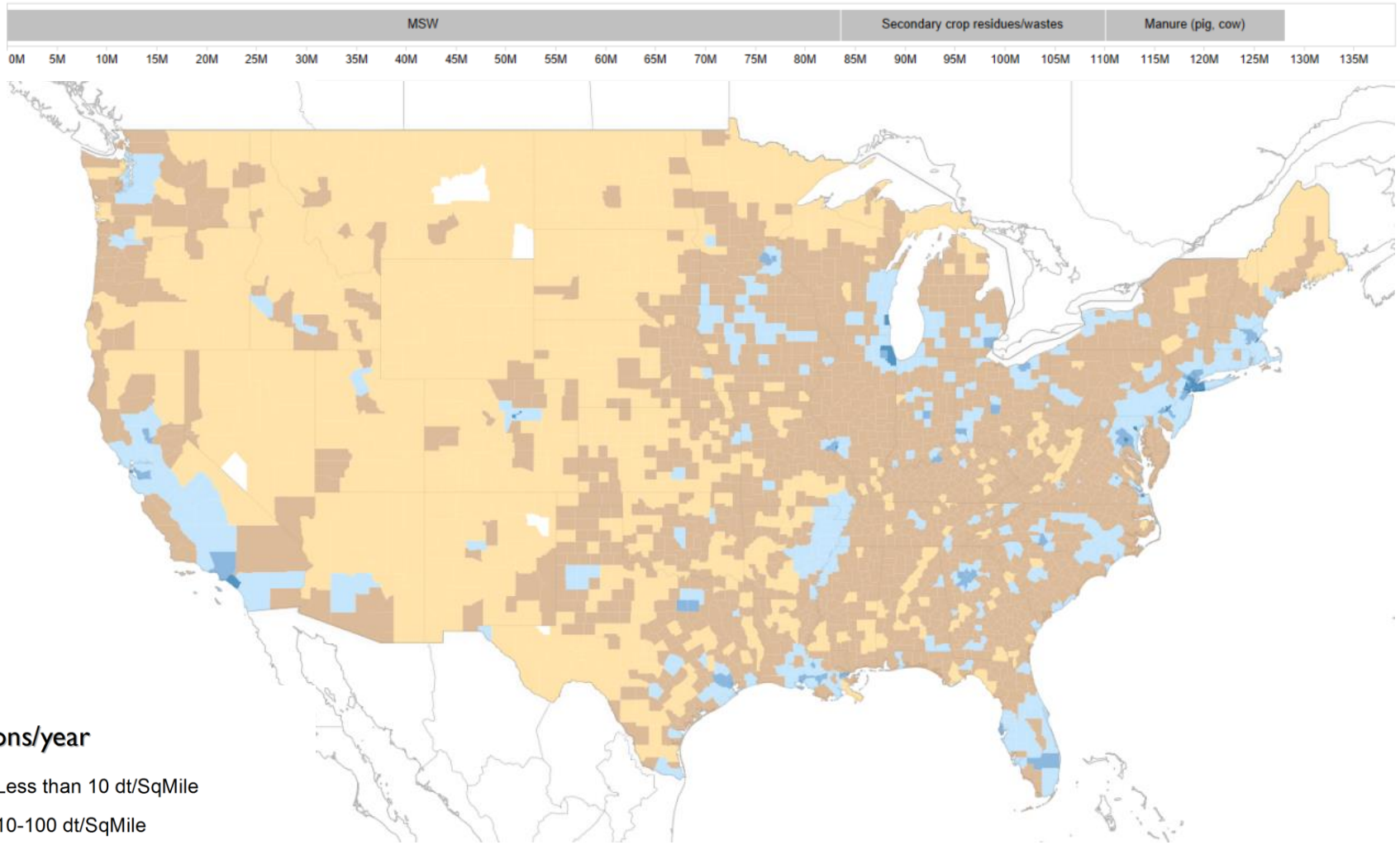
Current and Potential, Base Case at $60/dt



Waste Resources	2017	2040
	(million dry tons)	
C&D waste	22.8	22.8
Plastics	19.9	19.9
Paper and paperboard	16.1	16.1
Hog manure	10.2	10.9
Fats, oils, and greases	10.0	10.0
Textiles	8.2	8.2
Milk cow manure	7.9	7.5
MSW wood	6.3	6.3
Rice straw	4.9	5.6
Cotton residue	3.7	4.9
Rubber and leather	4.4	4.4

Waste Resources	2017	2040
	(million dry tons)	
Secondary mill residue	4.1	4.1
Sugarcane bagasse	3.6	3.8
Yard trimmings	3.3	3.3
Noncitrus residues	2.5	2.7
Other	2.6	2.6
Cotton gin trash	1.7	2.1
Tree nut residues	1.5	1.6
Citrus residues	1.5	1.6
Rice hulls	1.4	1.6
Sugarcane trash	1.0	1.0
Primary mill residue	0.5	0.5
Total	**138**	**142**

Base-case scenario, $60 offered price, waste resources, year 2017



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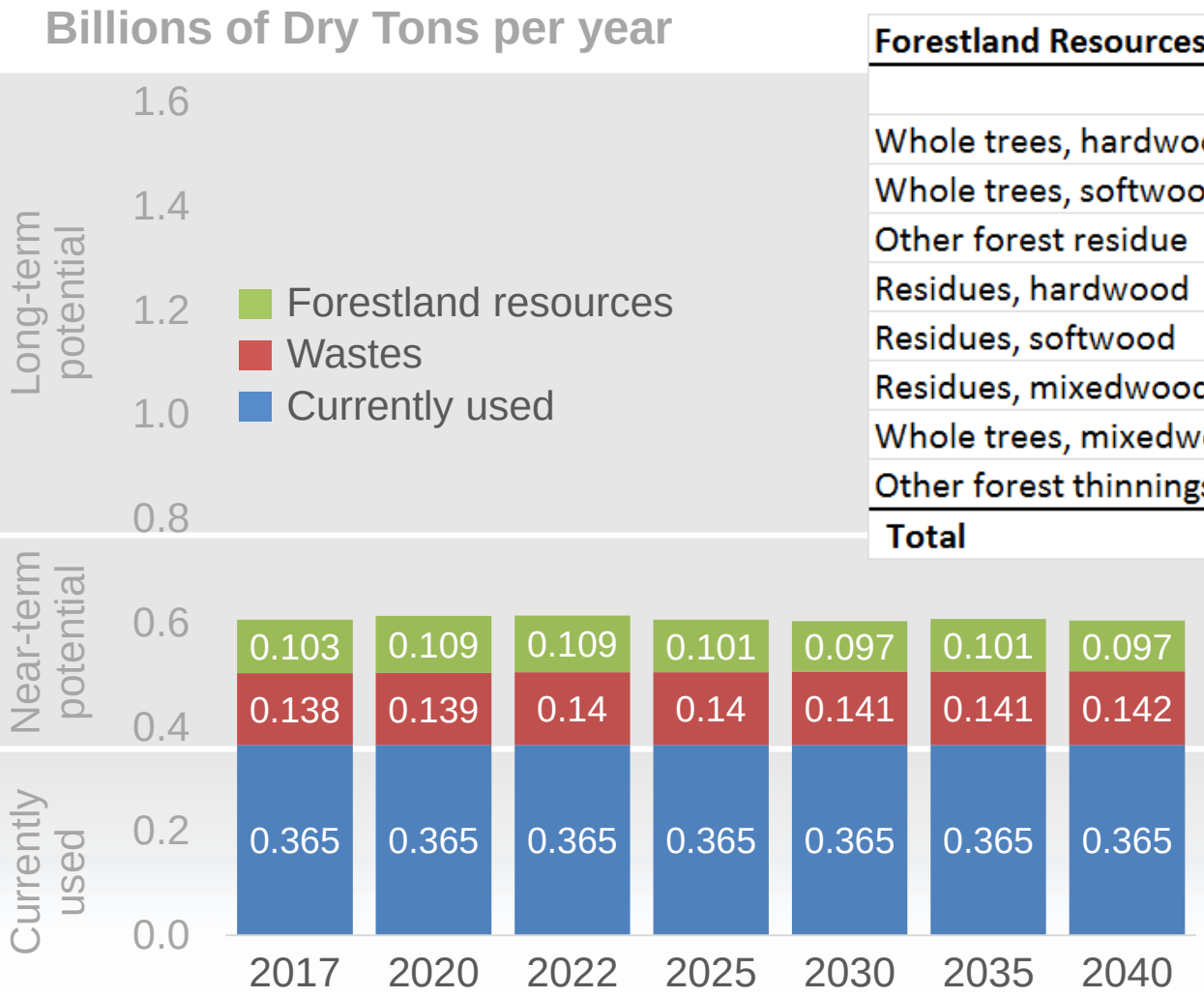
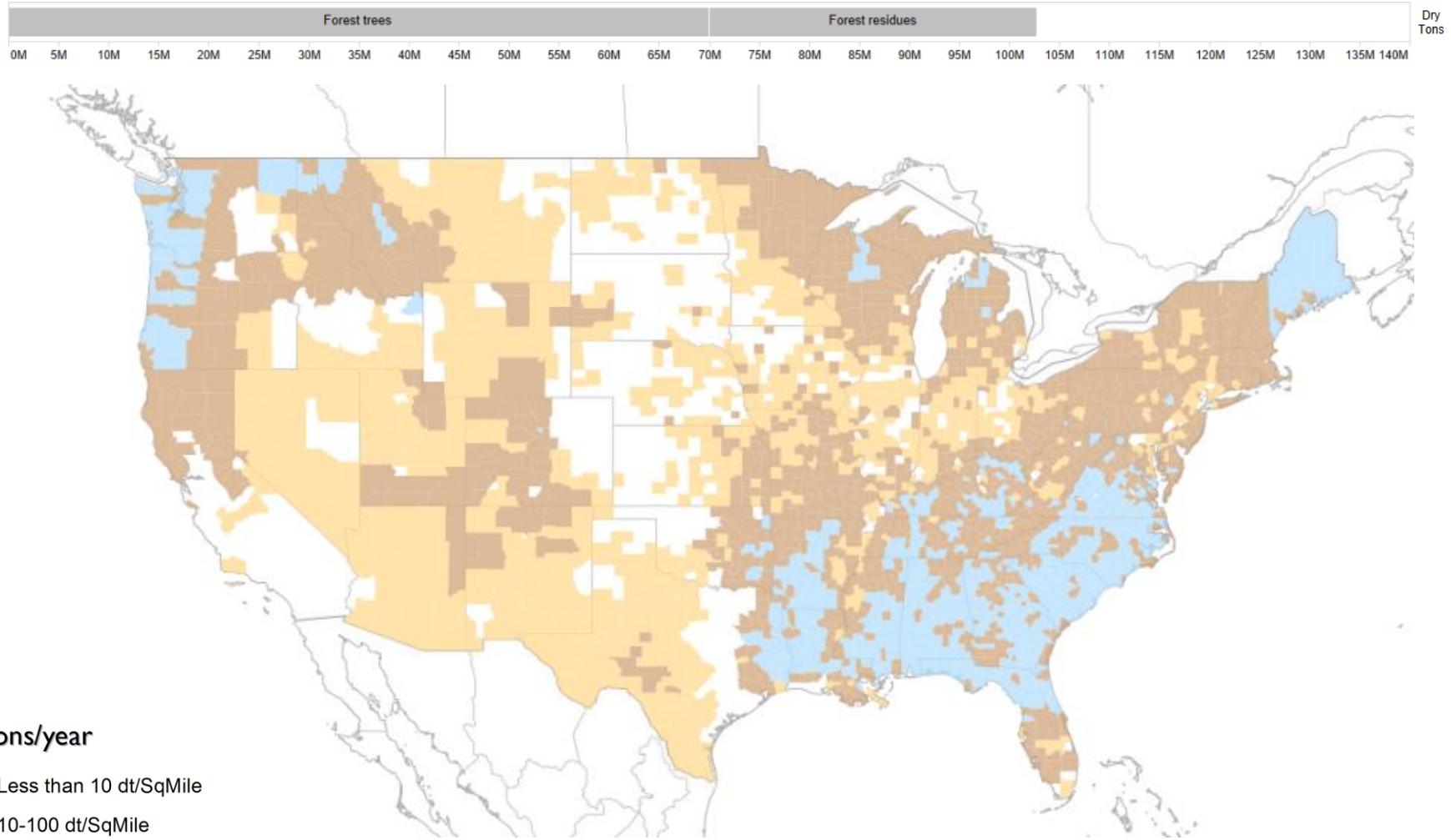
Current and Potential, Base Case at $60/dt



Forestland Resources	2017	2040
	(million dry tons)	
Whole trees, hardwood	39.0	24.9
Whole trees, softwood	28.1	33.4
Other forest residue	12.2	13.0
Residues, hardwood	6.9	8.0
Residues, softwood	6.8	10.0
Residues, mixedwood	4.2	2.7
Whole trees, mixedwood	2.8	2.4
Other forest thinnings	2.6	2.6
Total	**103**	**97**

Base-case scenario, $60 offered price, forestry resources, year 2017



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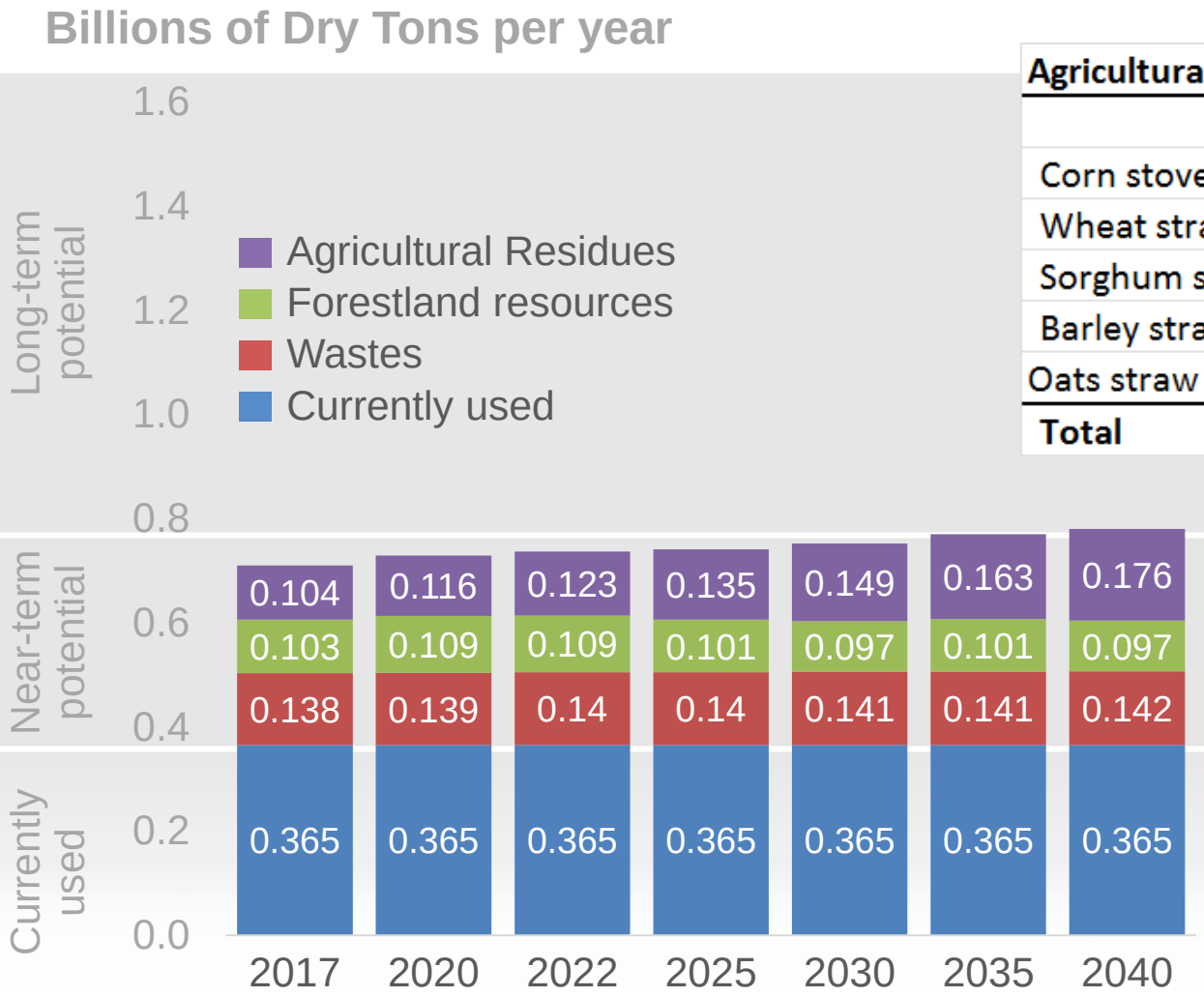
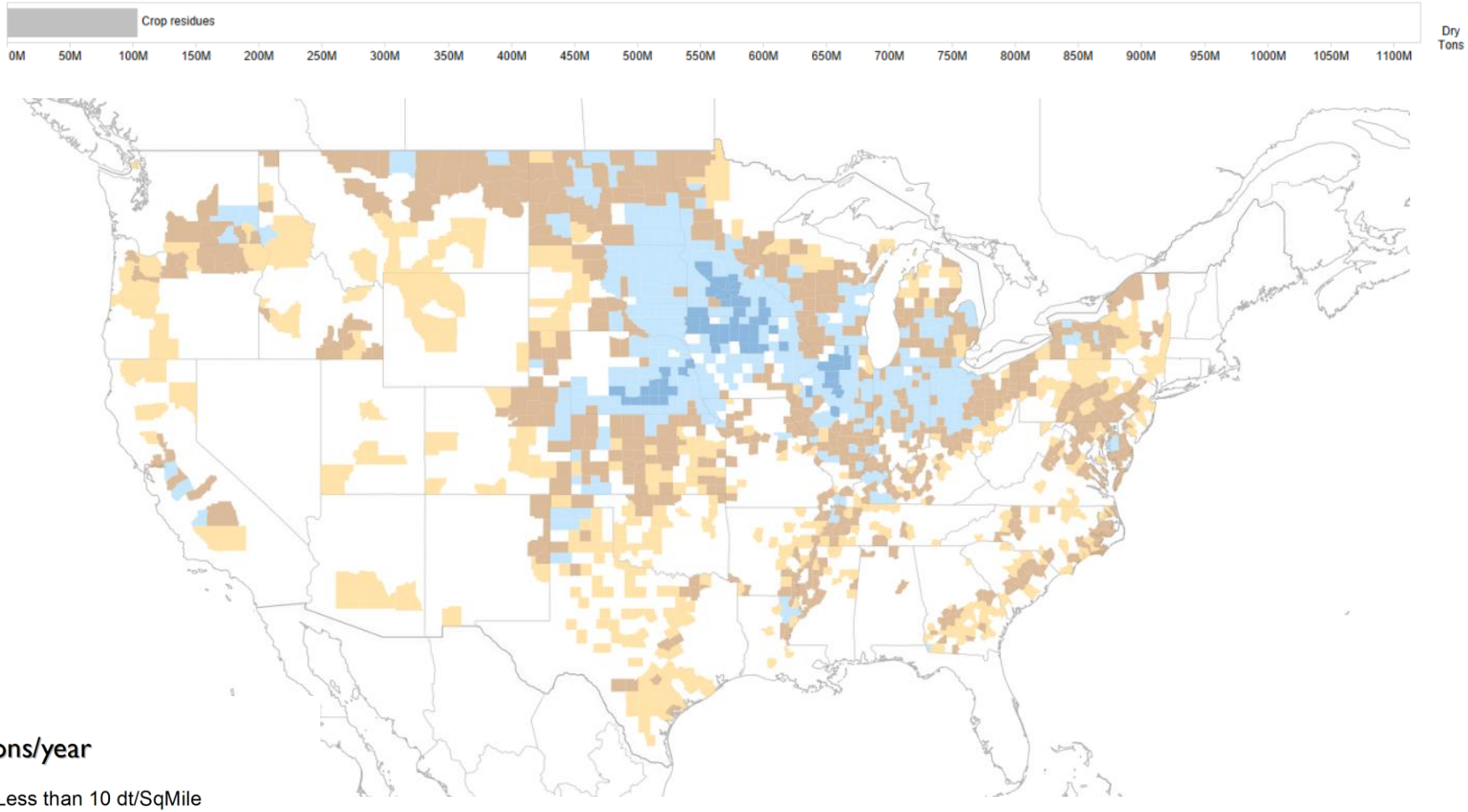
Current and Potential, Base Case at $60/dt



Agricultural Residues	2017	2040
	(million dry tons)	
Corn stover	89.4	153.9
Wheat straw	13.0	20.9
Sorghum stubble	0.7	1.1
Barley straw	0.4	0.6
Oats straw	<0.1	<0.1
Total	**104**	**176**

Base-case scenario, $60 offered price, agricultural resources, year 2017



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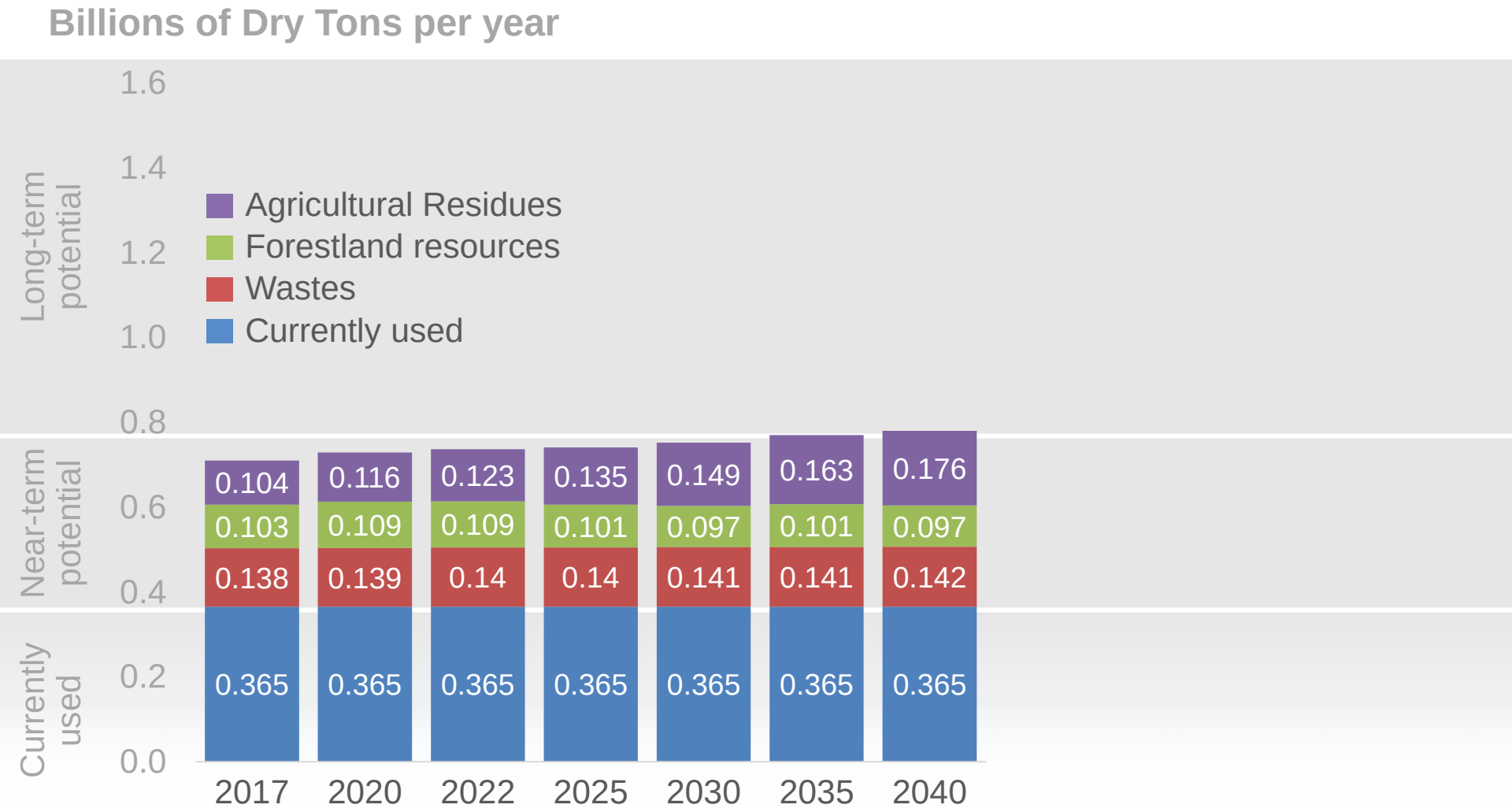
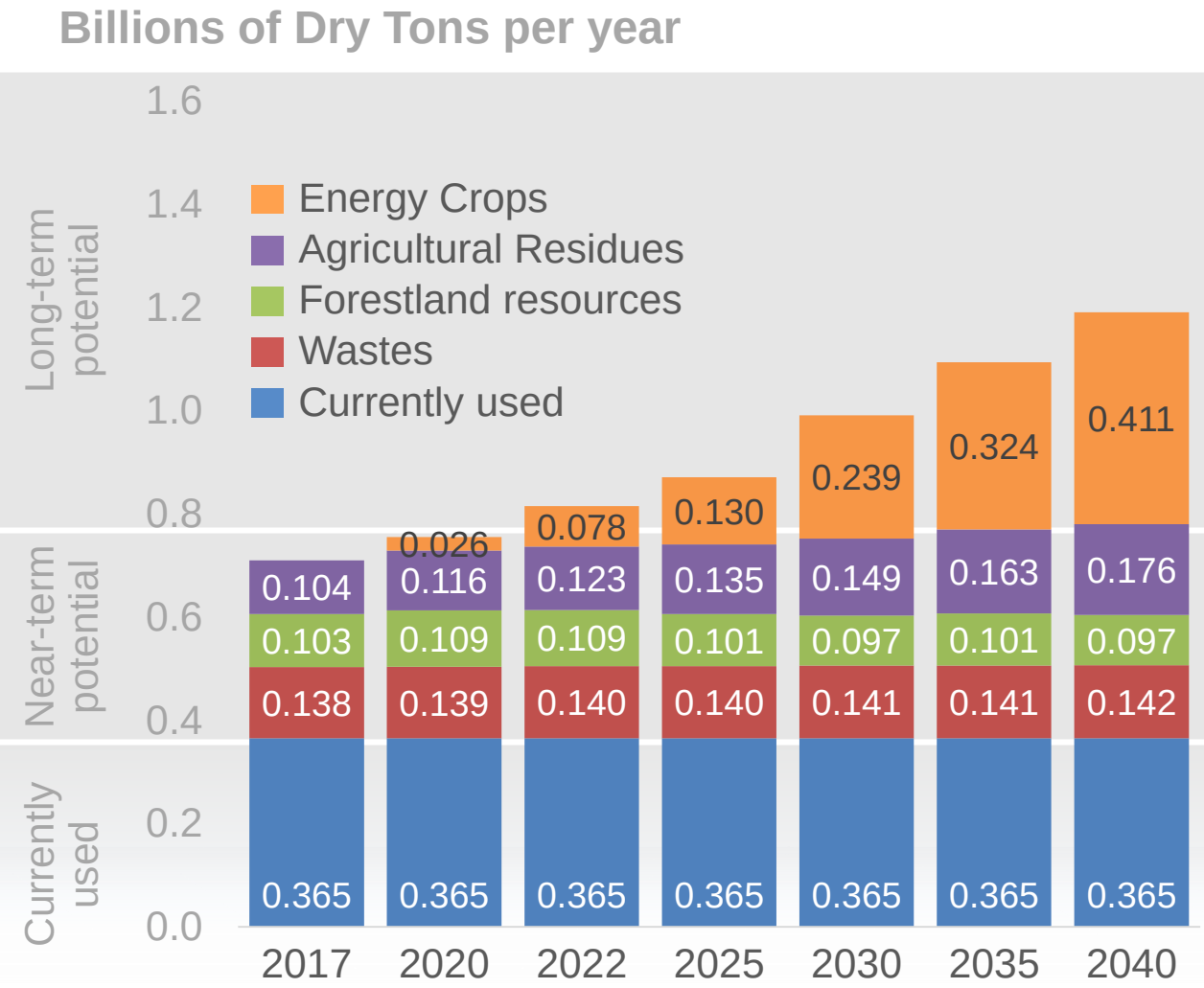
Current and Potential, Base Case at $60/dt

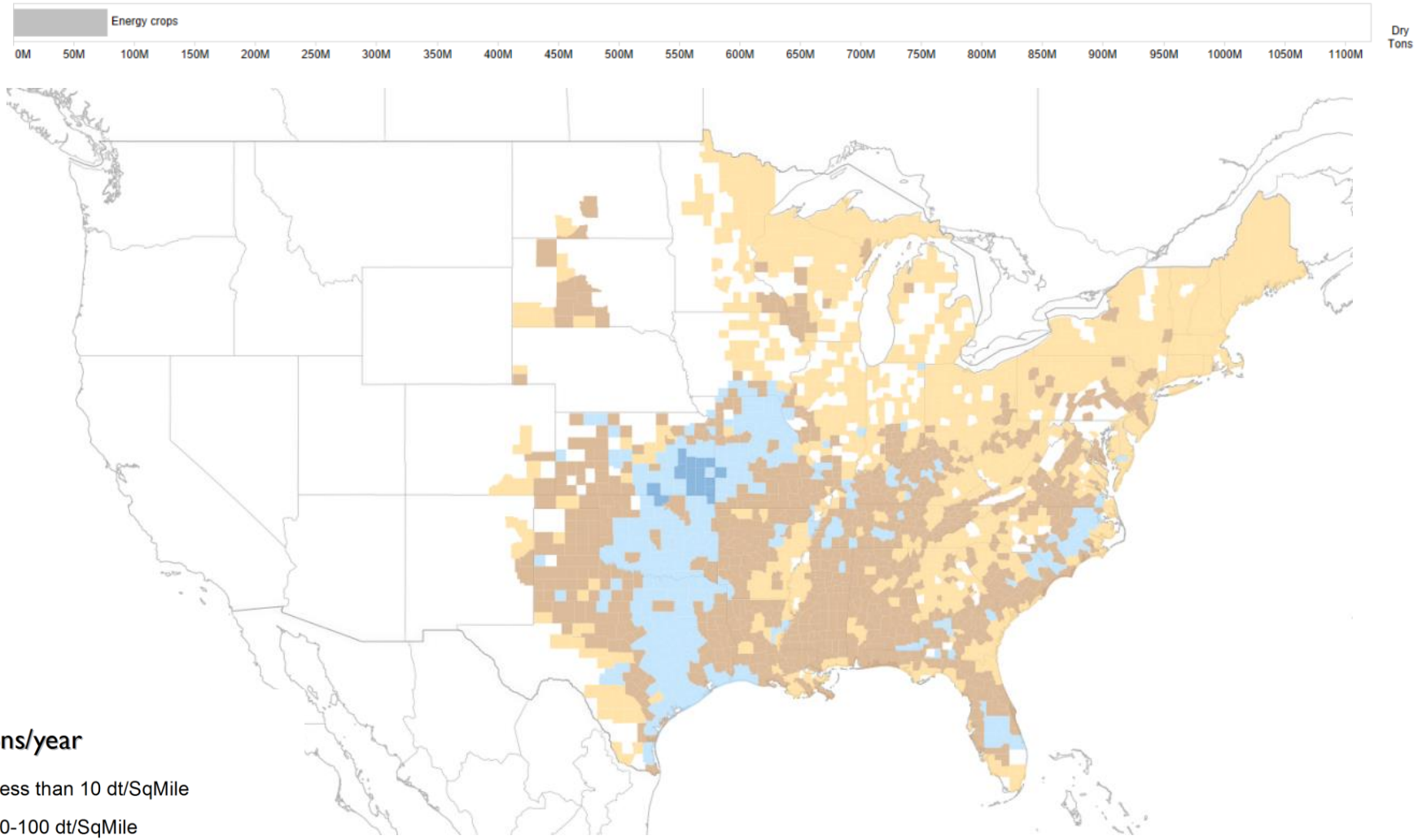


Current and Potential, Base Case at $60/dt



Energy crops	2017	2040
	(million dry tons)	
Switchgrass	-	160.5
Miscanthus	-	160.0
Poplar	-	44.9
Willow	-	25.1
Biomass sorghum	-	19.3
Eucalyptus	-	0.9
Energy cane	-	0.3
Pine	-	0.1
Total	-	**411**

Base-case scenario, $60 offered price, energy crops, year 2022



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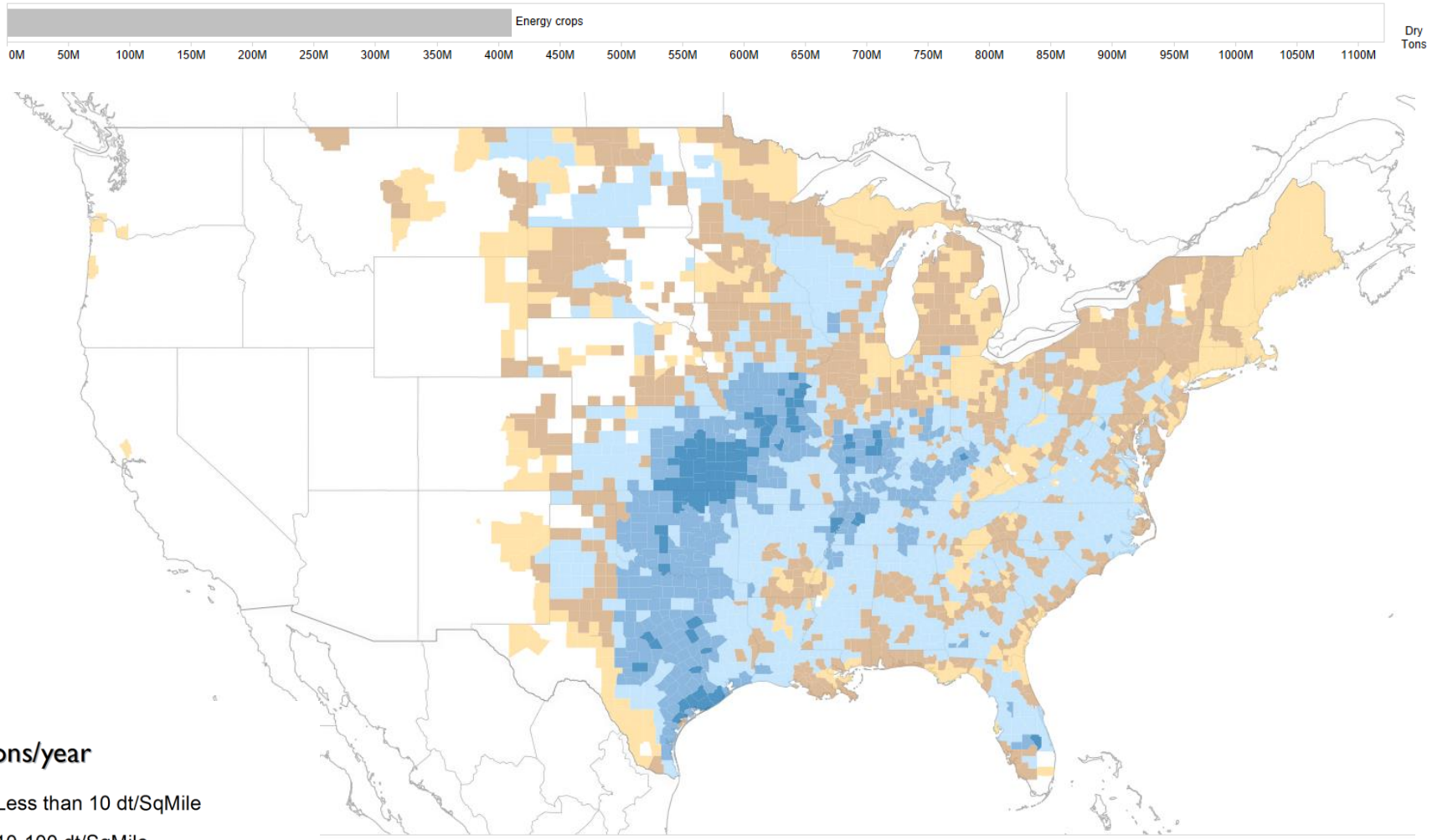
Base-case scenario, $60 offered price, energy crops, year 2040



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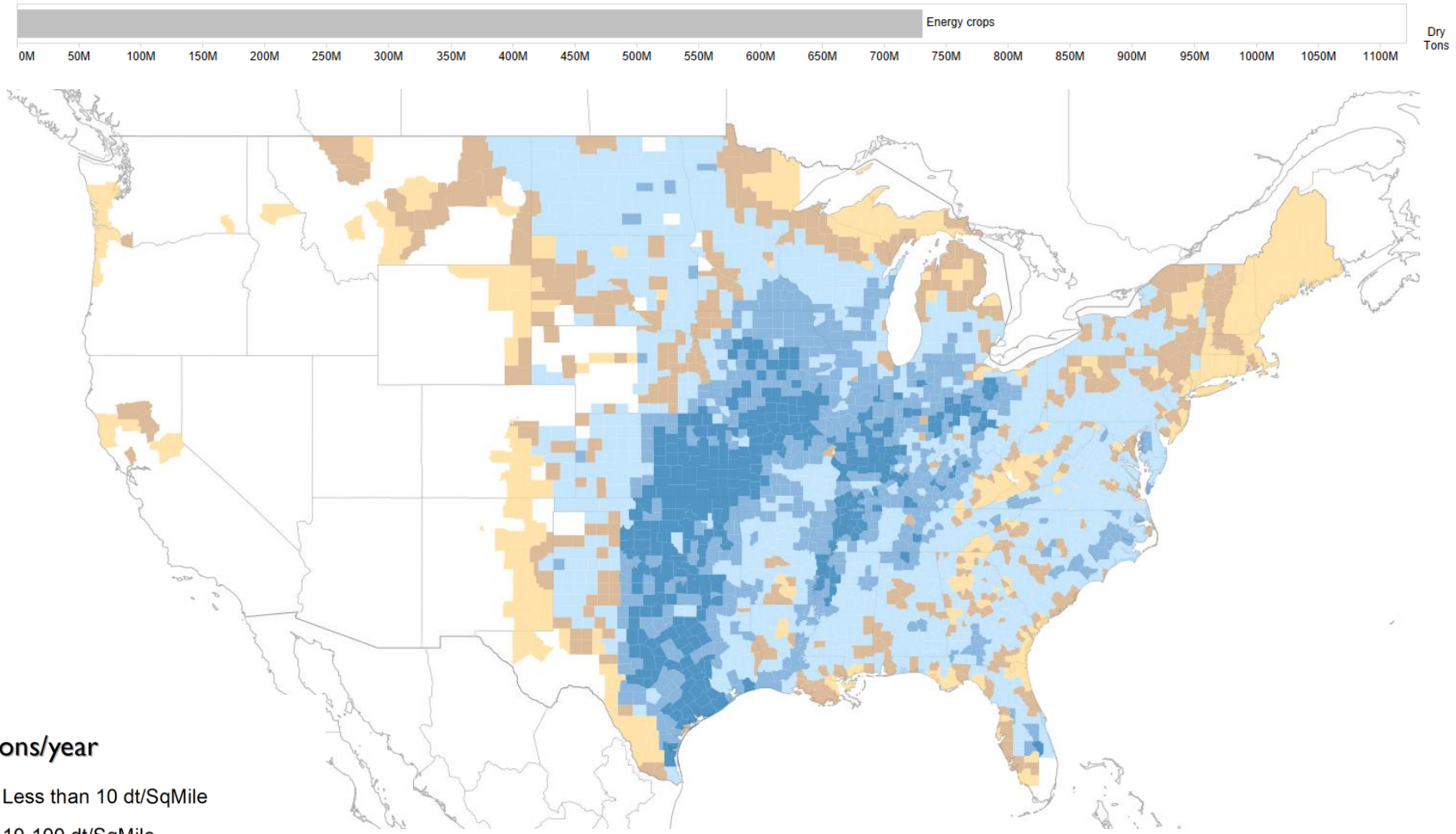
High-yield scenario, $60 offered price, energy crops, year 2040



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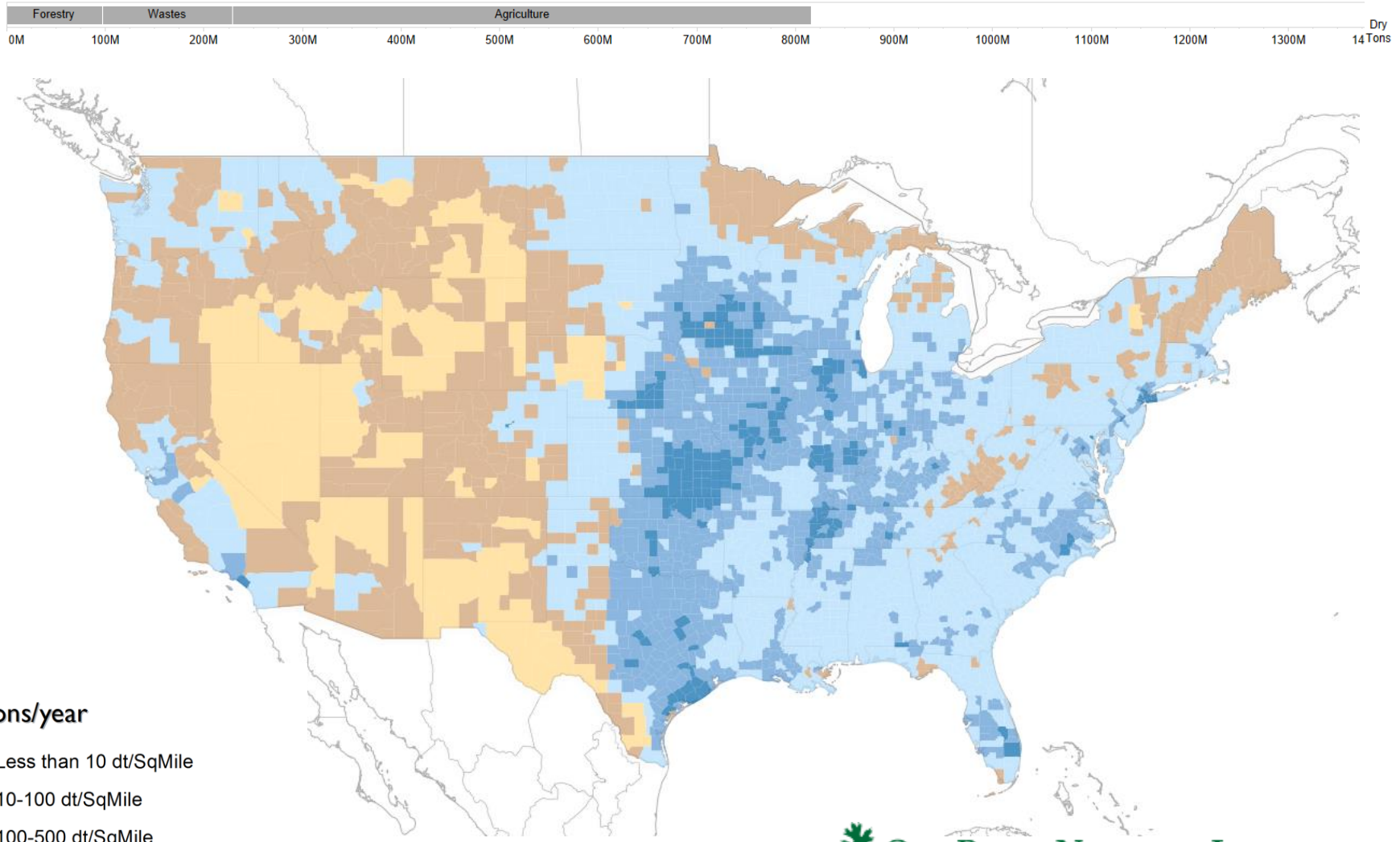
Base-case scenario, $60 offered price, combined resources, year 2040



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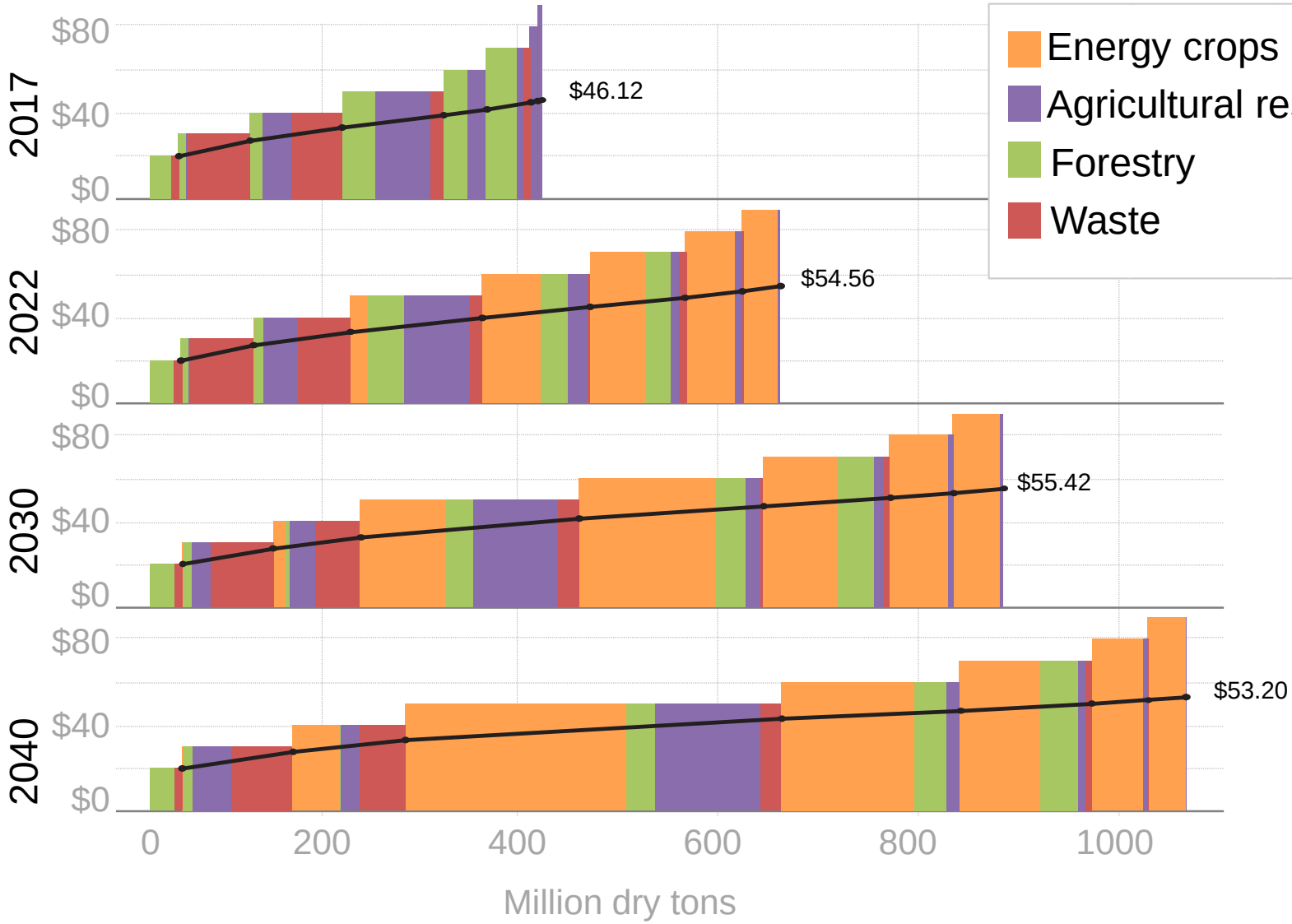
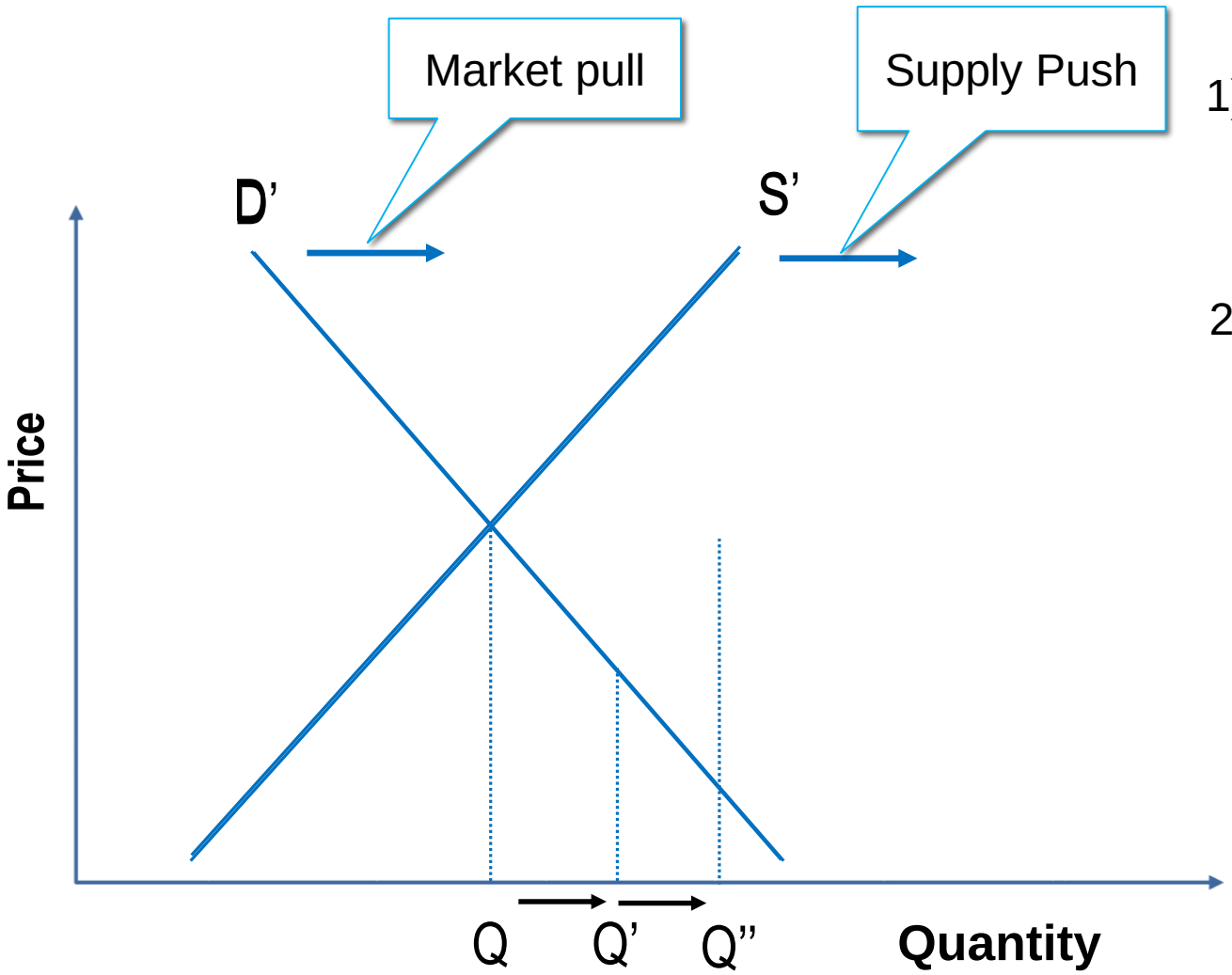
Supplies vary with price and time



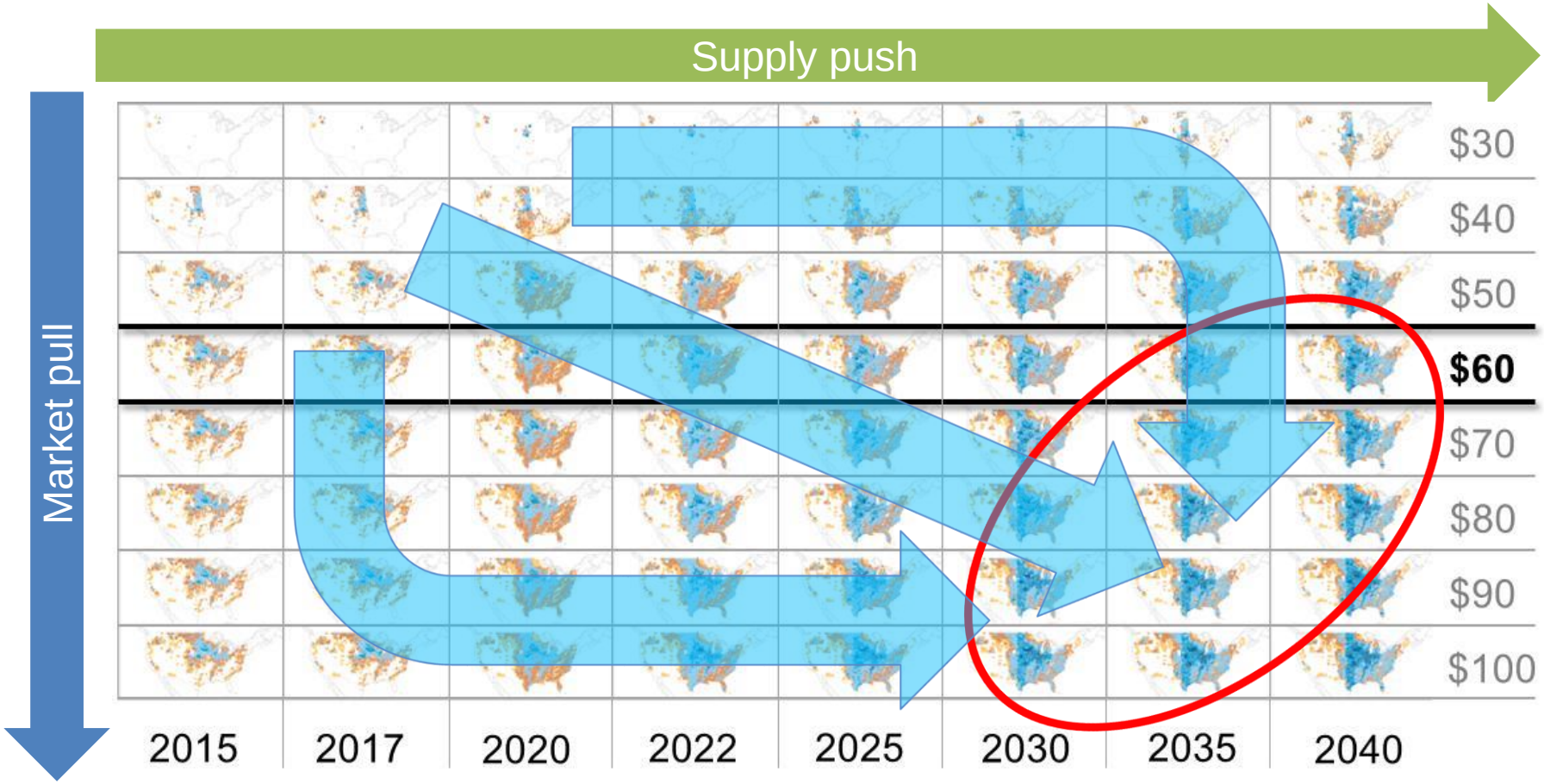
Advancing Resources

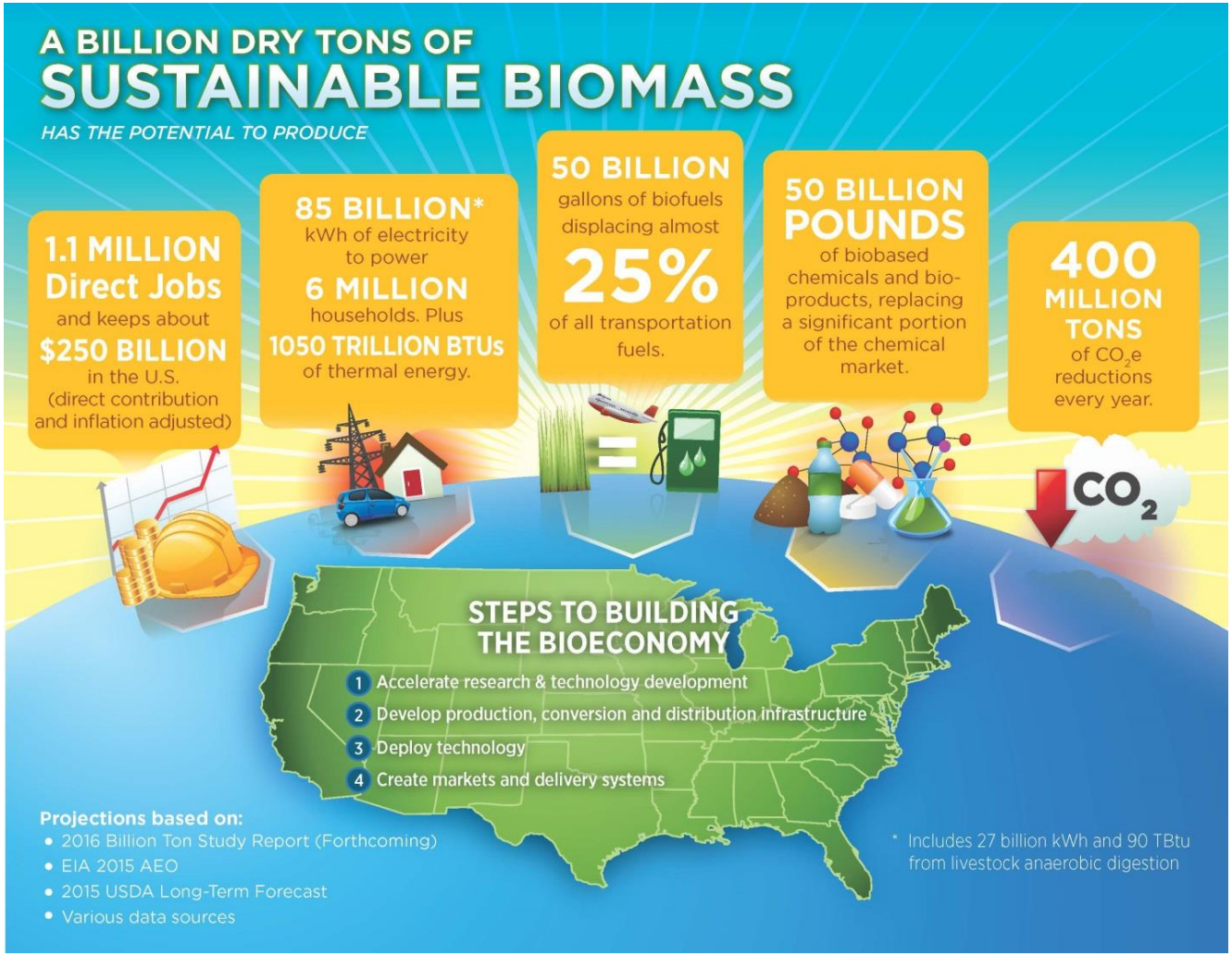


Future research:

1) Supply push
   a) Crop improvement
   b) Advanced logistics
   c) Precision agriculture
2) Market pull
   a) Conversion processes
   b) Co-optimization
   c) Co-products
   d) Aviation biofuels
   e) International markets
   f) Policy impacts

Advancing resources: Supply and demand



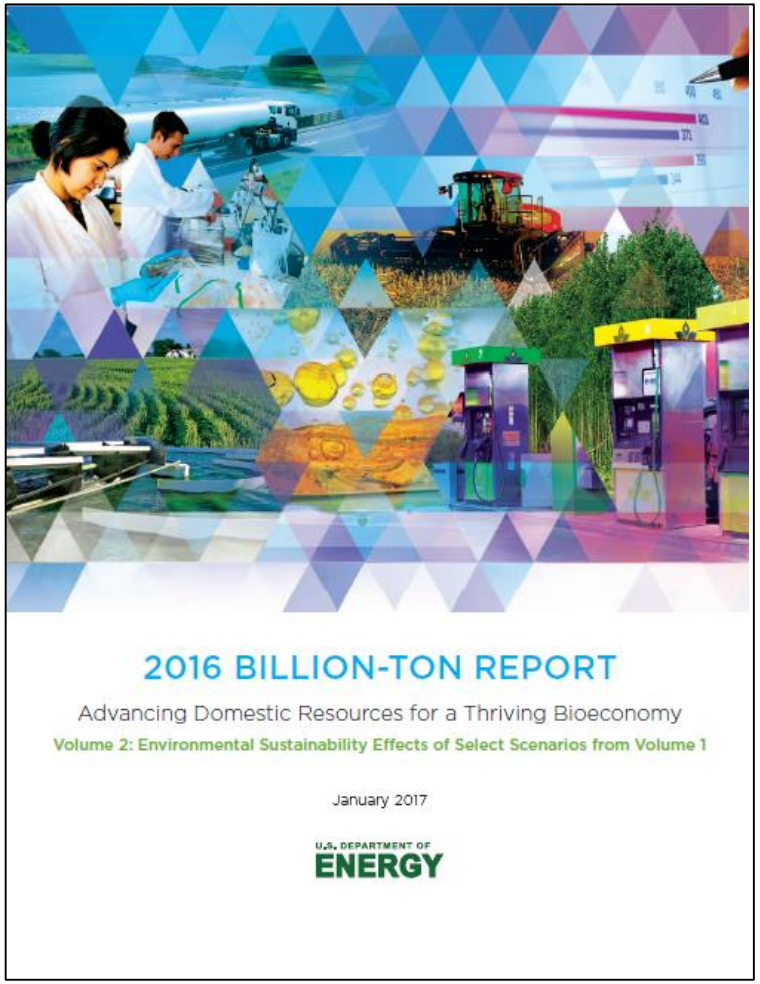


Graphic: BCS, Incorporated in support of DOE's Bioenergy Technologies Office; Biomass Research and Development (R&D) Board, 2016.

Source: Rogers, J. N., Stokes, B., Dunn, J., Cai, H., Wu, M., Haq, Z. and Baumes, H. (2017), An assessment of the potential products and economic and environmental impacts resulting from a billion ton bioeconomy. Biofuels, Bioprod. Bioref., 11: 110–128. doi:10.1002/bbb.1728

BT16 volume 2: Environmental Sustainability Effects of Select Scenarios from Volume 1

- Volume 2 is the first effort to address a critical knowledge gap about potential environmental implications.
- Volume 2 provides an extensive online resource to enable additional analyses and inform future R&D.



Summary

Resource assessments indicate vast national sustainable potential: >1 billion tons/year

Future biomass utilization is a function of supply and demand interactions

Resource assessments can help to:

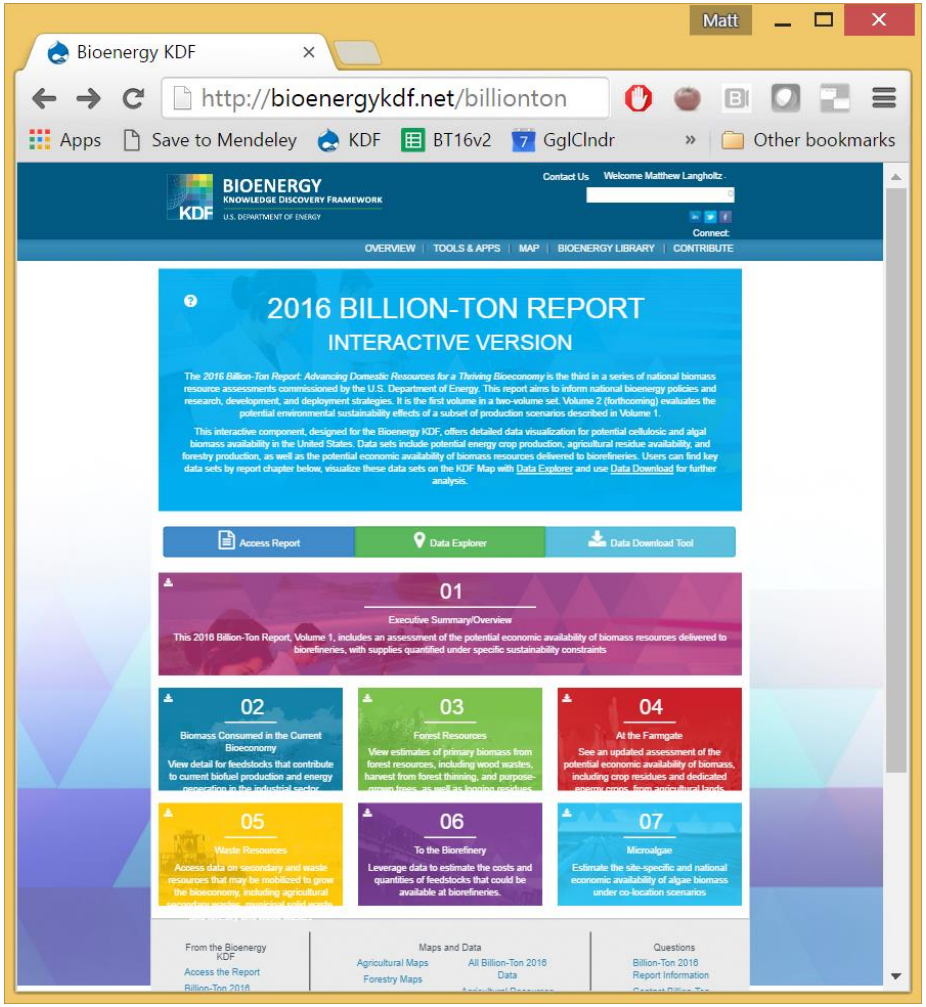
Evaluate impacts of supply push and market pull

Inform strategies to increase biomass utilization

Future research should advance from “how much is there?” to “how can it happen?”

Interactive components of BT16

http://bioenergykdf.net/billionton



Discussion

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Backup slides

Sustainability criteria: Forestry

Category	Sustainability assumption or constraint	Implementation
Soil quality, water quality	Acceptable residue removal for fuel treatment thinning different for different slopes (0%, 60%, or 70%)	Management assumptions
	Acceptable residue removal for logging residues (70%)	
Soil quality	No biomass removal in wet areas to avoid soil compaction	Excluded land area
Bio-diversity	No production in administratively reserved forestlands, such as wilderness areas and National Parks	Excluded land area
	No production in roadless areas, as inventoried by USDA Forest Service, which may qualify for wilderness or conservation protection	

BT16 includes an analysis of the biomass potential of microalgae

Cultivating algae strains near CO_2 facilities

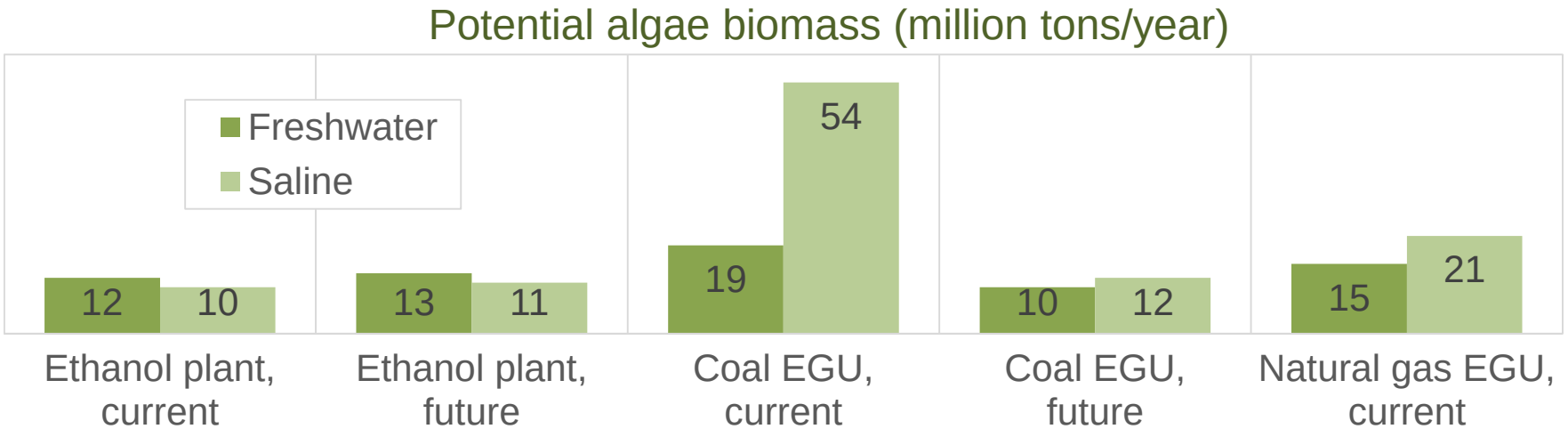
Coal-fired and natural gas electric generating units (EGUs)

Ethanol production plants

2 productivity scenarios

Current rate

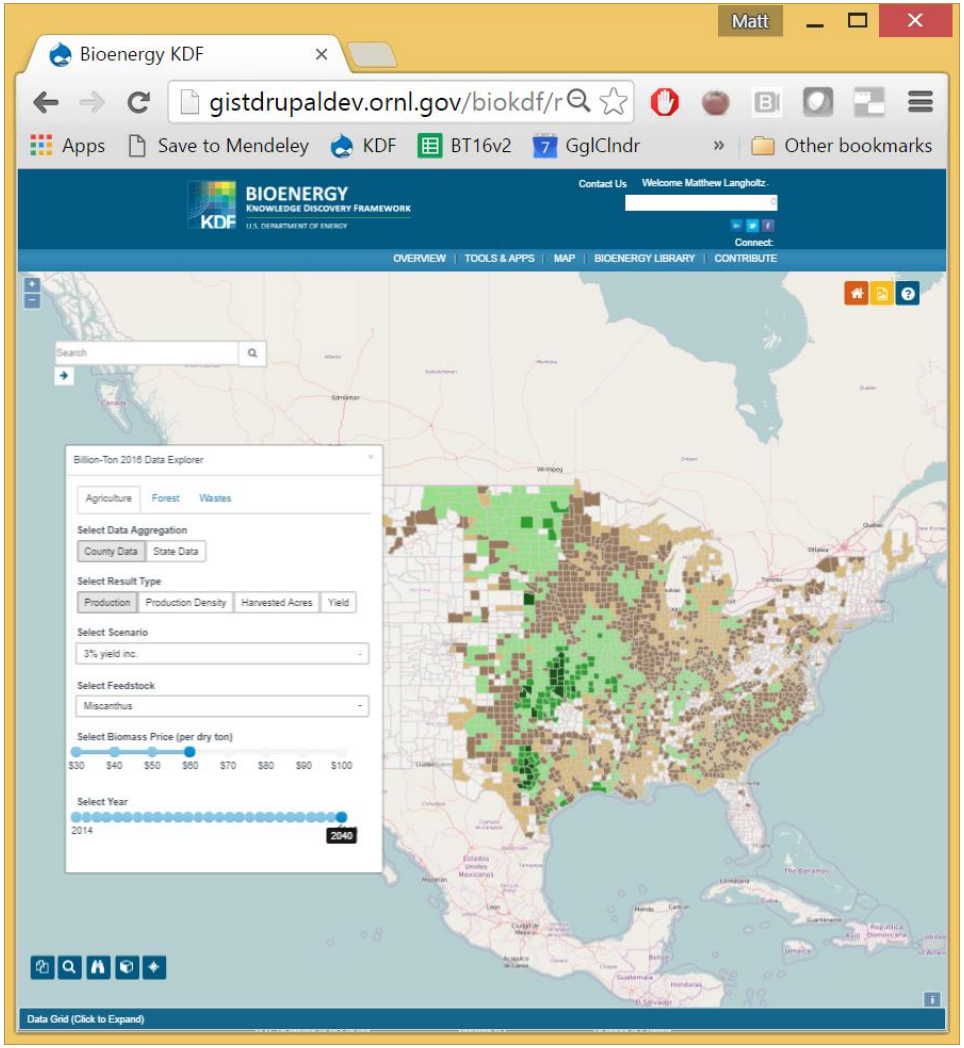
Future high-productivity case (not considered for natural gas)



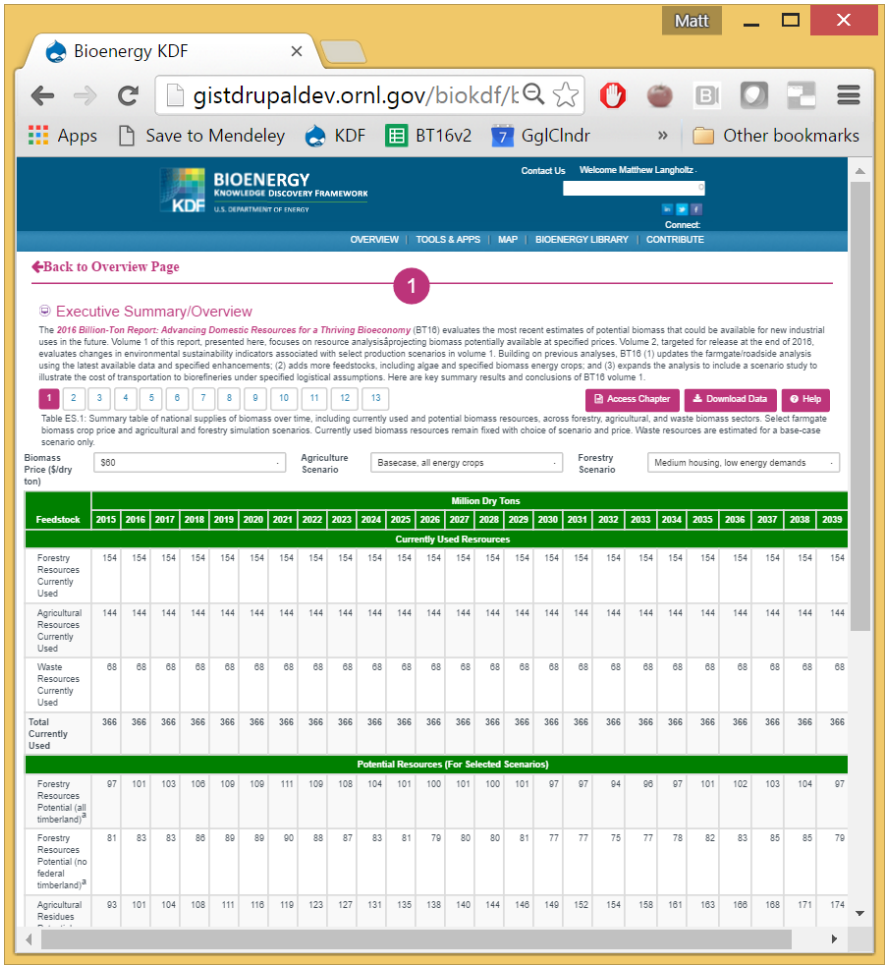
Sustainability Criteria: Agriculture

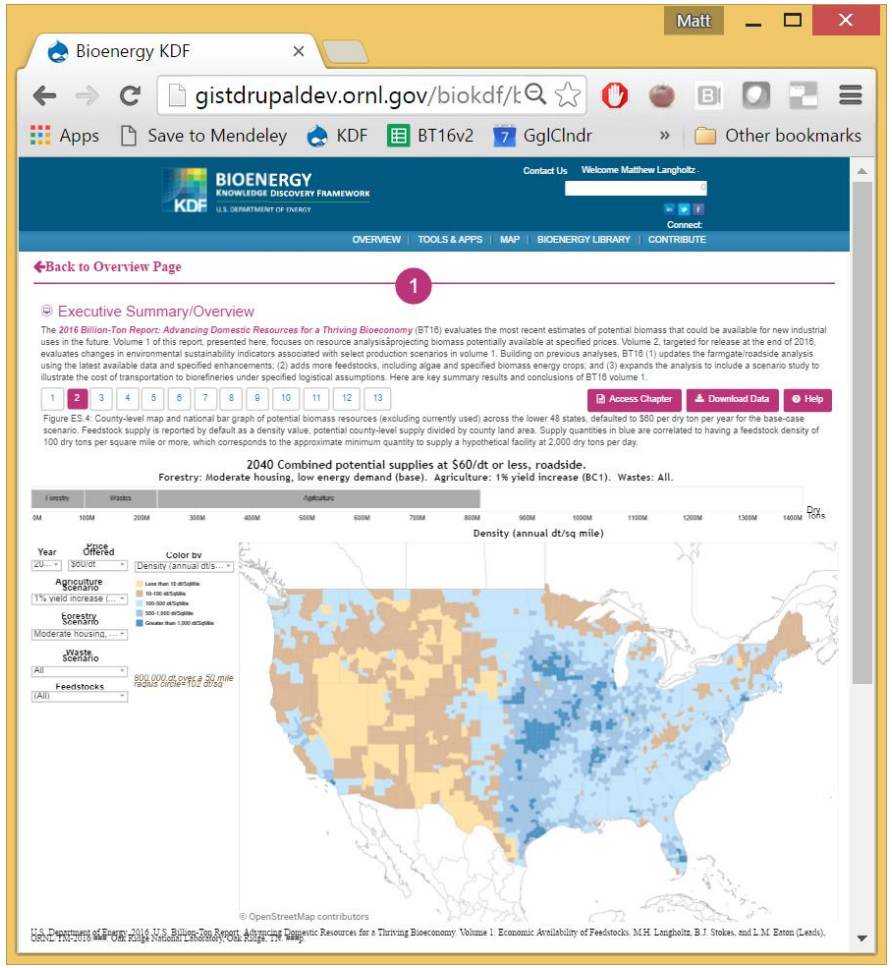
Category	Sustainability assumption or constraint	Implementation
Soil quality, water quality	Trend toward reduced/no till for corn, wheat	Management assumptions
	High fraction of no-till crop acres	
	No residue removal on conventionally tilled acres	
	Acceptable residue removal different for reduced/no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

Data resources

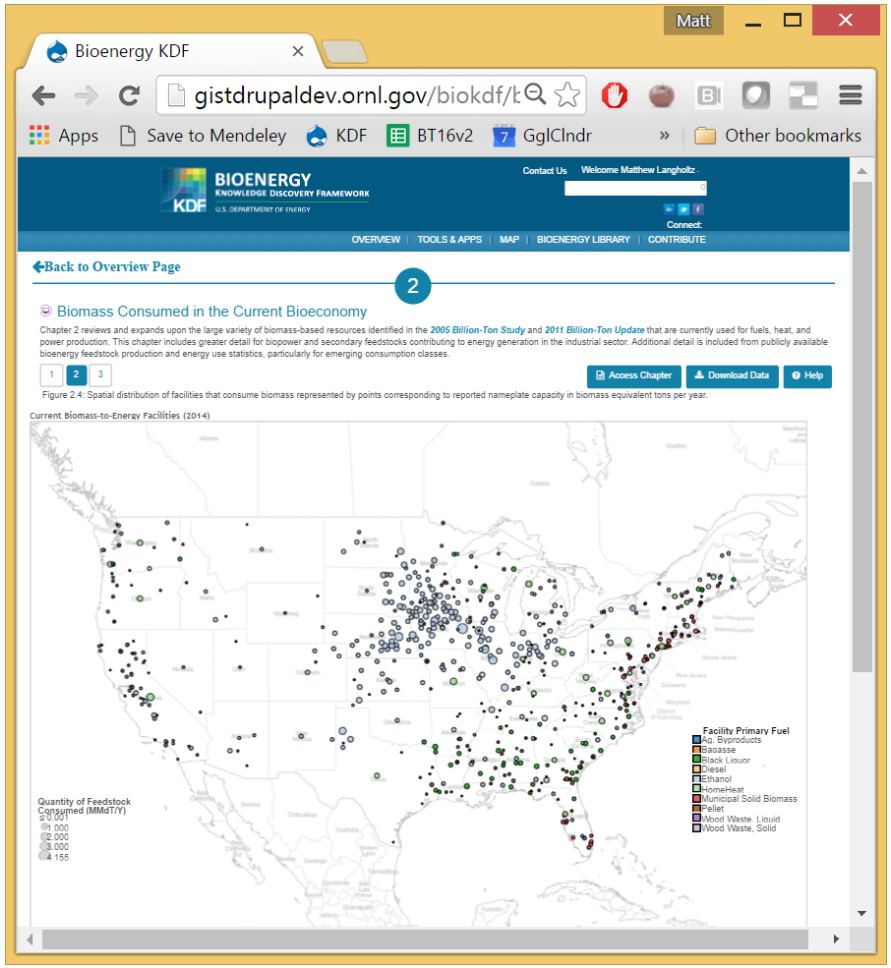


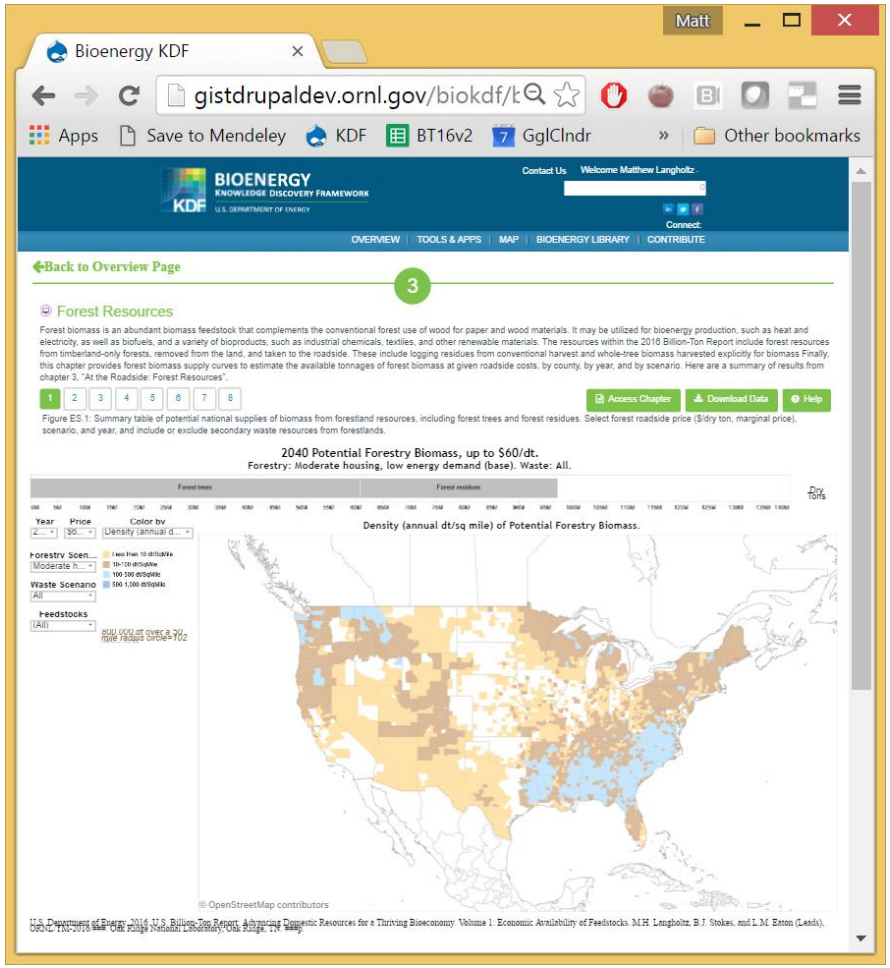
Navigating BT16



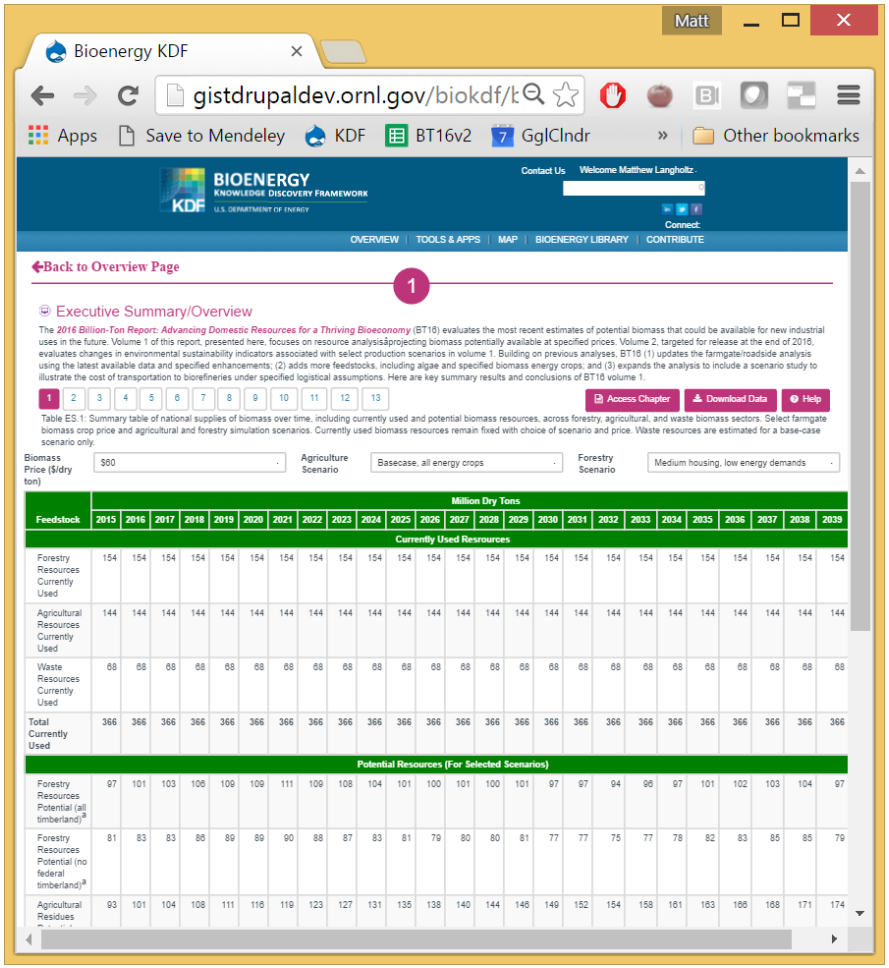


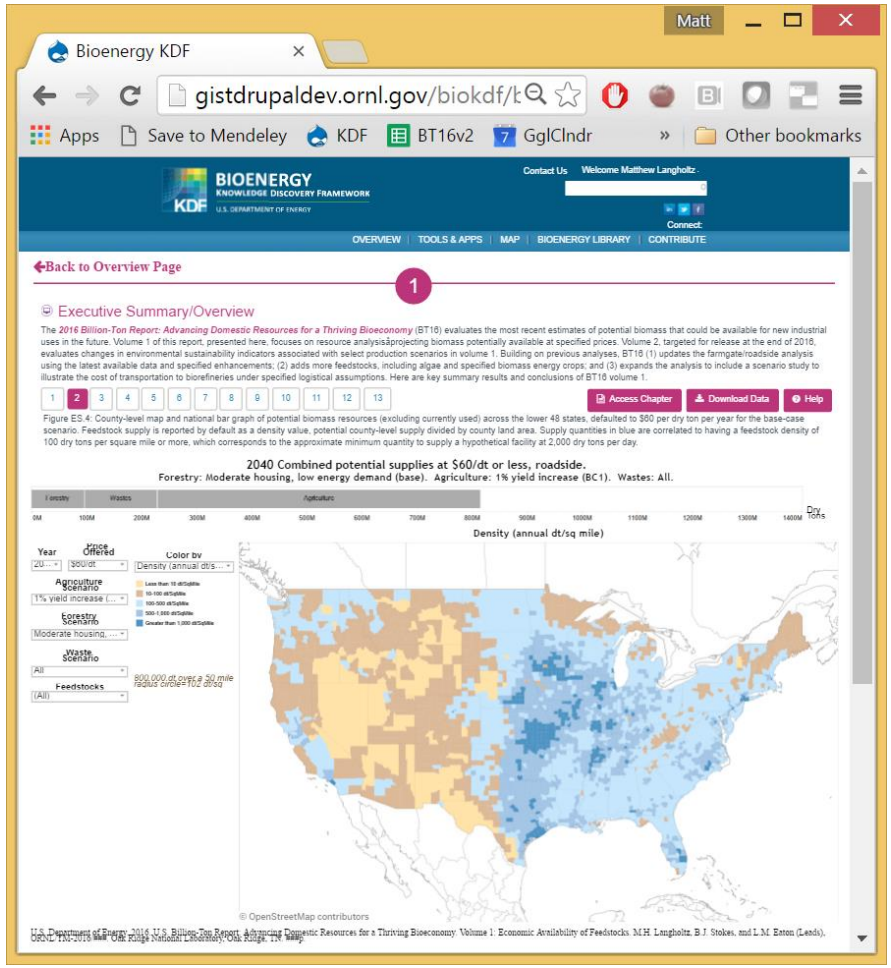
BT16: Chapters 2 and 3



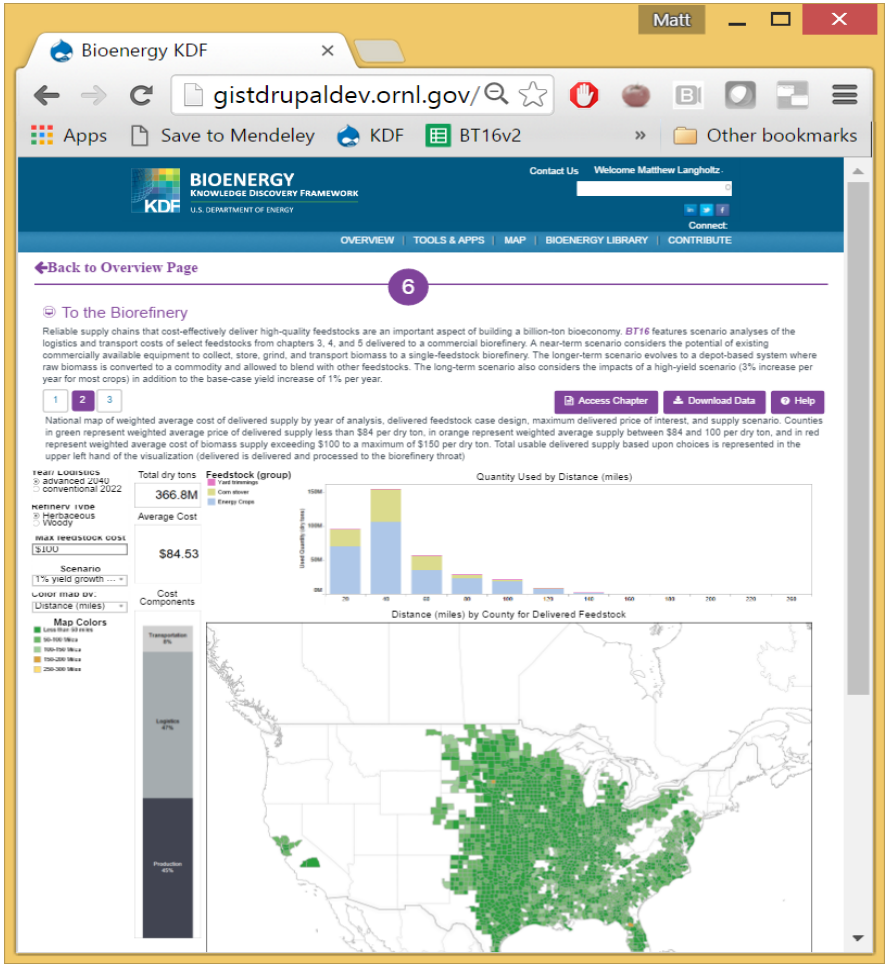


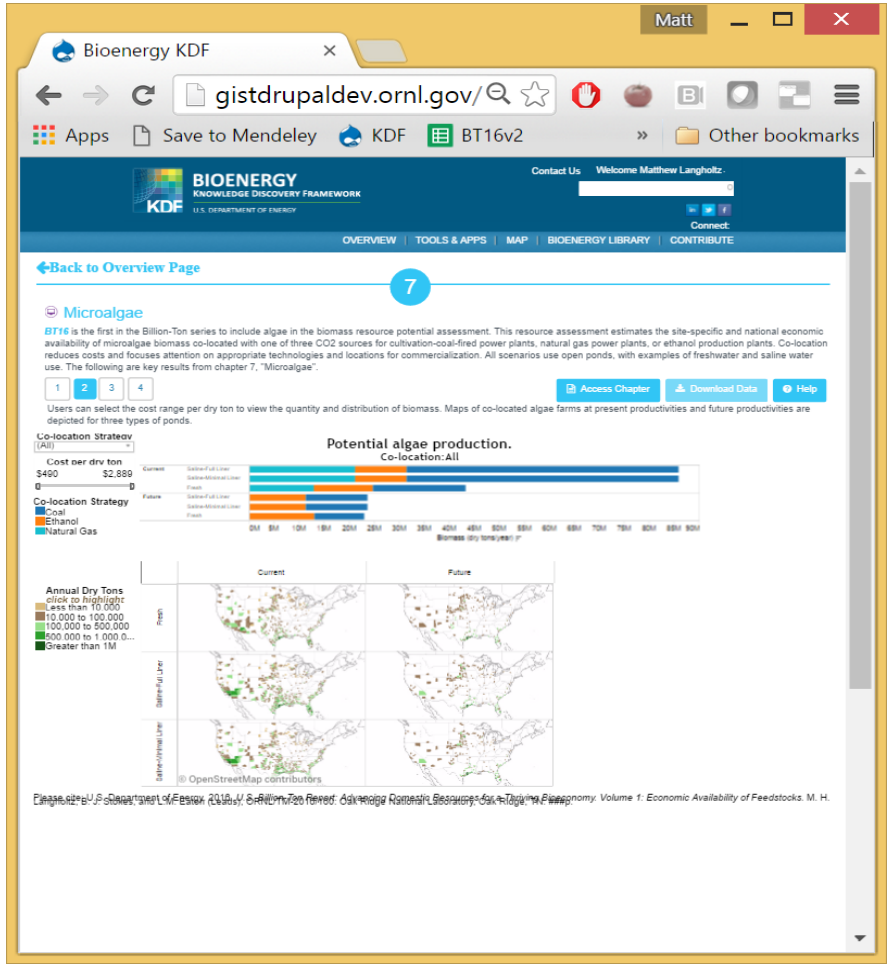
BT16: Chapters 4 and 5





BT16: Chapters 6 and 7





Models/Data Used in BT16 Volume 1

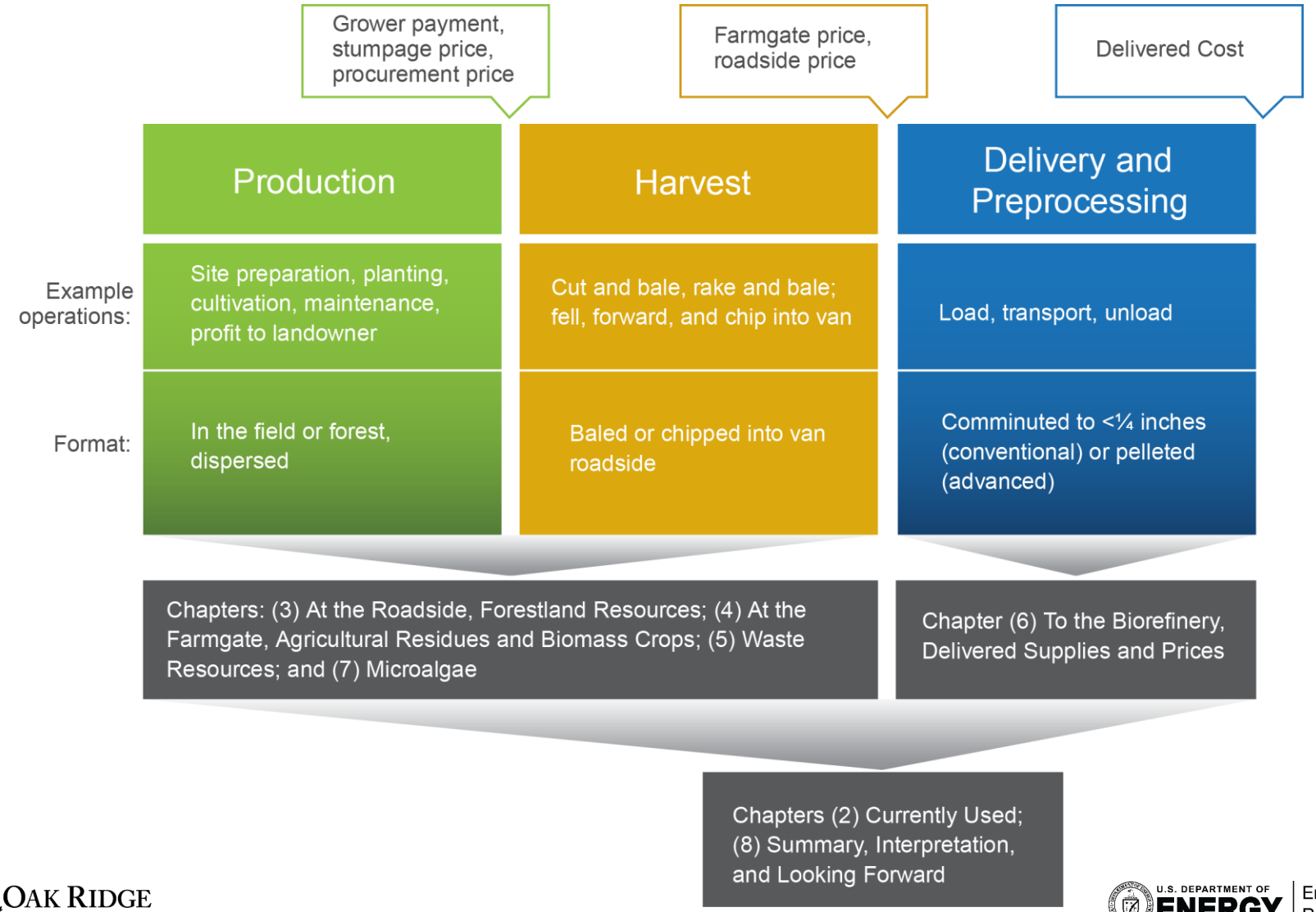
Models

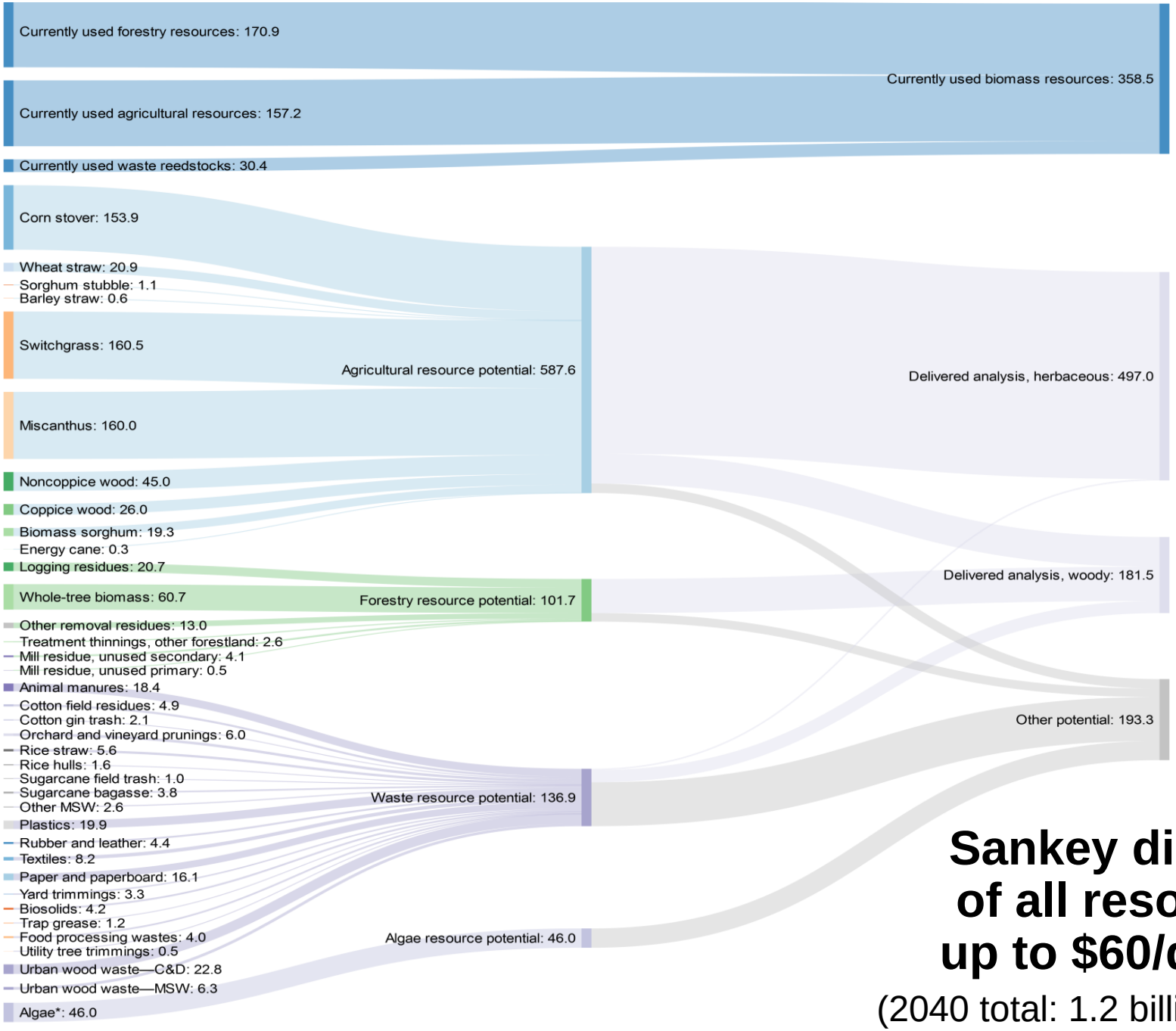
- POLYSYS: Policy Analysis System
- ForSEAM: Forest Sustainable and Economic Analysis Model
- SRTS: Subregional Timber Supply Model
- USFPM/GFPM: U.S. Forest Products Module/Global Forest Products Model
- PRISM-EM: Parameter-elevation Relationships on Independent Slopes Model
- SCM: Supply Characterization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

Data

- USDA Long-Term Agricultural Projections
- 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

The report addresses all stages of the biomass supply chain





Sankey diagram of all resources up to $60/dry ton

(2040 total: 1.2 billion tons/year)