A Summary of the Results of the 2016 Billion-Ton Report:
Advancing Domestic Resources for a Thriving Bioeconomy, volume 1

SRWC focus

Oct 12th, 2016

SRWCOWG

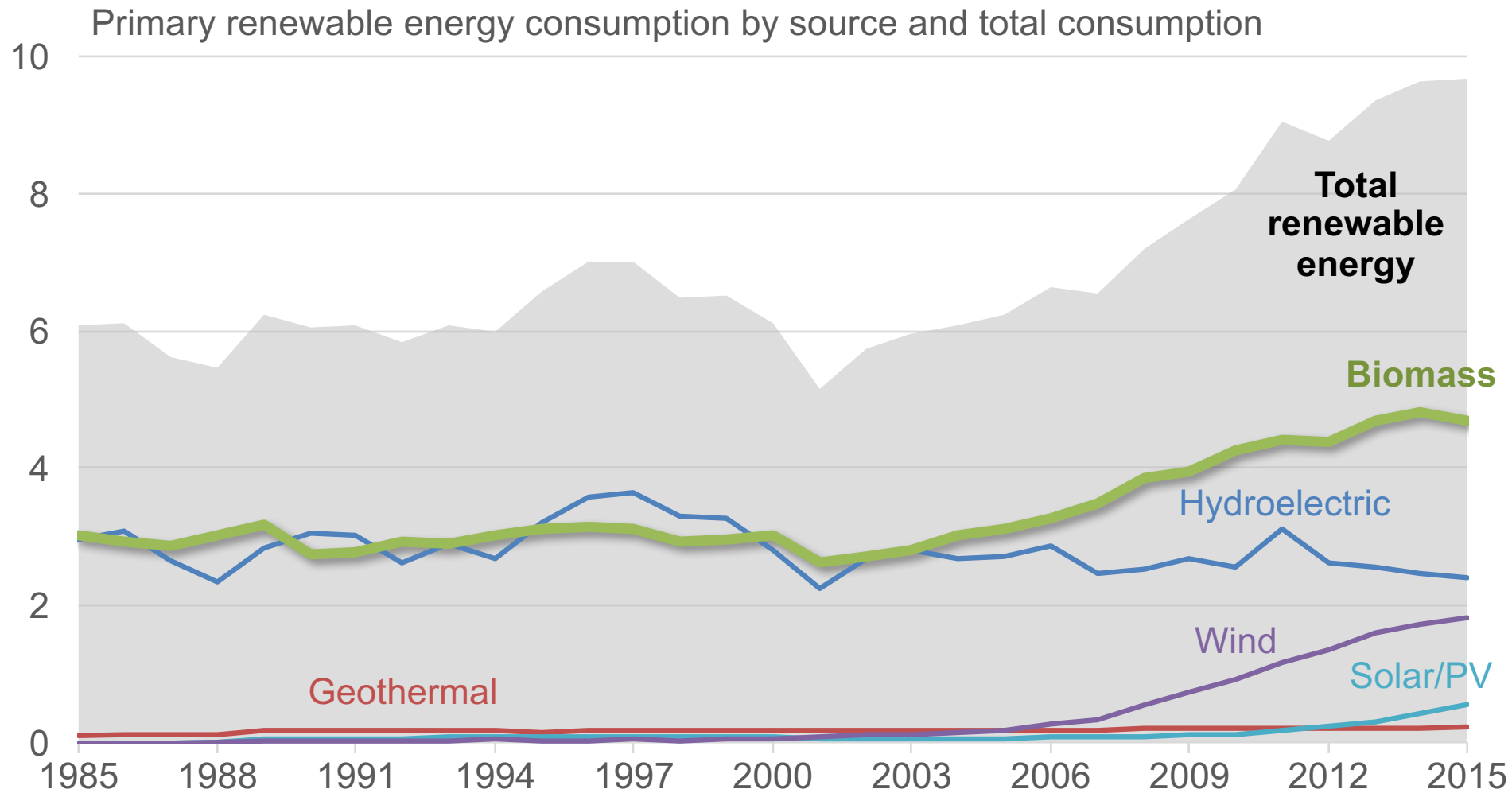
OAK RIDGE National Laboratory

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

Outline

- BT16 Synopsis
  - Update and comparison with 2011 BT2
  - Overall results
- BT16 SRWCs
  - Background
  - Methods
  - SRWC results
  - Interpretation
- Conclusions

Biomass is our largest source of domestic renewable energy

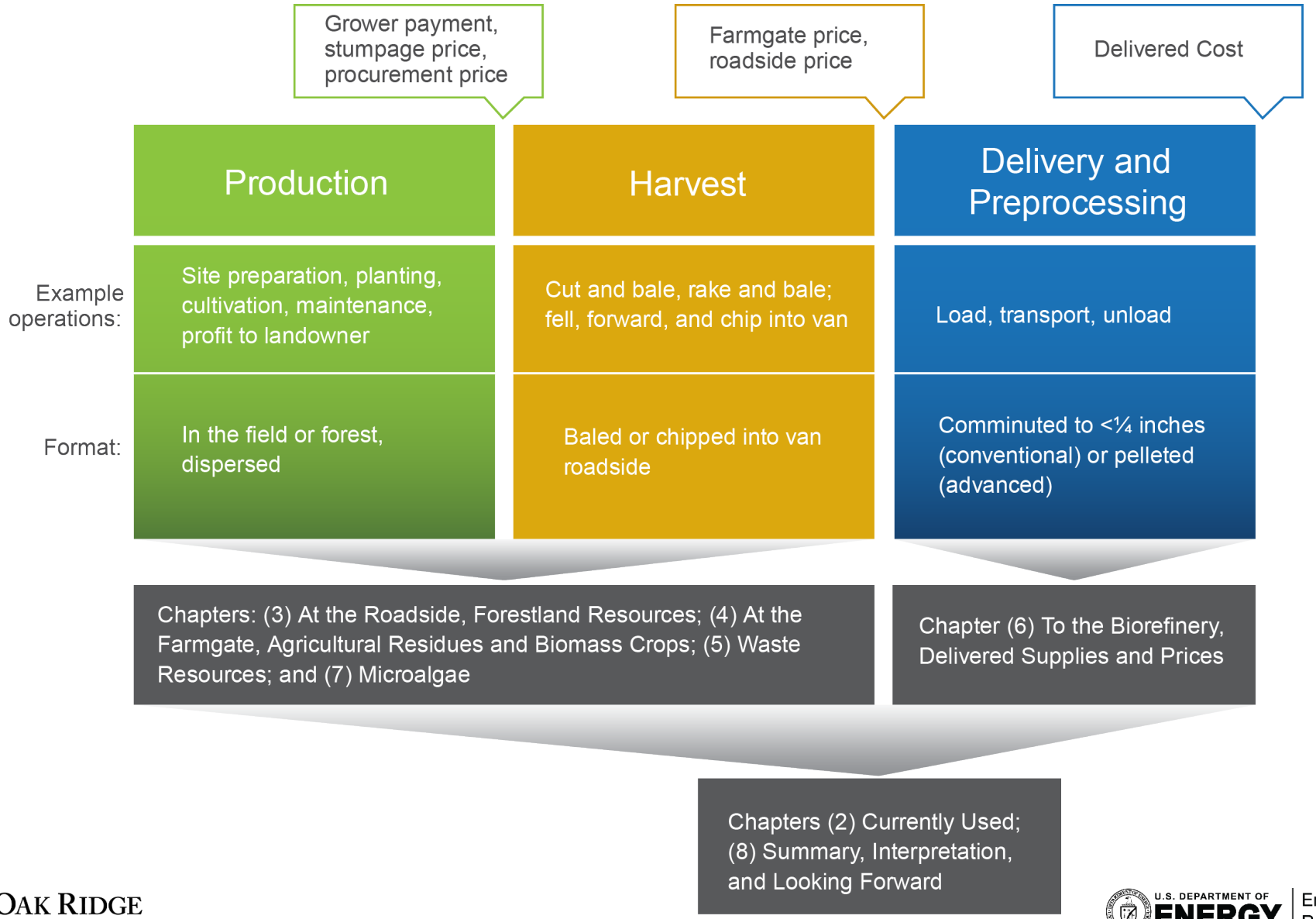


Preamble

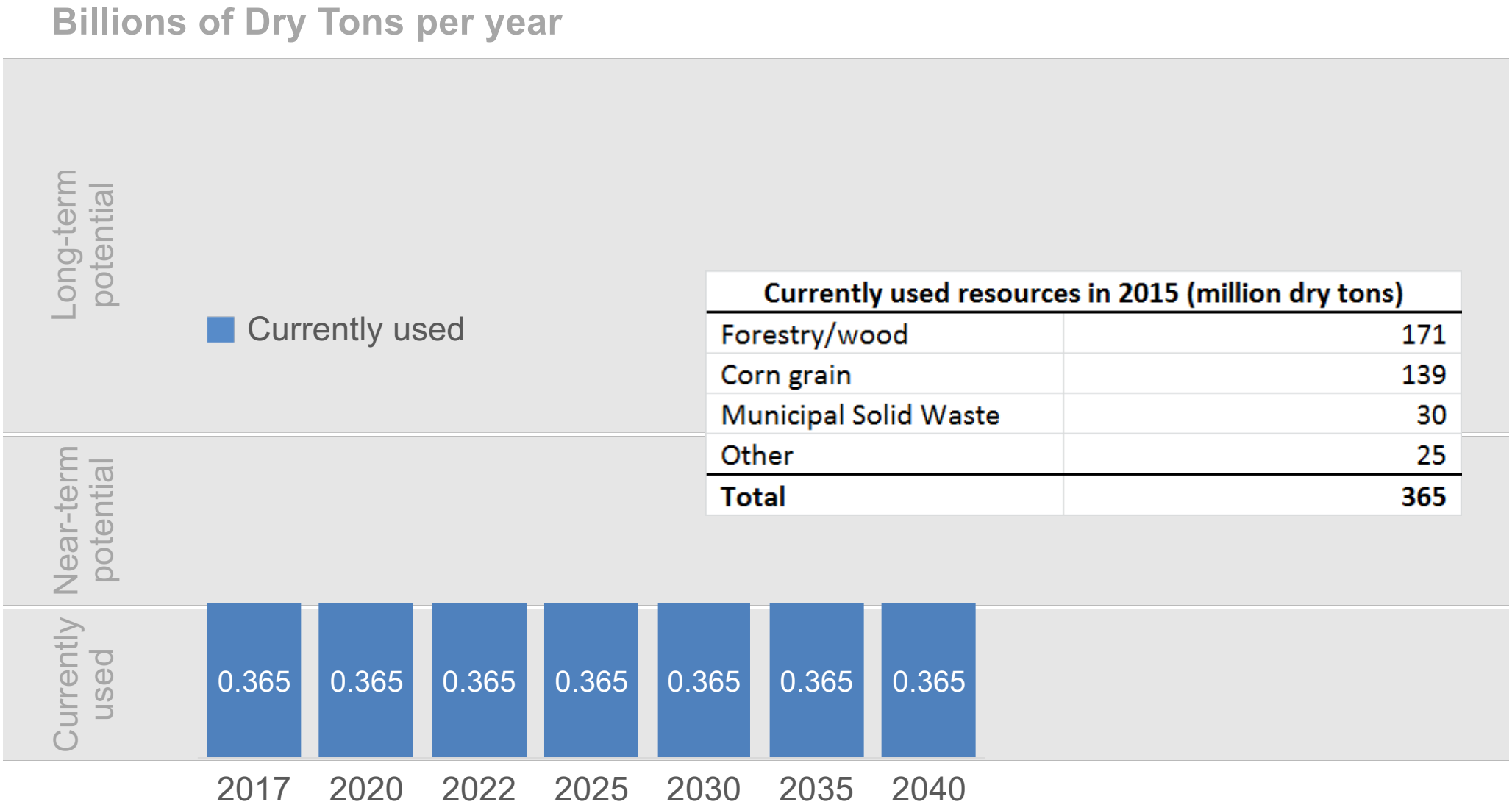
- Excludes policy and end use
- Prioritizes food, forage, feed, fiber, and export to ensure social sustainability
- Economic supply curve approach
- Underlying conservative assumptions with environmental sustainability considerations
- Two volumes: Resource assessment and environmental sustainability effects of select scenarios
- Multi-lab/agency effort

Contributors

The report addresses all stages of the biomass supply chain



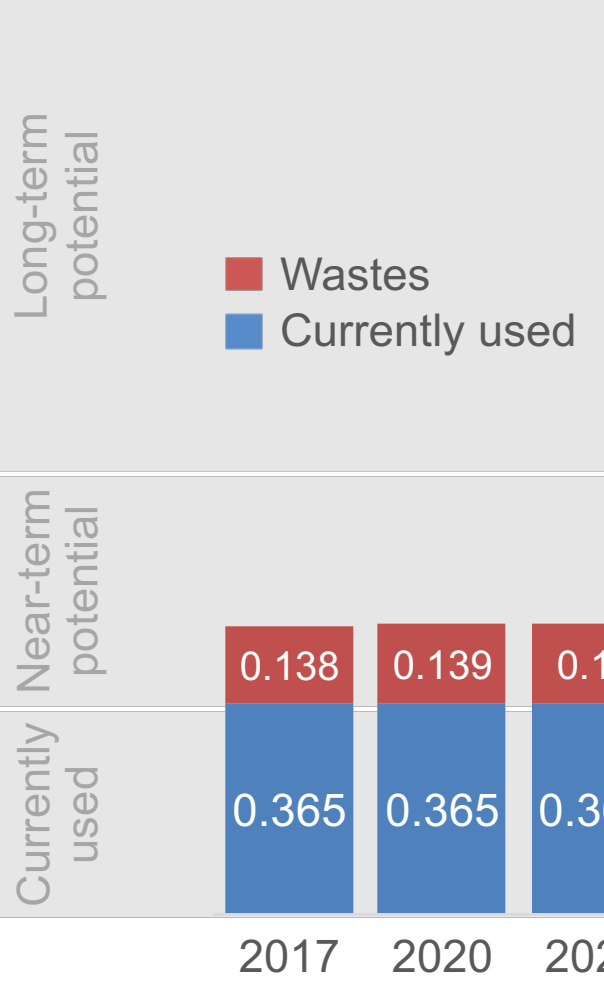
Current and Potential, Base Case



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

Current and Potential, Base Case at $60/dt

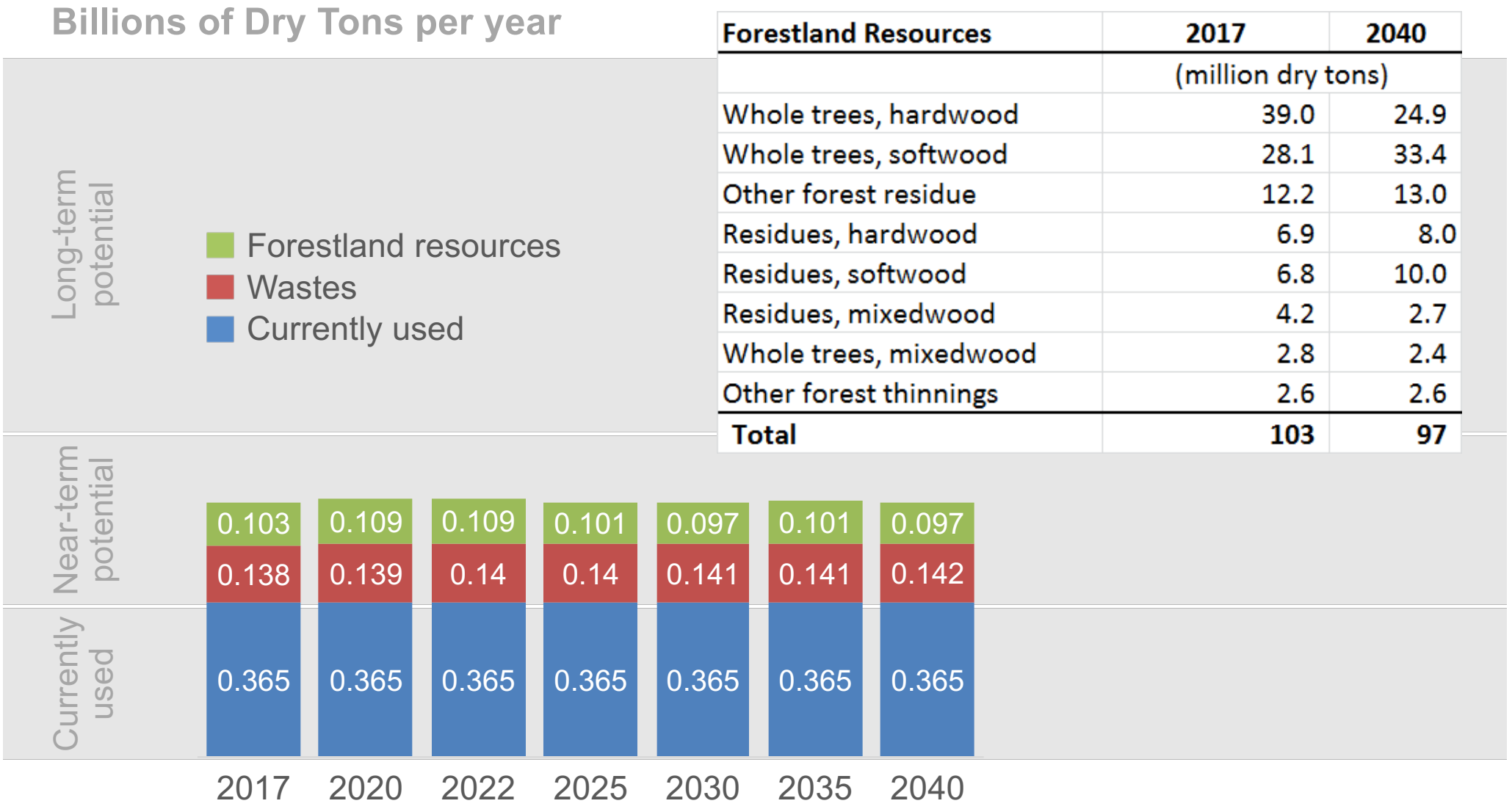
Billions of Dry Tons per year



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

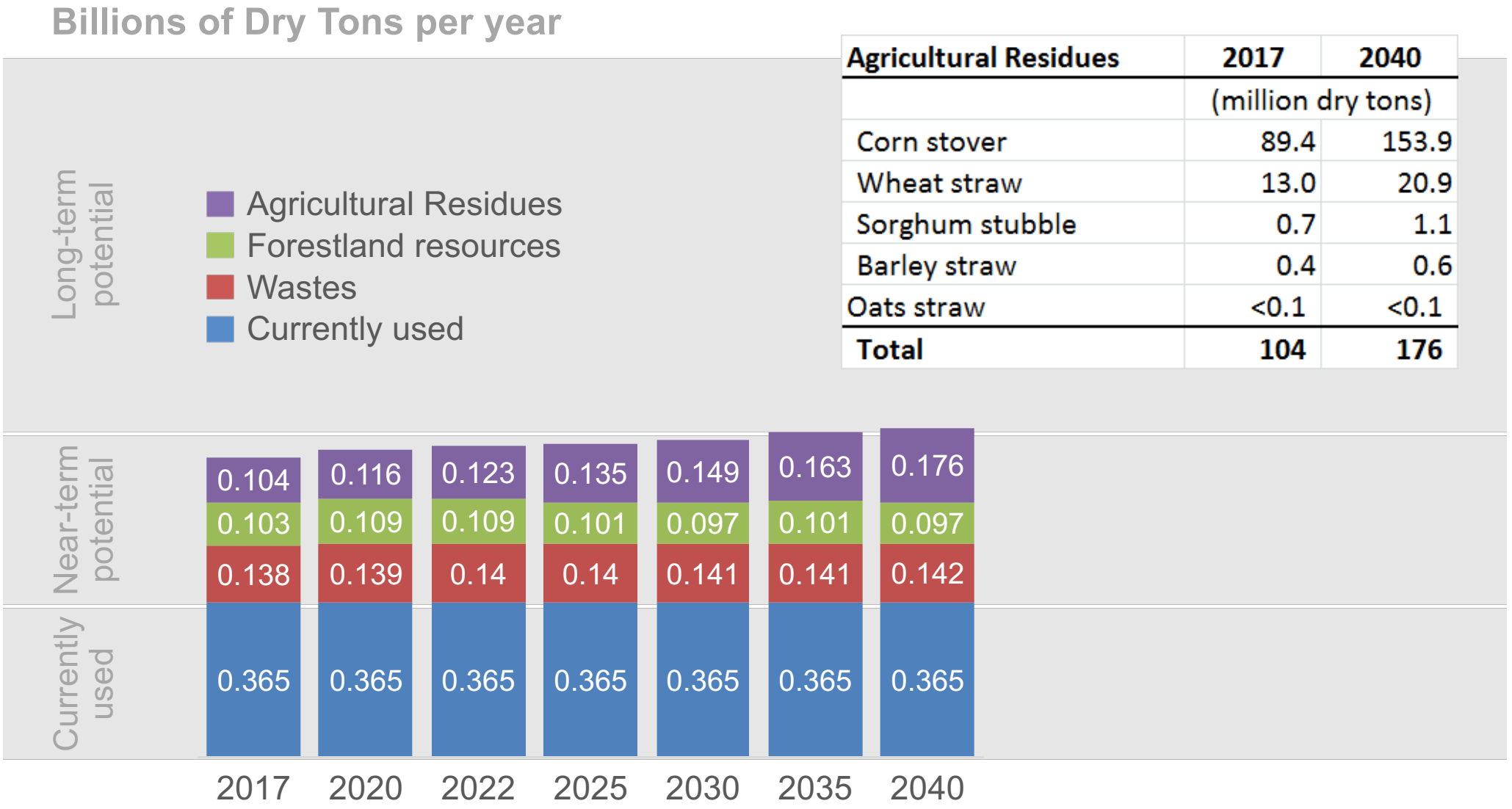
Waste Resources	2017	2040
	(million dry tons)	
Secondary mill residue	4.1	4.1
Sugarcane bagasse	3.6	3.8
Yard trimmings	3.3	3.3
Noncitrus residues	2.5	2.7
Other	2.6	2.6
Cotton gin trash	1.7	2.1
Tree nut residues	1.5	1.6
Citrus residues	1.5	1.6
Rice hulls	1.4	1.6
Sugarcane trash	1.0	1.0
Primary mill residue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

Current and Potential, Base Case at $60/dt



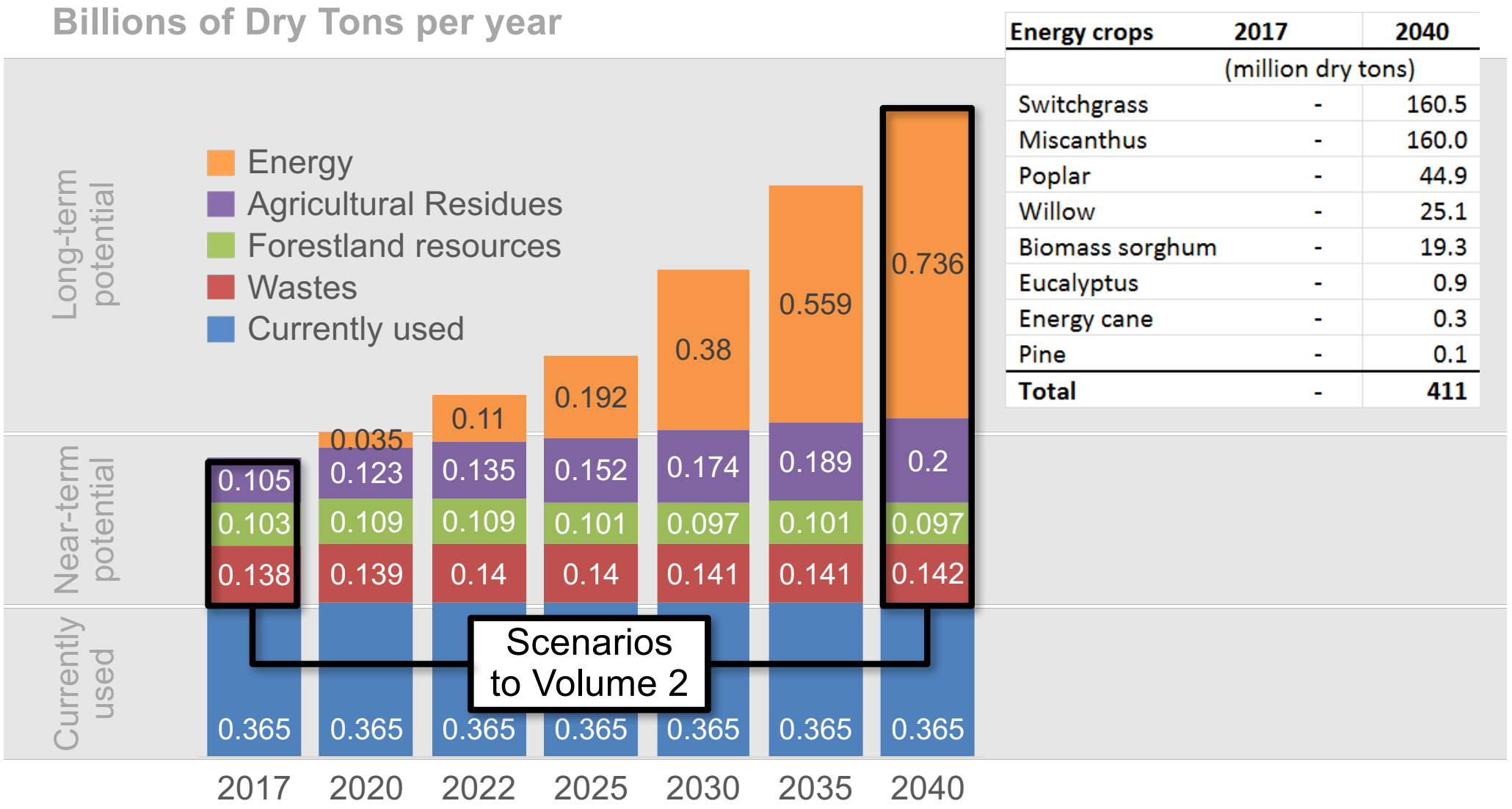
Forestland Resources	2017	2040
	(million dry tons)	
Whole trees, hardwood	39.0	24.9
Whole trees, softwood	28.1	33.4
Other forest residue	12.2	13.0
Residues, hardwood	6.9	8.0
Residues, softwood	6.8	10.0
Residues, mixedwood	4.2	2.7
Whole trees, mixedwood	2.8	2.4
Other forest thinnings	2.6	2.6
Total	**103**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

Current and Potential, Base Case at $60/dt



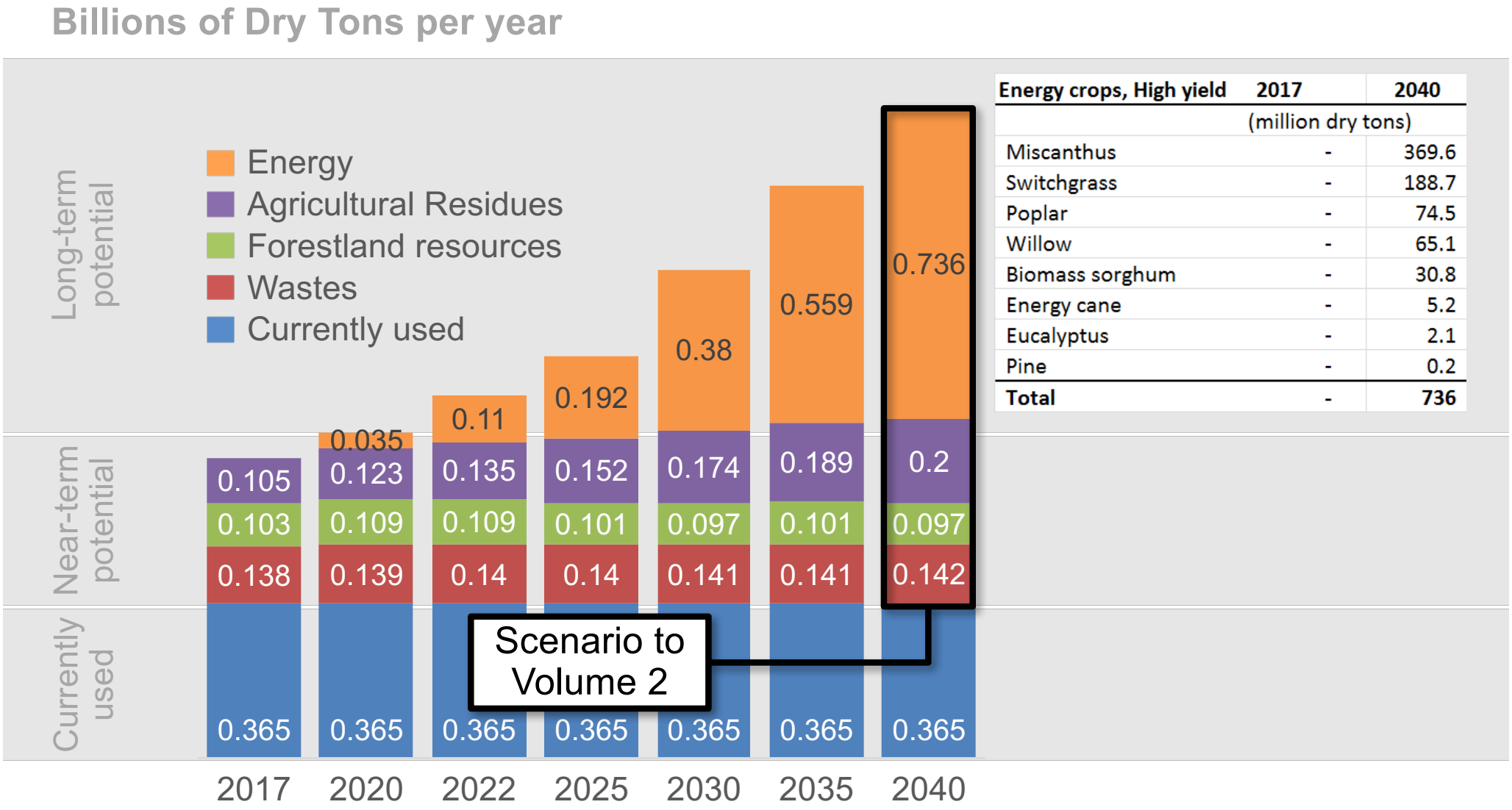
Agricultural Residues	2017	2040
	(million dry tons)	
Corn stover	89.4	153.9
Wheat straw	13.0	20.9
Sorghum stubble	0.7	1.1
Barley straw	0.4	0.6
Oats straw	<0.1	<0.1
Total	**104**	**176**

Current and Potential, Base Case at $60/dt



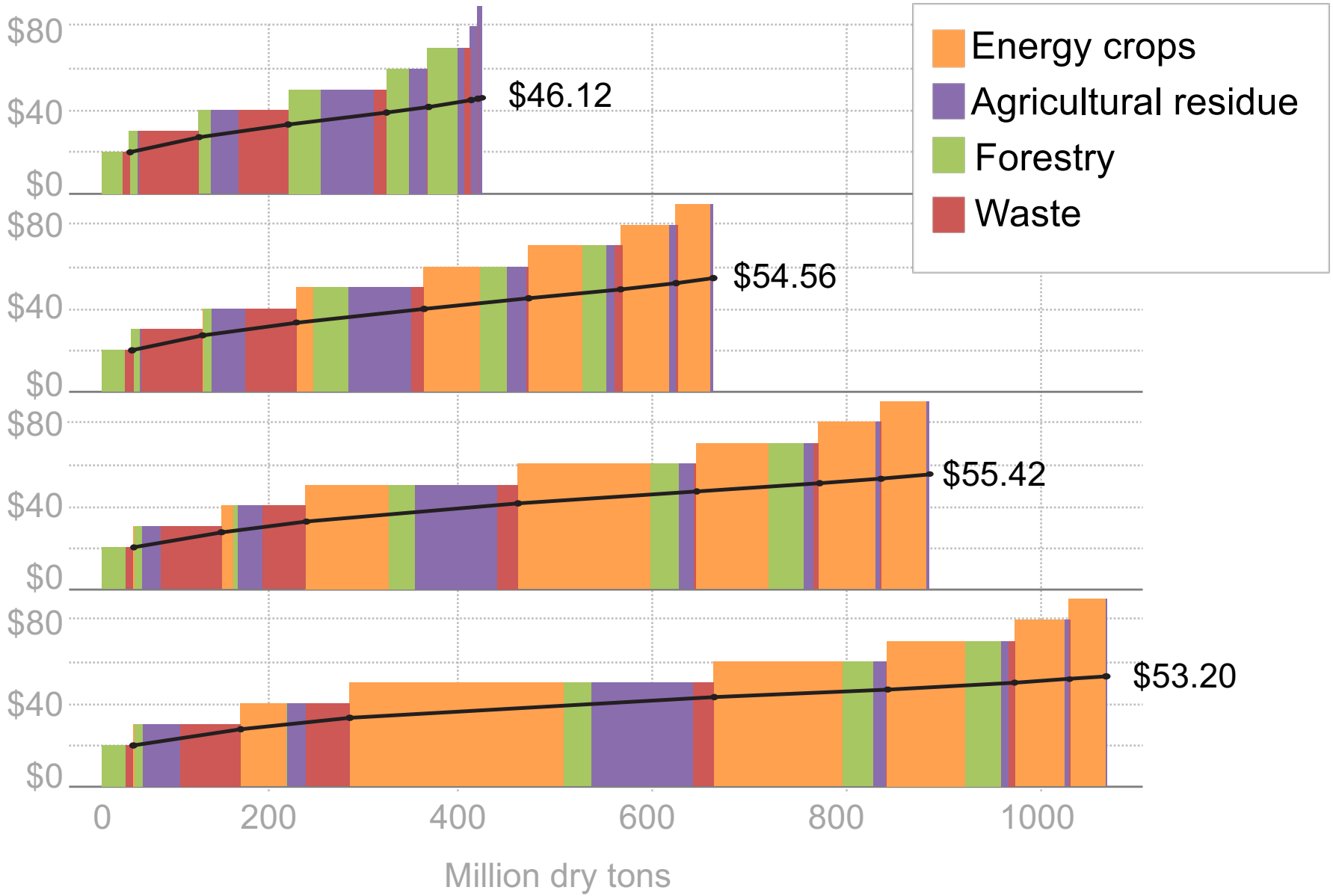
Energy crops	2017	2040
	(million dry tons)	
Switchgrass	-	160.5
Miscanthus	-	160.0
Poplar	-	44.9
Willow	-	25.1
Biomass sorghum	-	19.3
Eucalyptus	-	0.9
Energy cane	-	0.3
Pine	-	0.1
Total	-	**411**

Current and Potential, Base Case at $60/dt

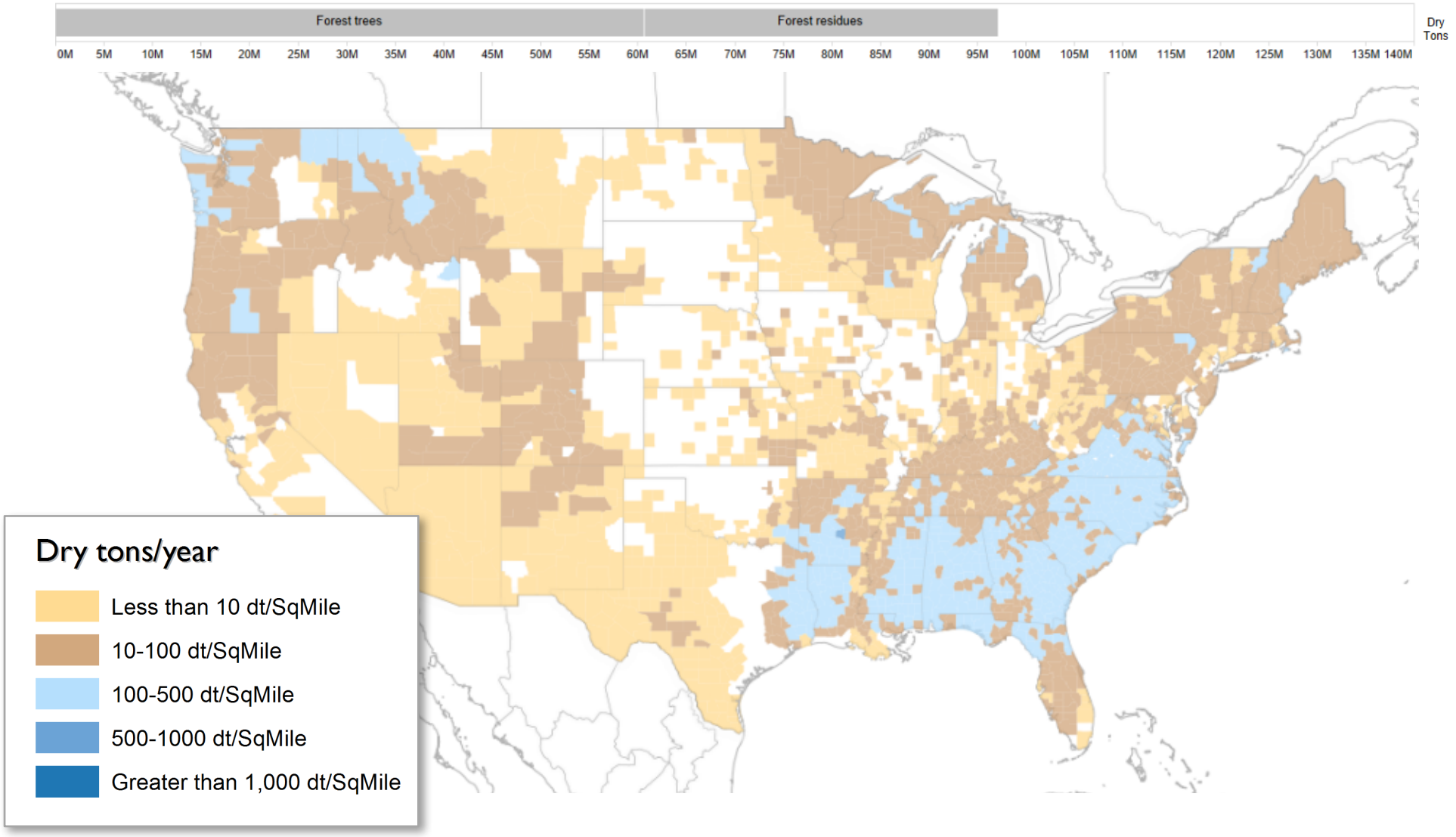


Energy crops, High yield	2017	2040
	(million dry tons)	
Miscanthus	-	369.6
Switchgrass	-	188.7
Poplar	-	74.5
Willow	-	65.1
Biomass sorghum	-	30.8
Energy cane	-	5.2
Eucalyptus	-	2.1
Pine	-	0.2
Total	-	**736**

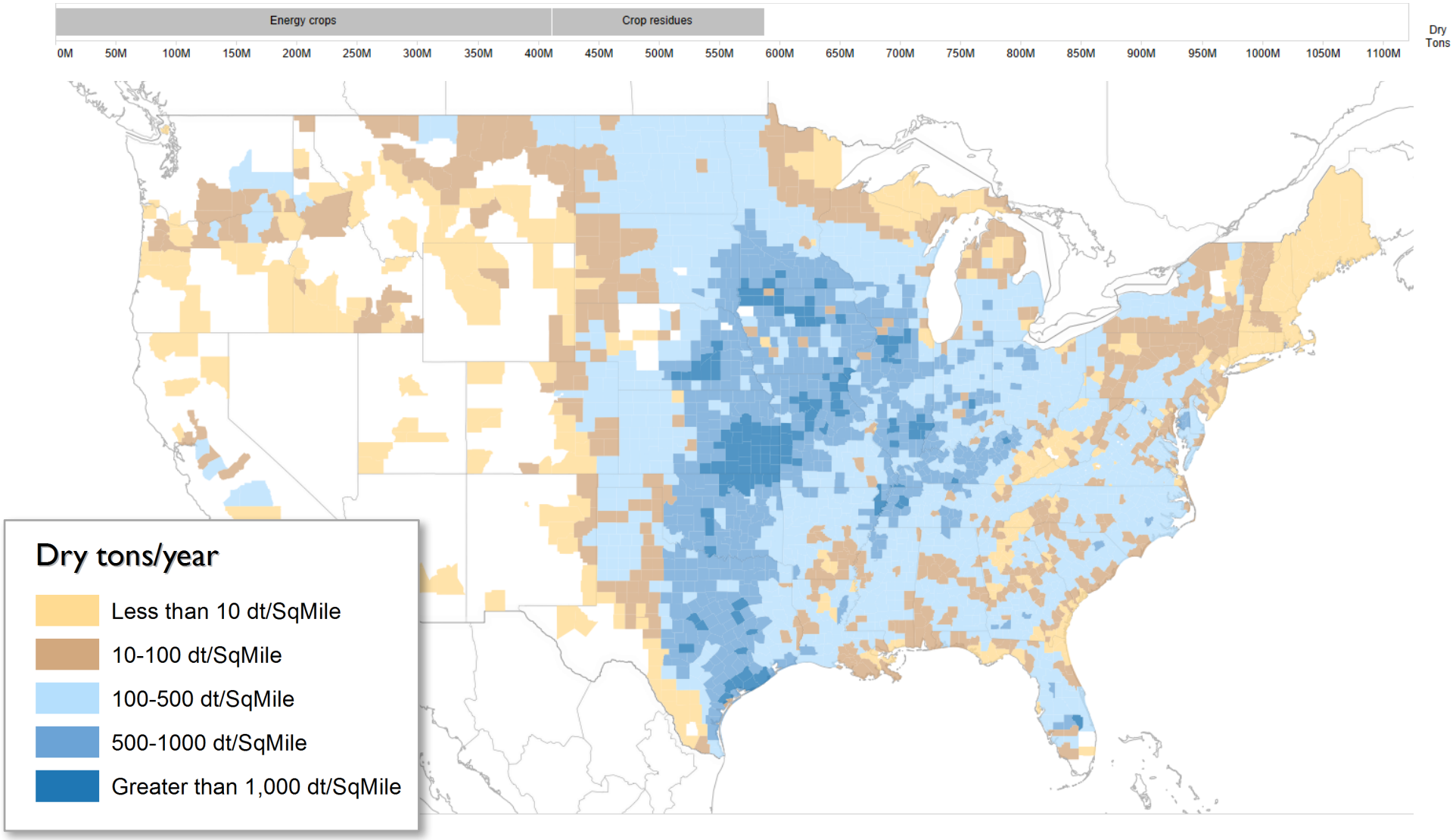
Supplies vary with price and time



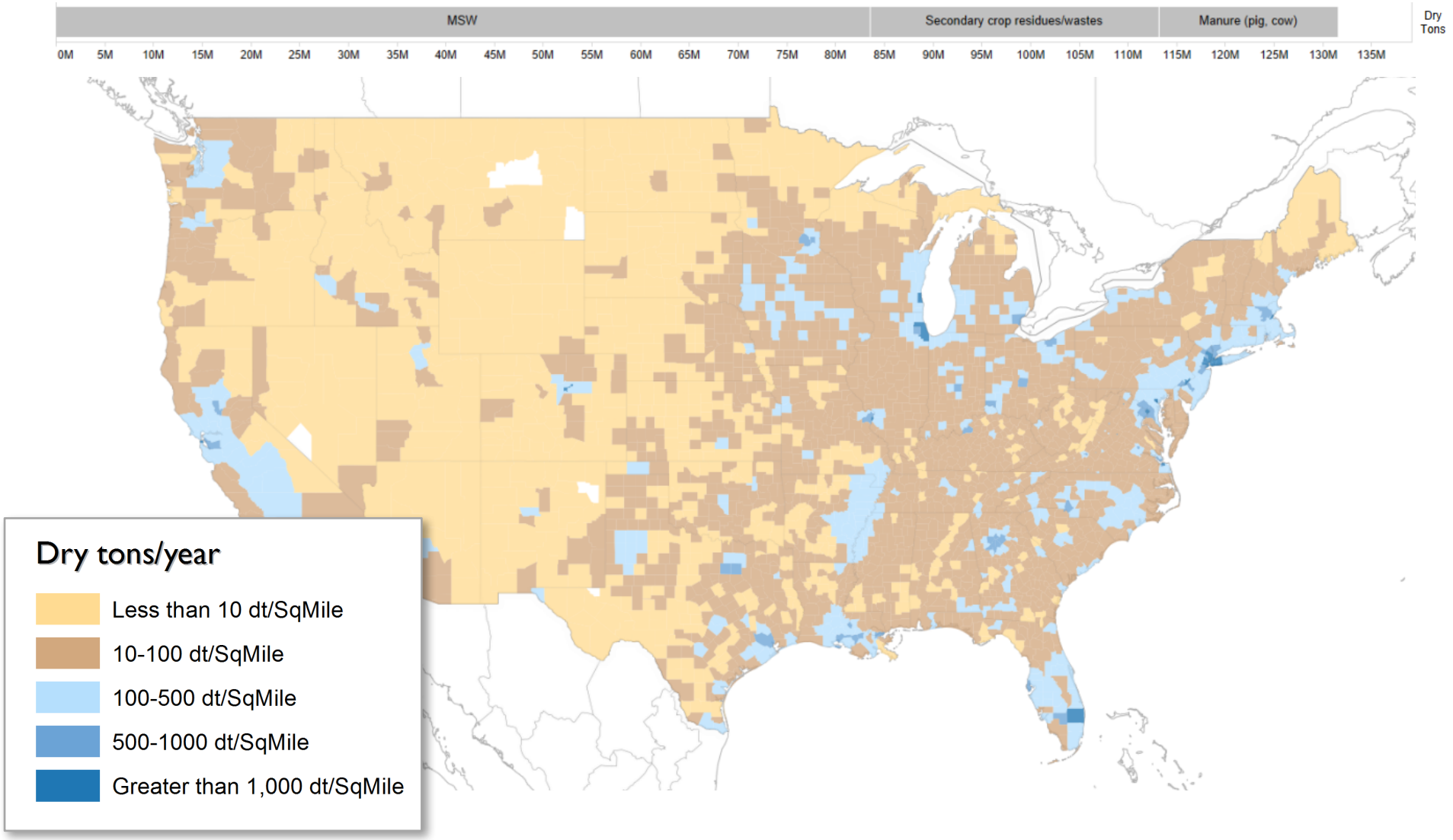
Base-case scenario: $60 offered price, forestry resources, year 2040



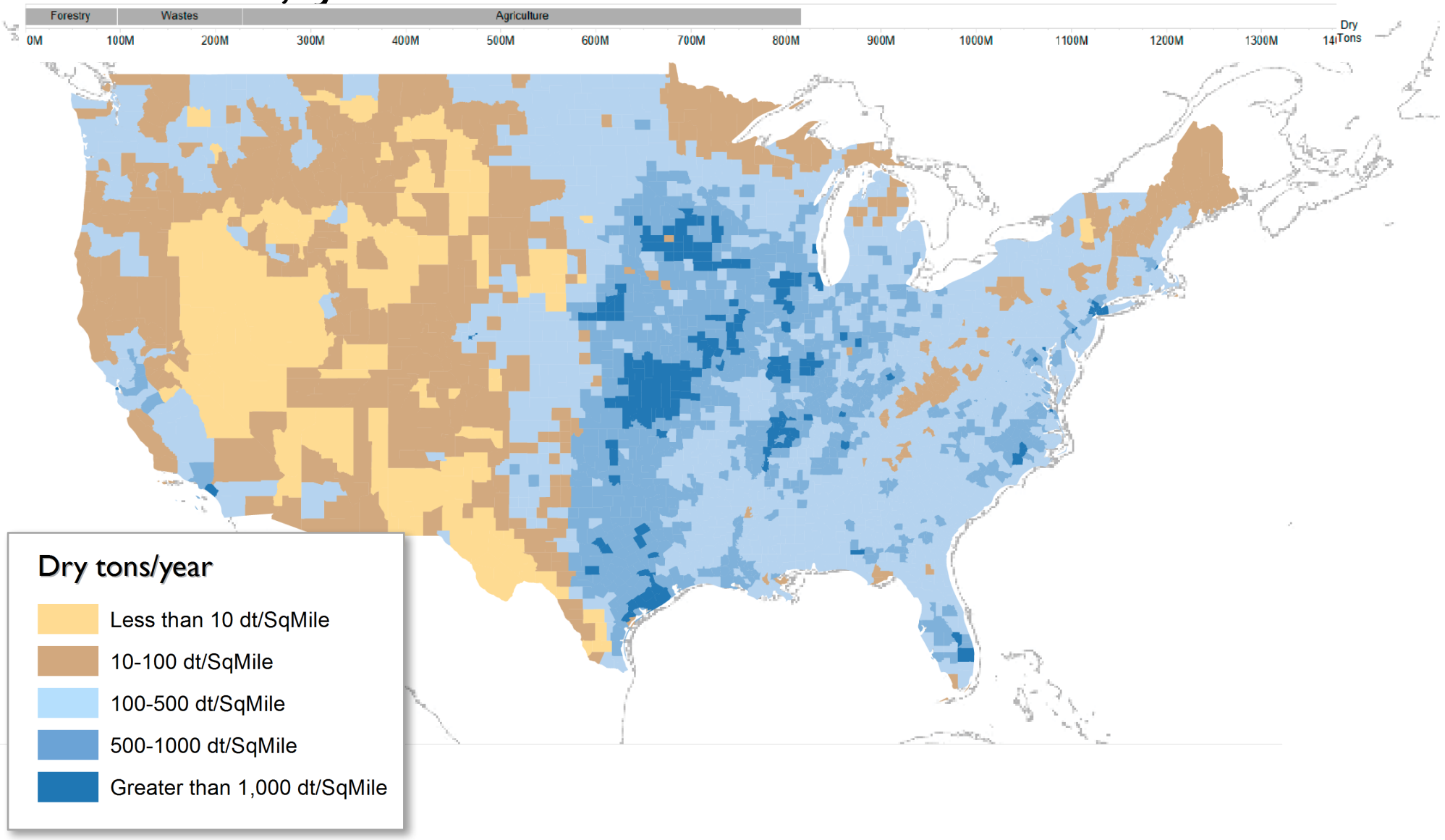
Base-case scenario, $60 offered price, agricultural resources, year 2040

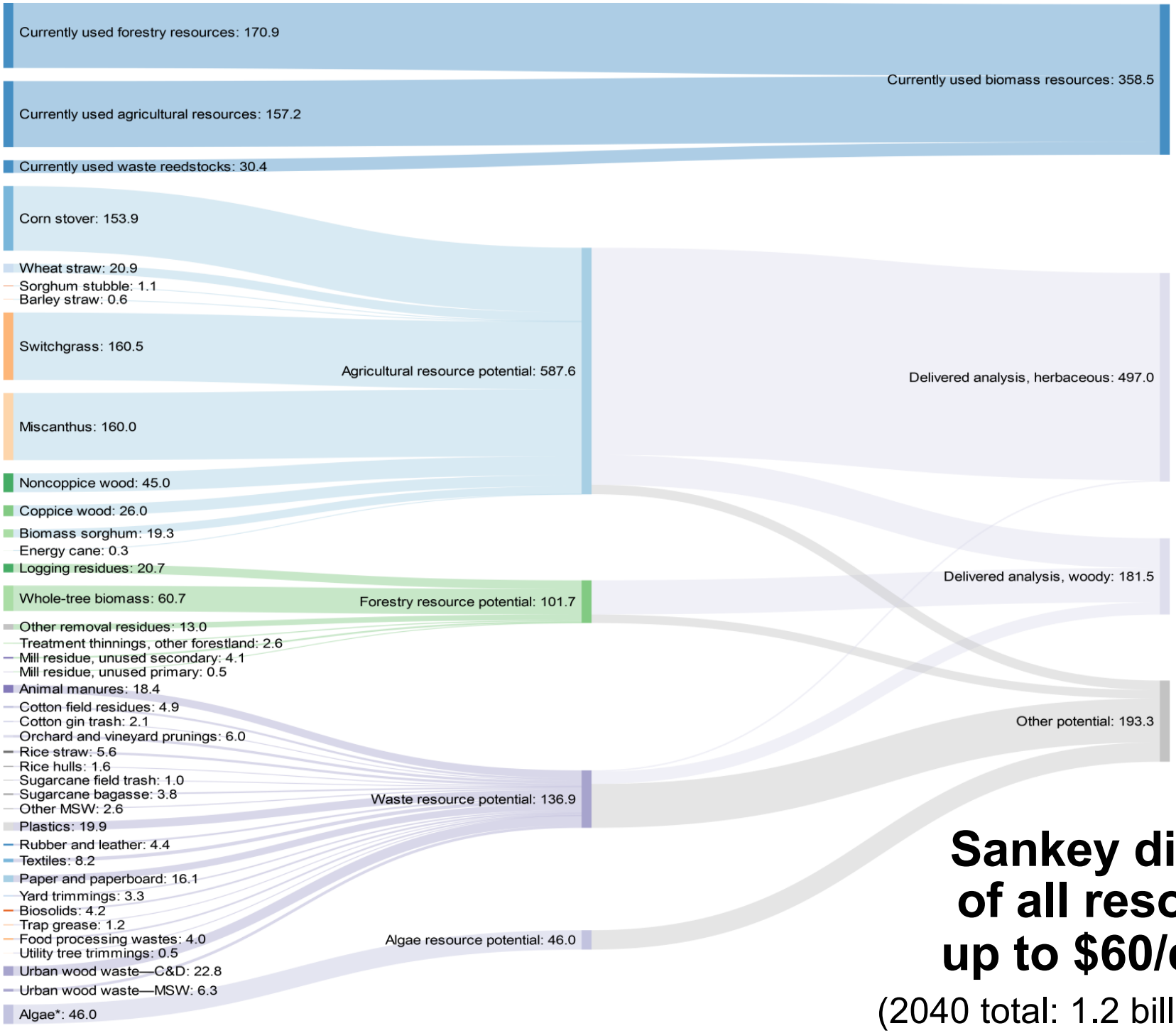


Base-case scenario, $60 offered price, waste resources, year 2040



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

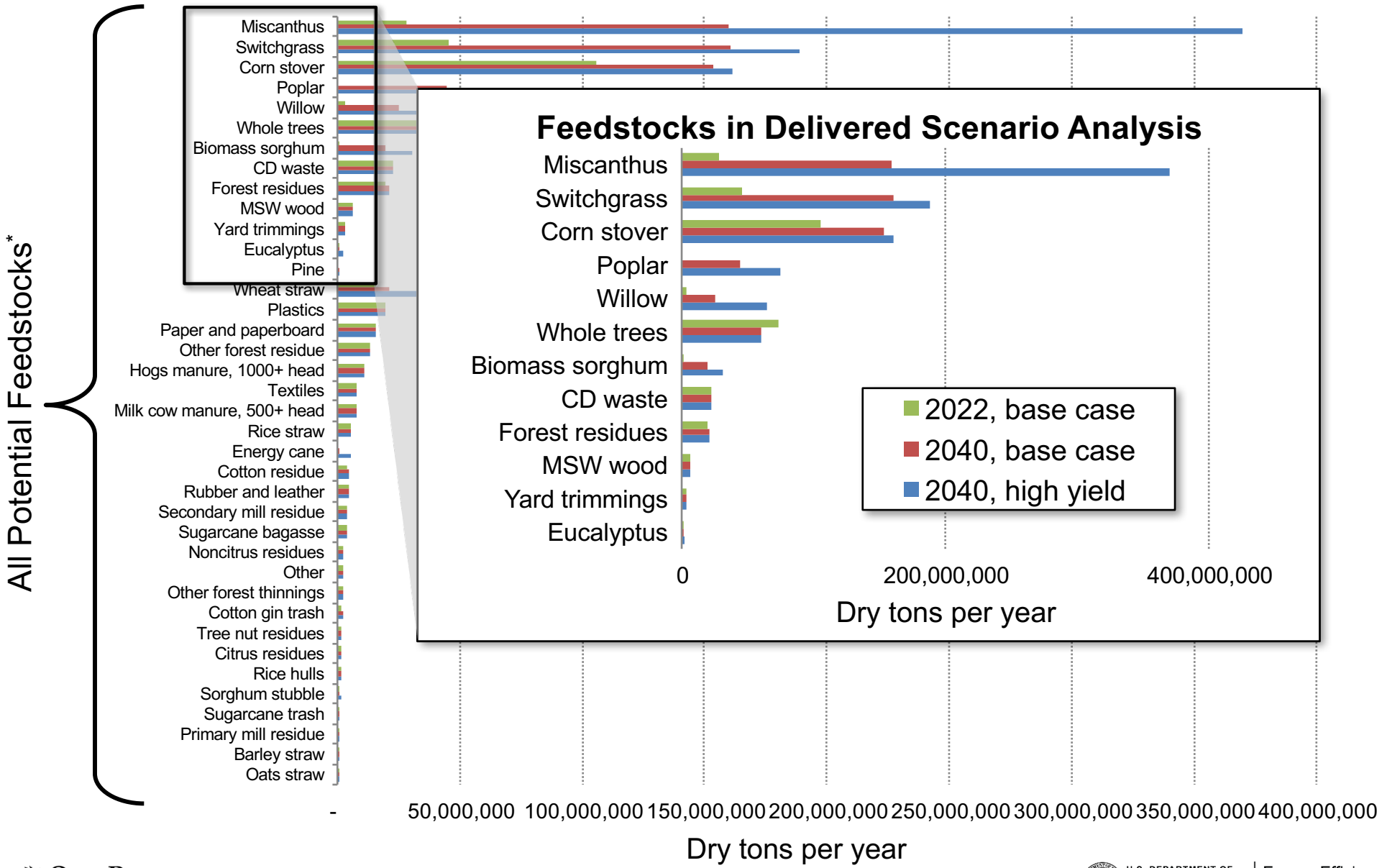




Sankey diagram of all resources up to $60/dry ton

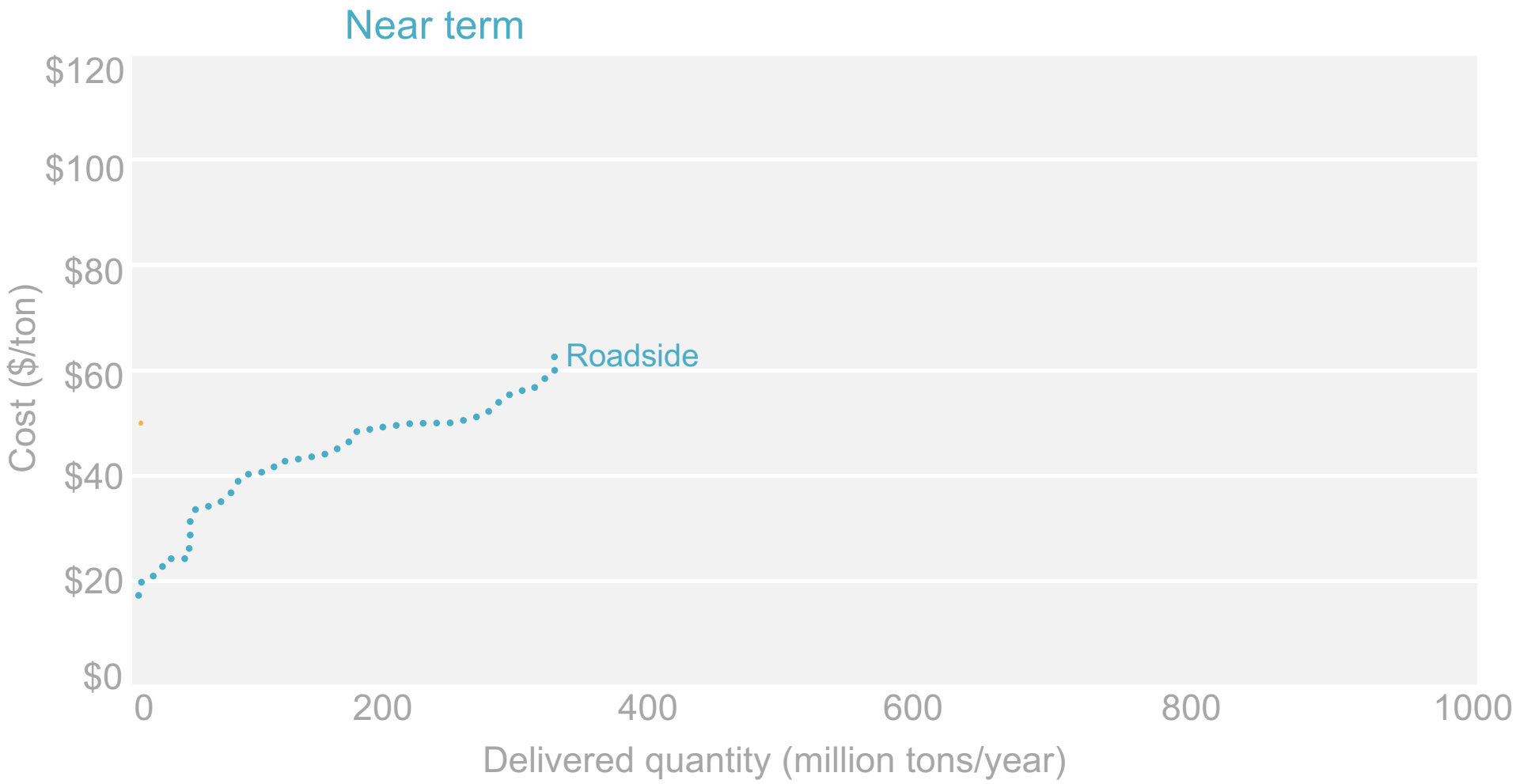
(2040 total: 1.2 billion tons/year)

Feedstocks to the Delivered Analysis

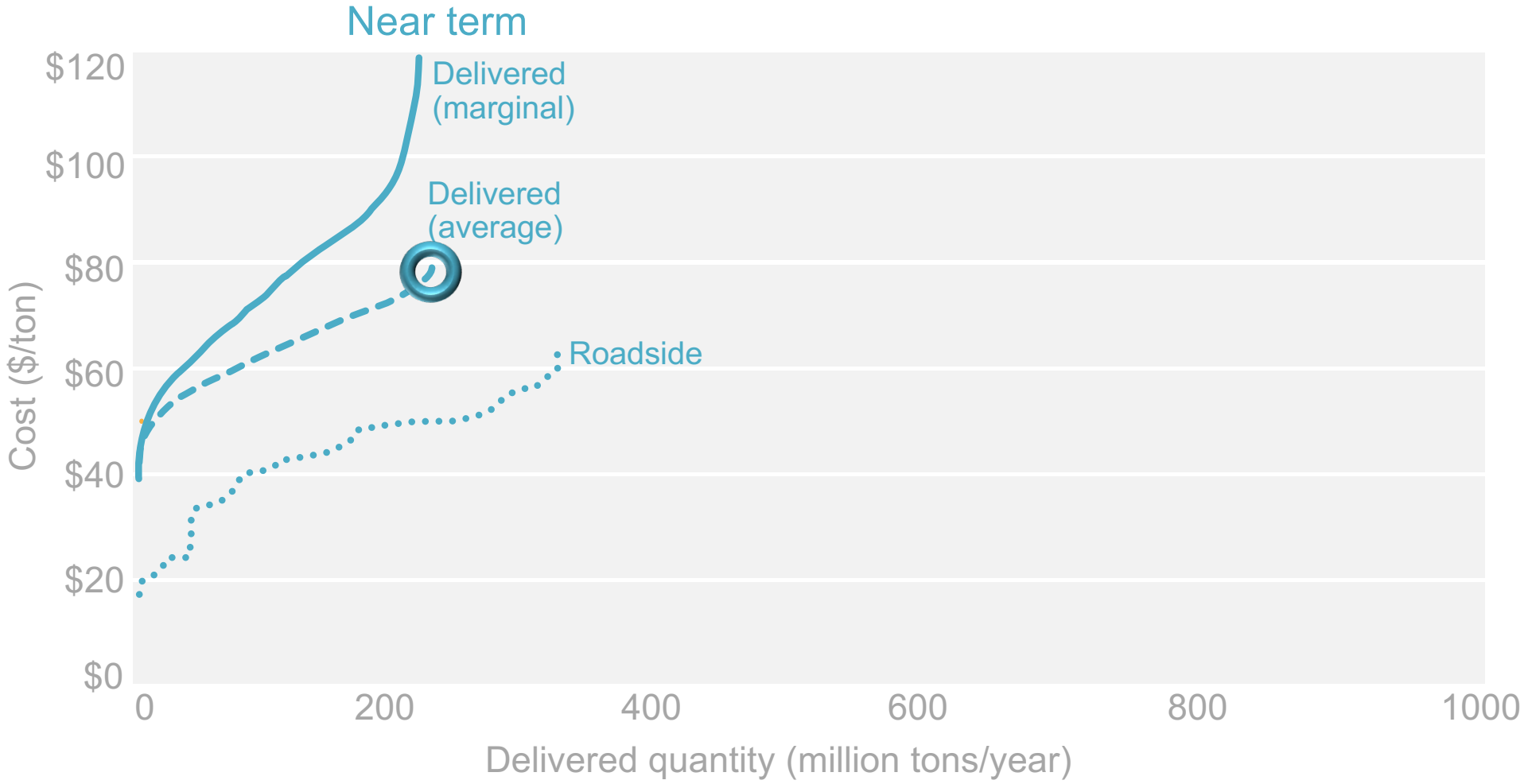


*Potentially available at up to $60/dry ton

Delivered Scenario Analysis



Delivered Scenario Analysis



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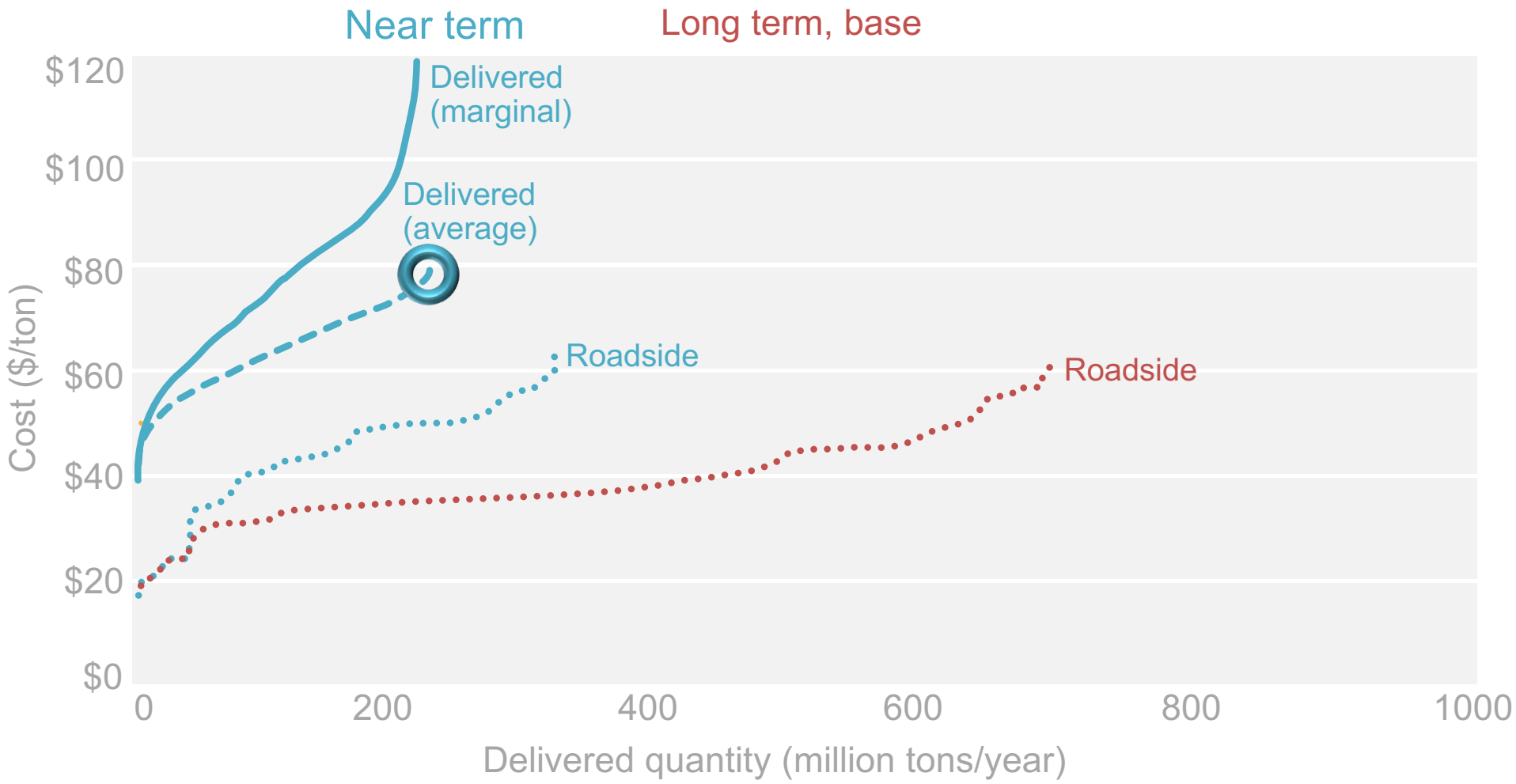

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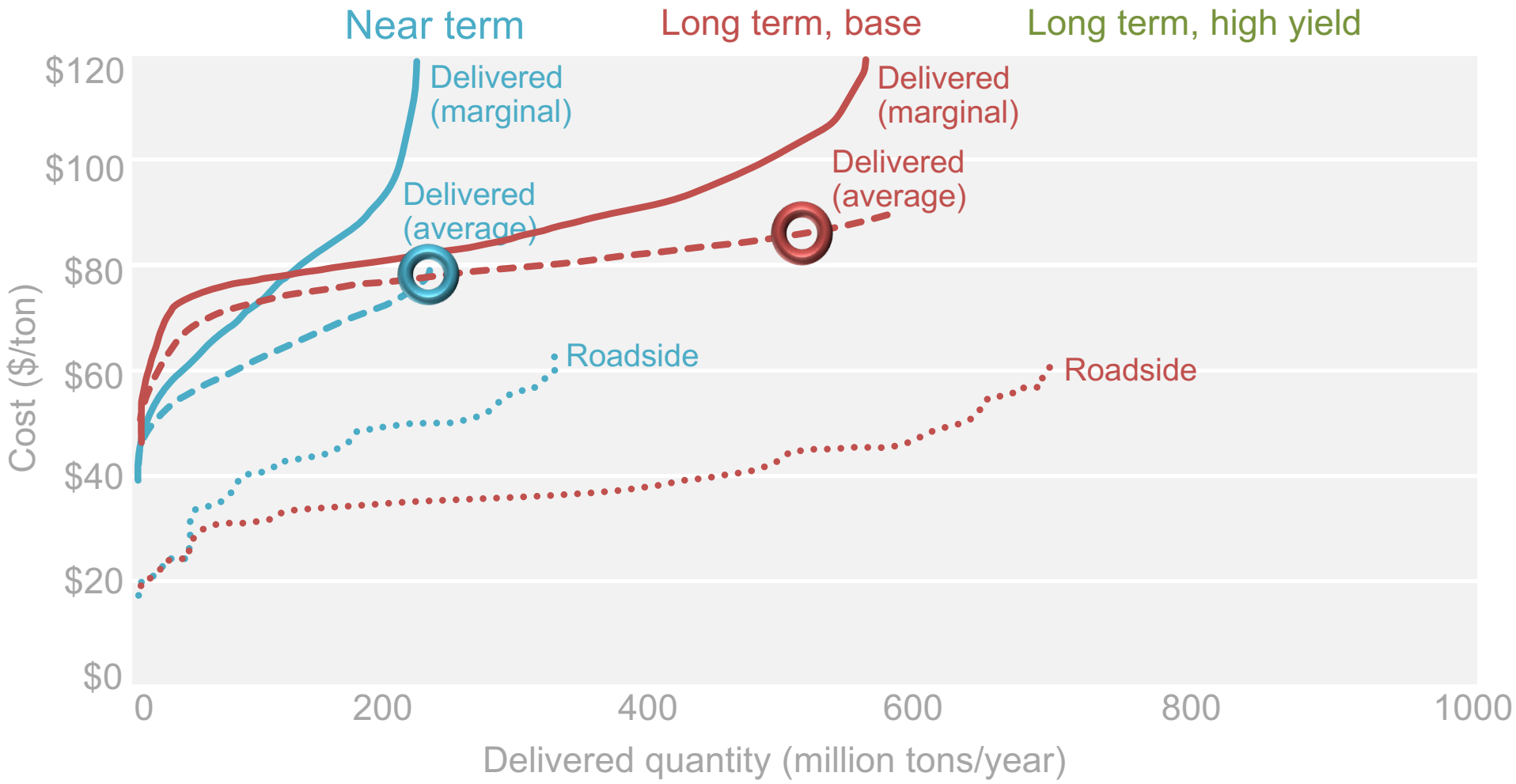

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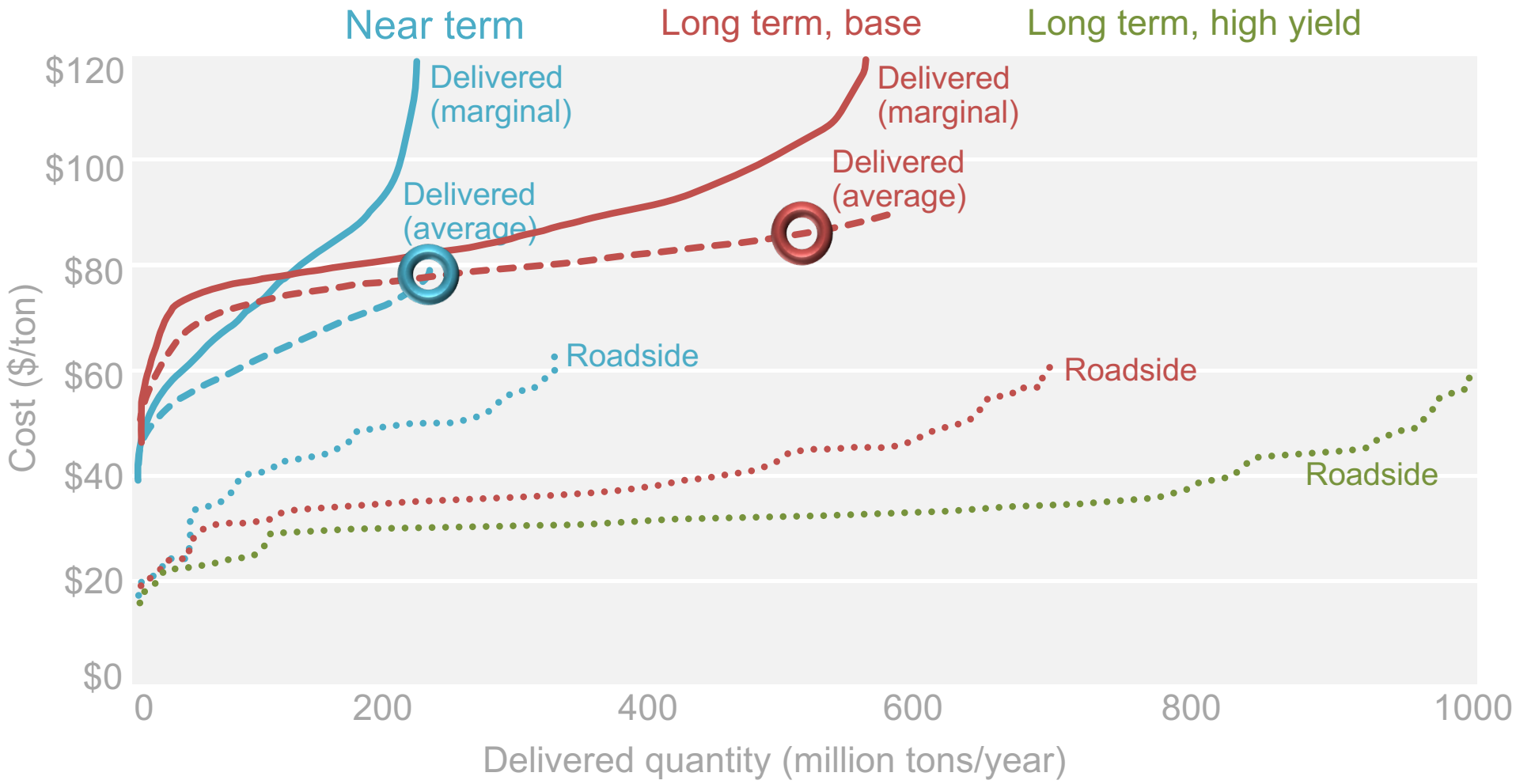

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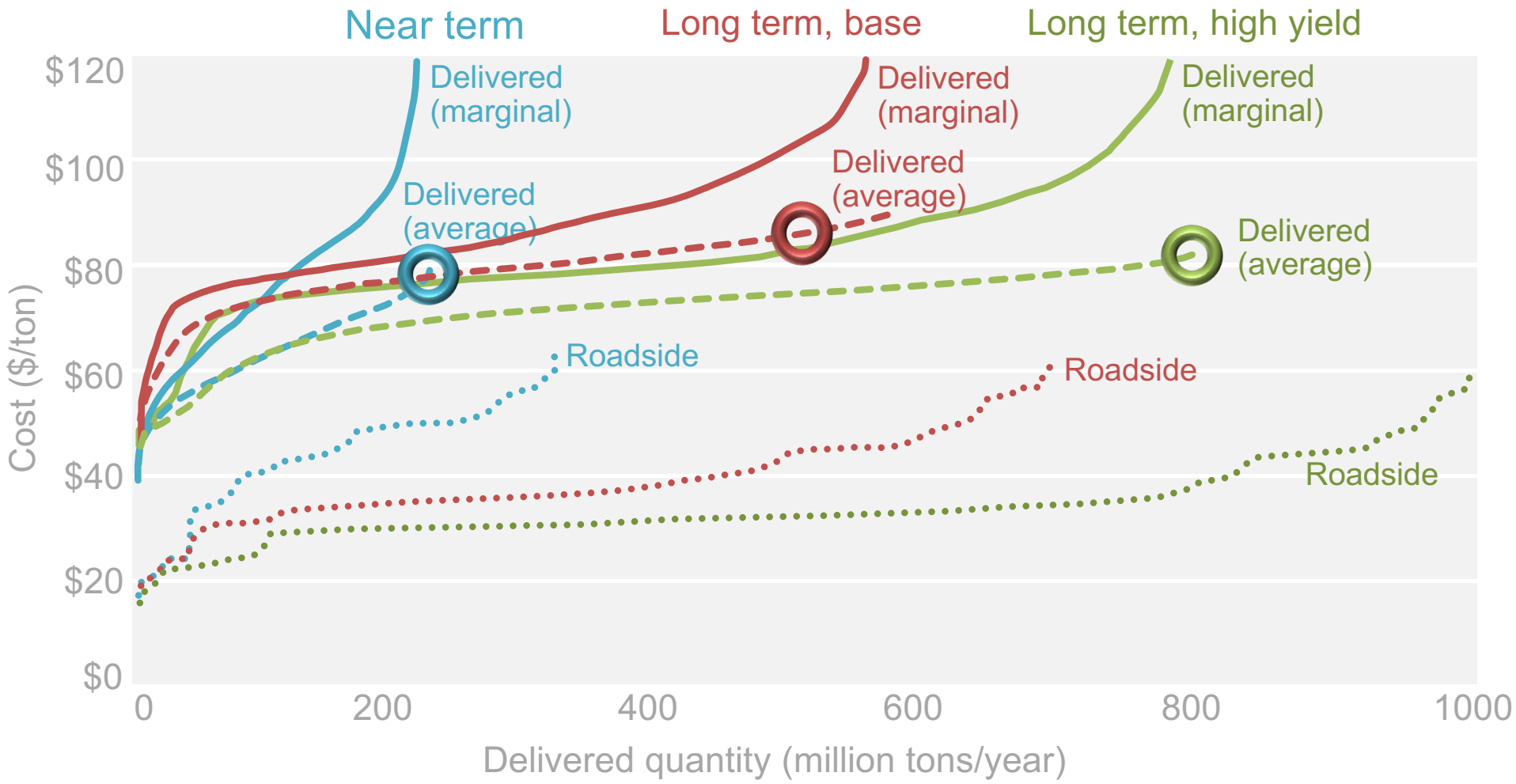

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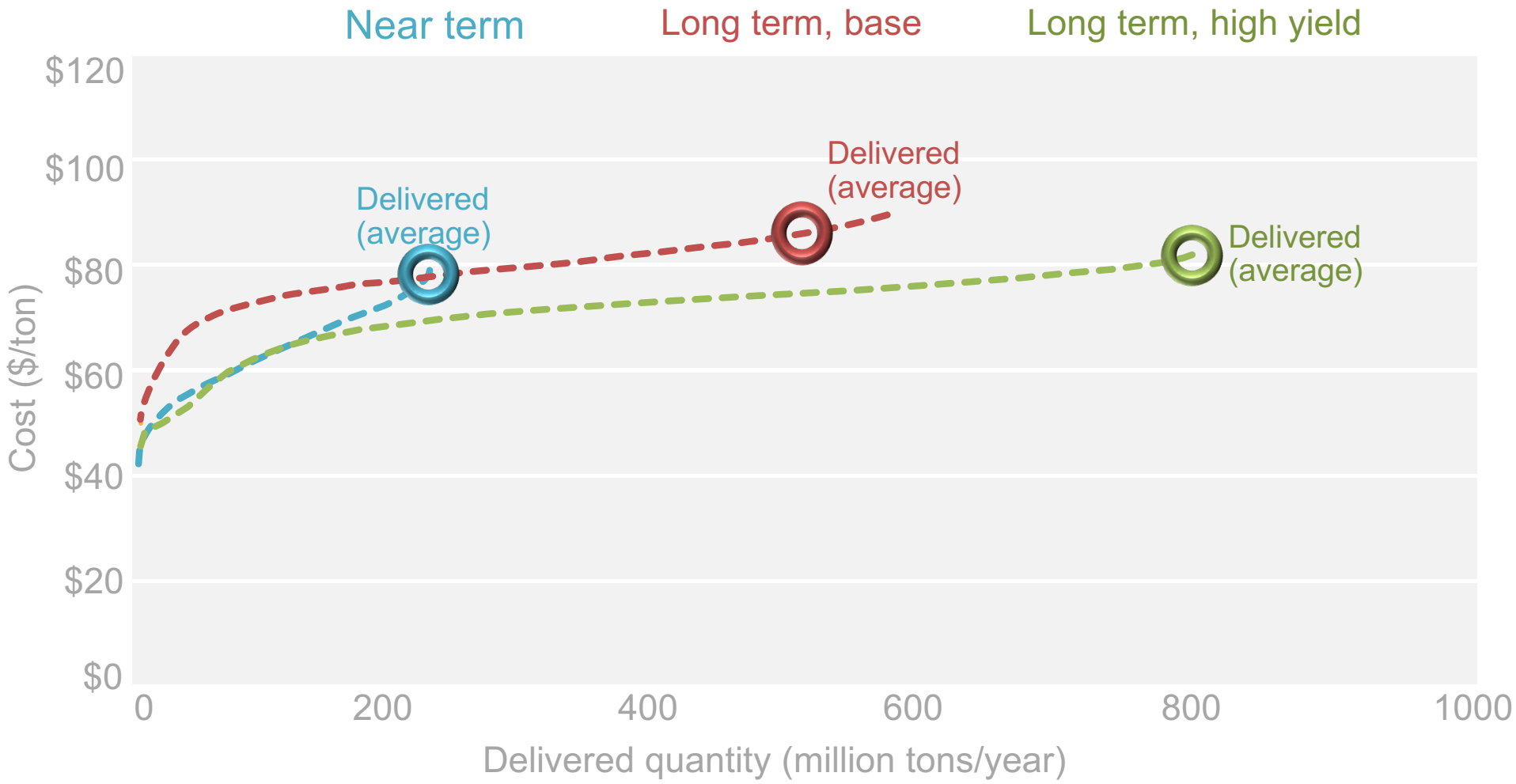
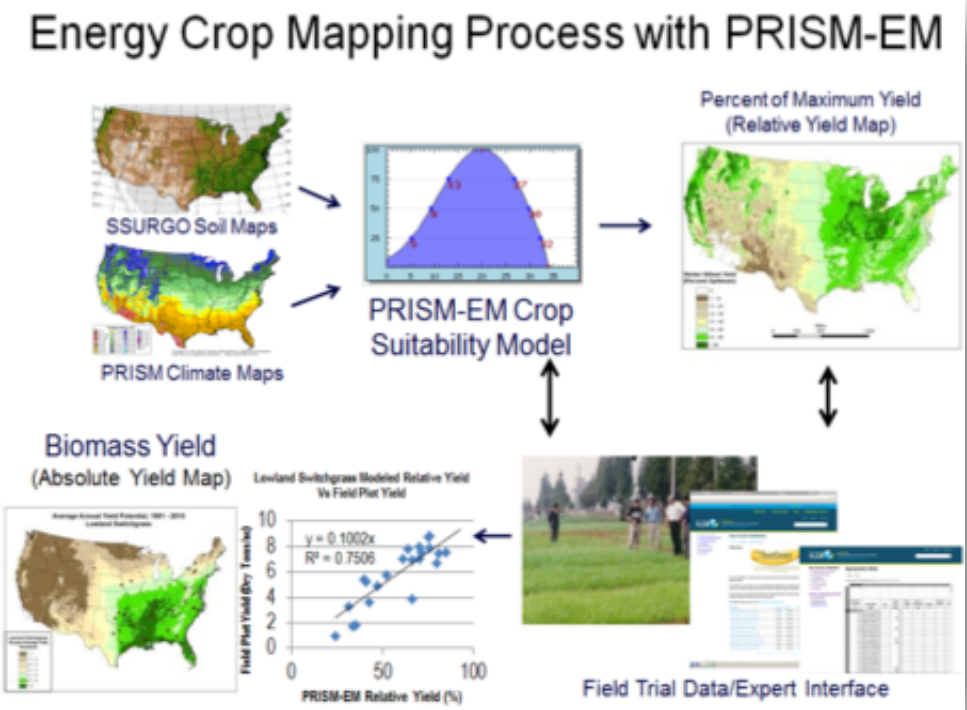


SRWC modeling in BT16 (aka “Poplar Peaks”)

- 2011 BT2 post-processed
- BT16, first effort: Incremental planting; 30-year planning horizon.
- BT16, second and final effort: NPV calculated as non-incremental planting, implemented as incremental planting; 32-year planning horizon.
- General SRWC assumptions
  - 15% yield bump starting on 1st coppice
  - SRWCs “locked in” for 20 years
  - More in Table C-8 on page 376 of BT16 Vol 1.

Energy Crop Yield Estimation



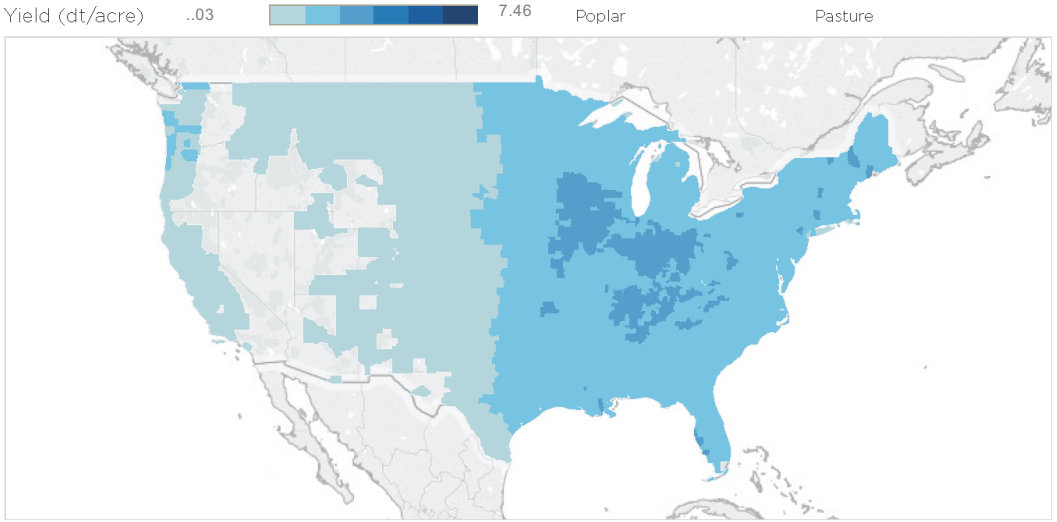
- 110 Field Trails
- 2008-2014 replicated trials with historical data
- Five manuscripts for Special Issue in preparation for GCB Biology- Bioenergy
- Guest Editor: Larry Smart

SunGrant INITIATIVE

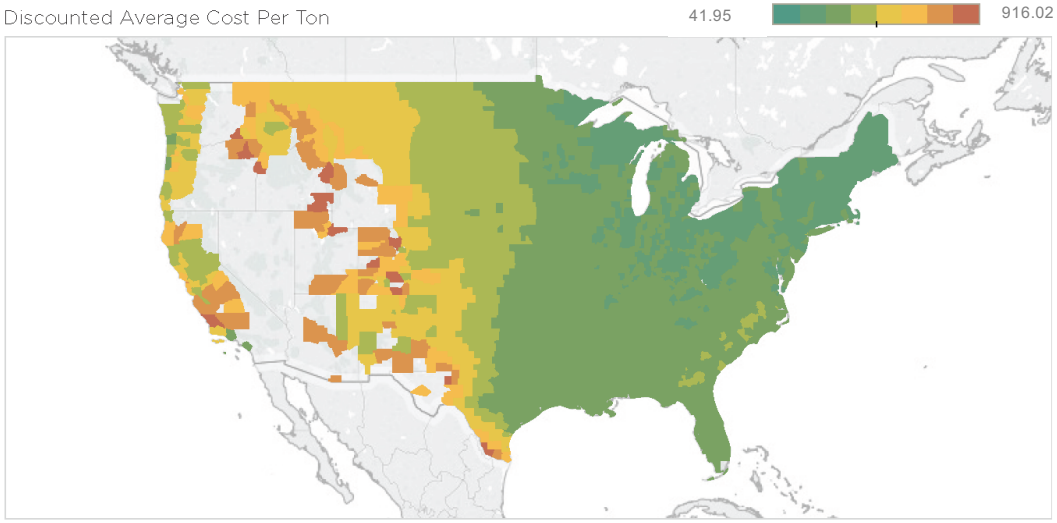
- Irrigation: Non-irrigated conditions; summer fallow not assumed
- Cultivar selection: "Best local cultivar" at the time of trial – used the highest yielding cultivar at each site
- Harvest frequency: Once per year to maximize biomass; MAI for woody
- Yield Gap: Adjusted between test plot and farm if plots were small
- Establishment: Assume successful established, no establishment year data
- Fertilizer Application: Best management practice based on soil type, mass balance approach for removal
- Fungicide/Pesticide Application: Best practice, typically minimal inputs

Inputs: Yield and cost for **Non-coppice woody crops**

Yield (dry tons/acre)

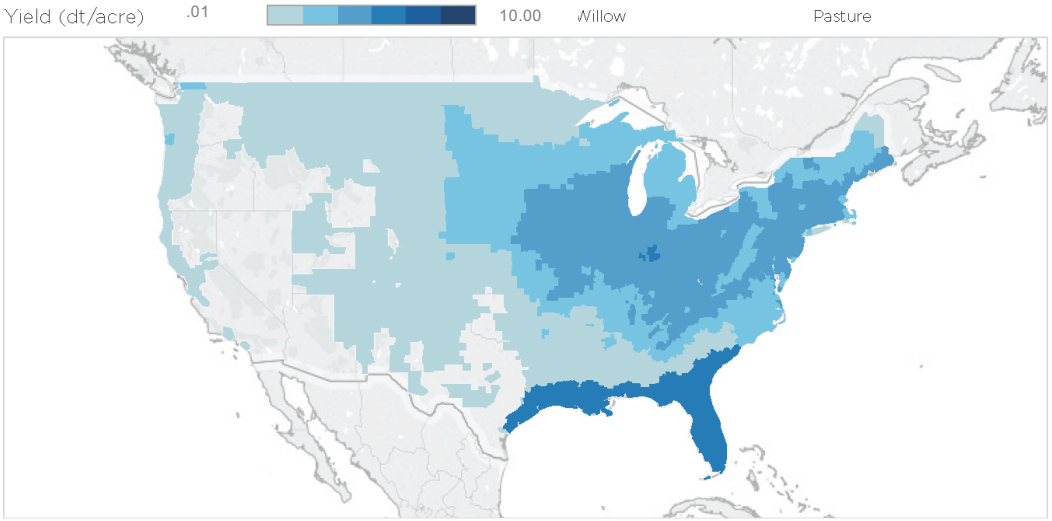


Cost ($/ton)

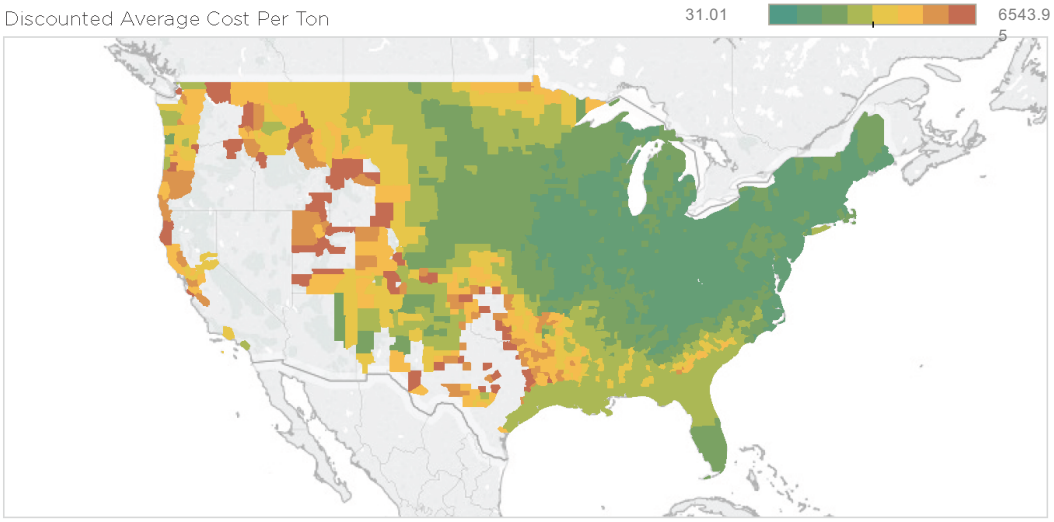


Inputs: Yield and cost for **Coppice woody crops**

Yield (dry tons/acre)

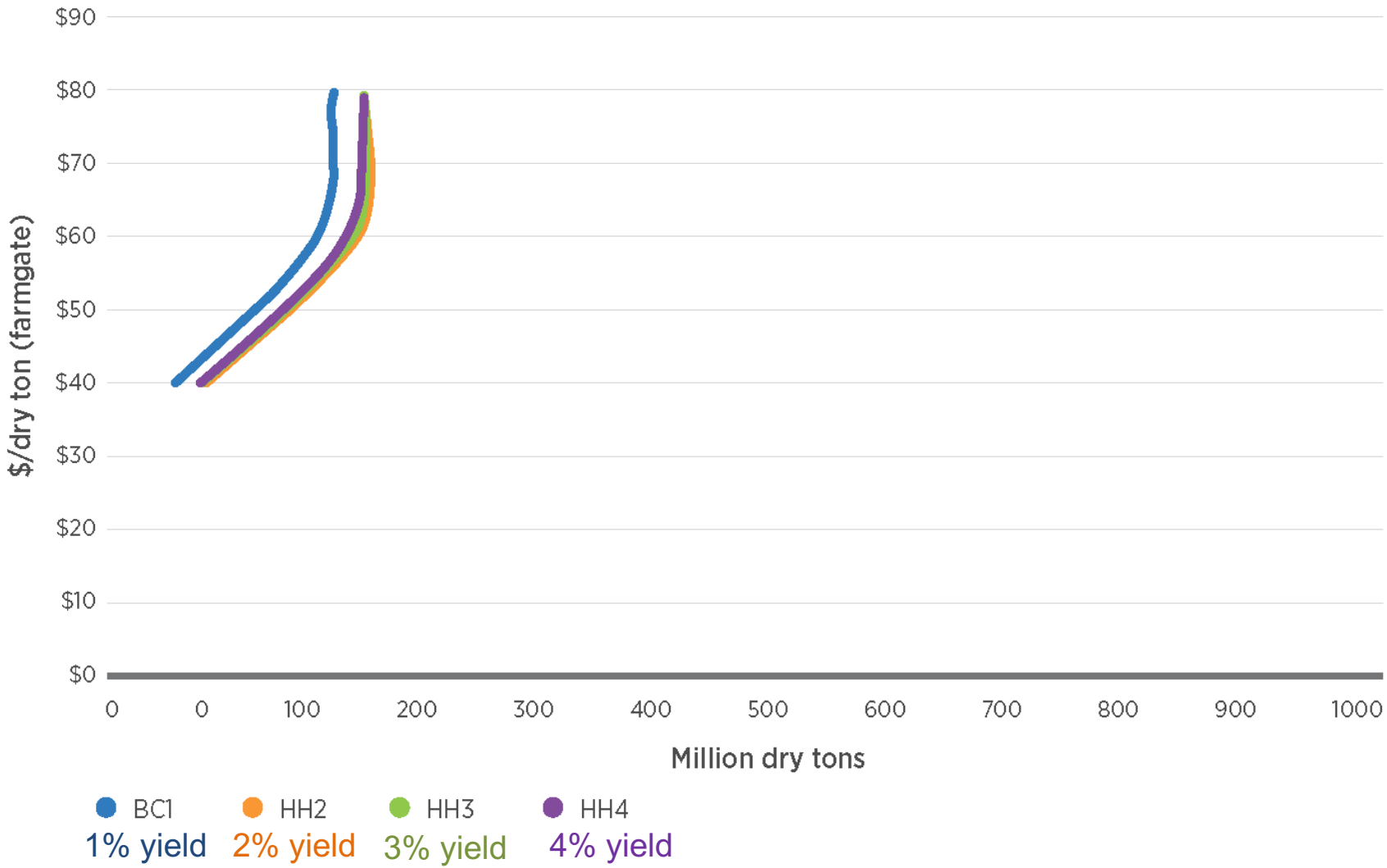


Cost ($/ton)

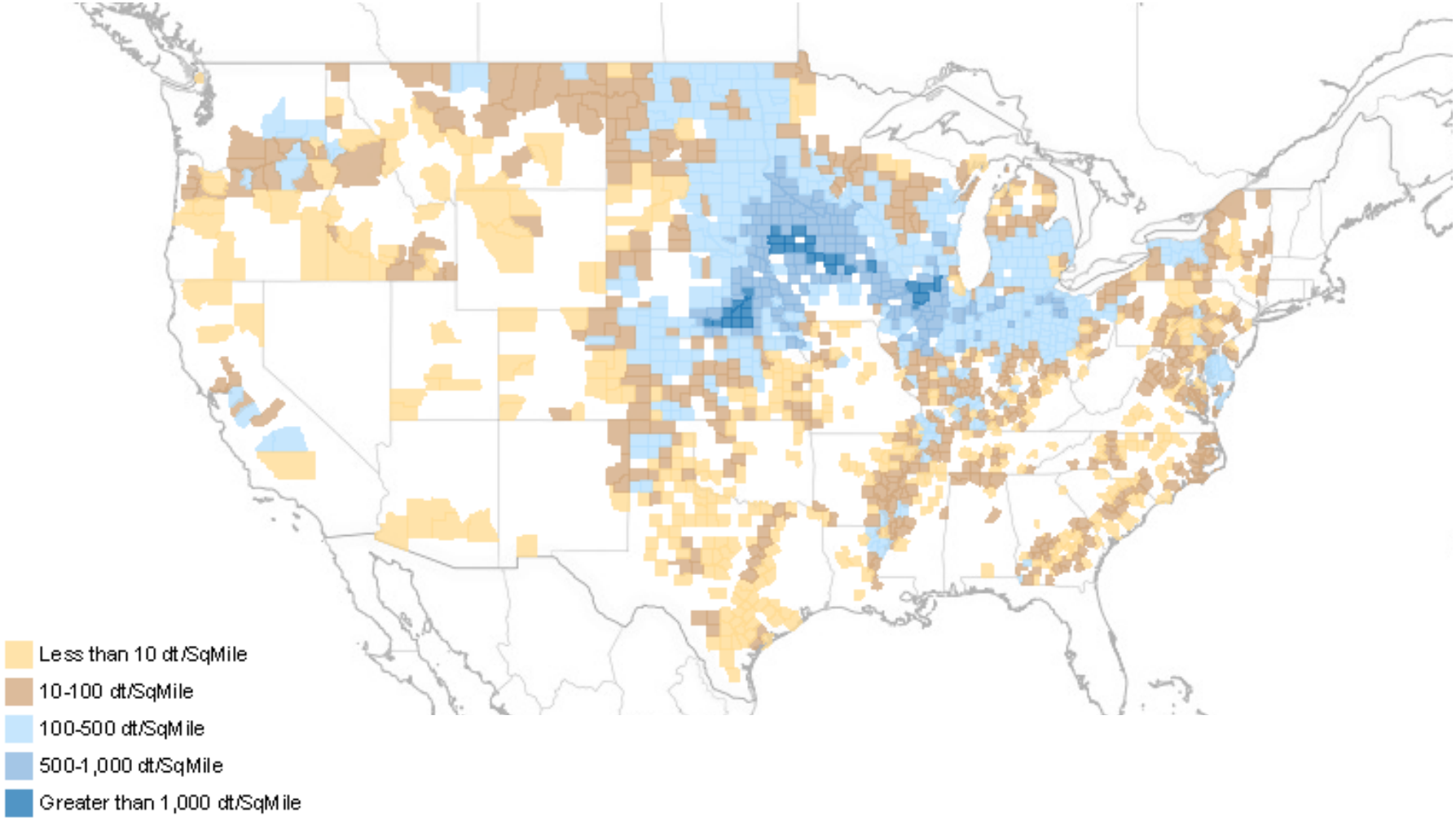


https://bioenergykdf.net/billionton2016/4/4/tableau

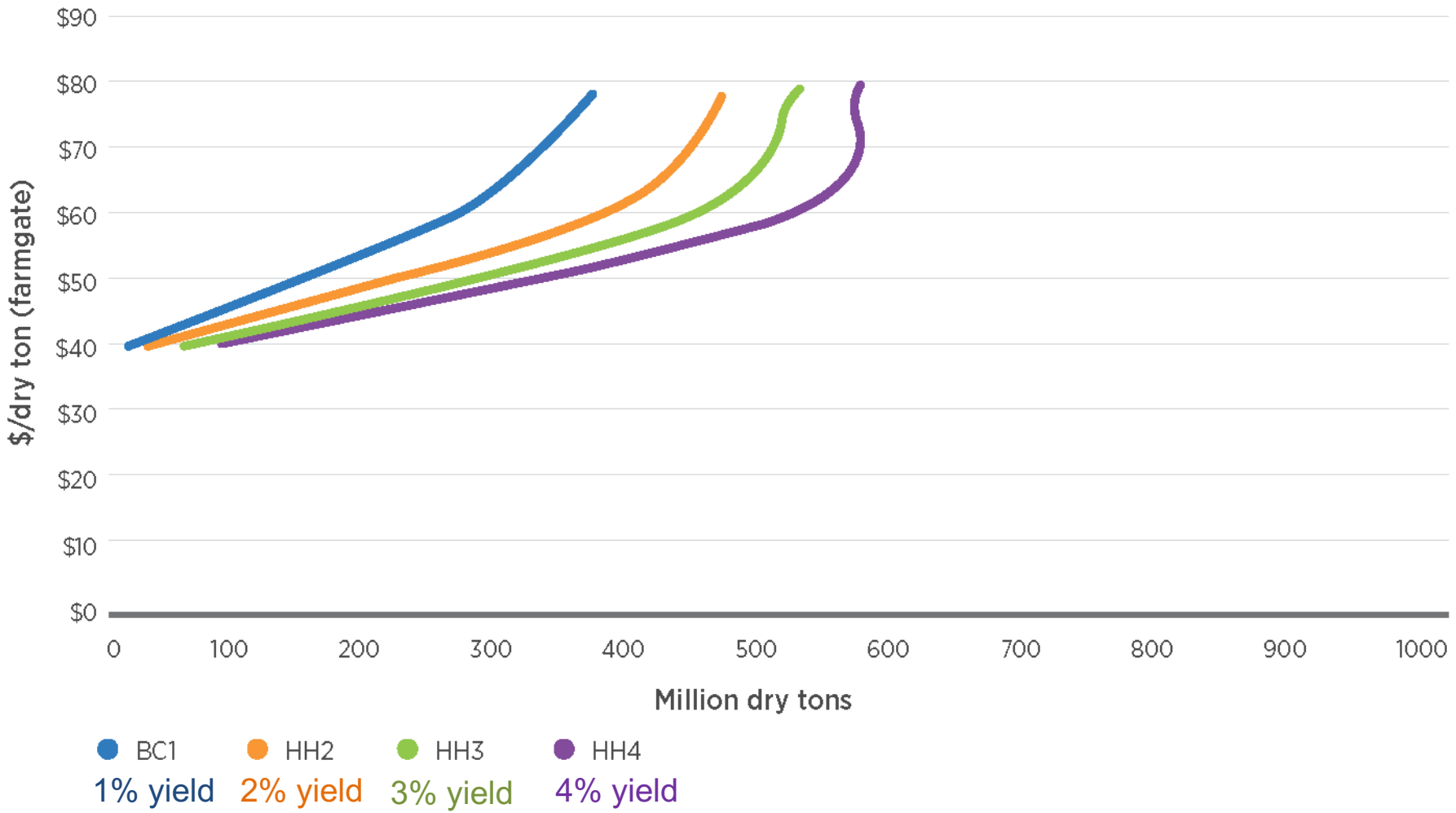
Results: Residues 2035



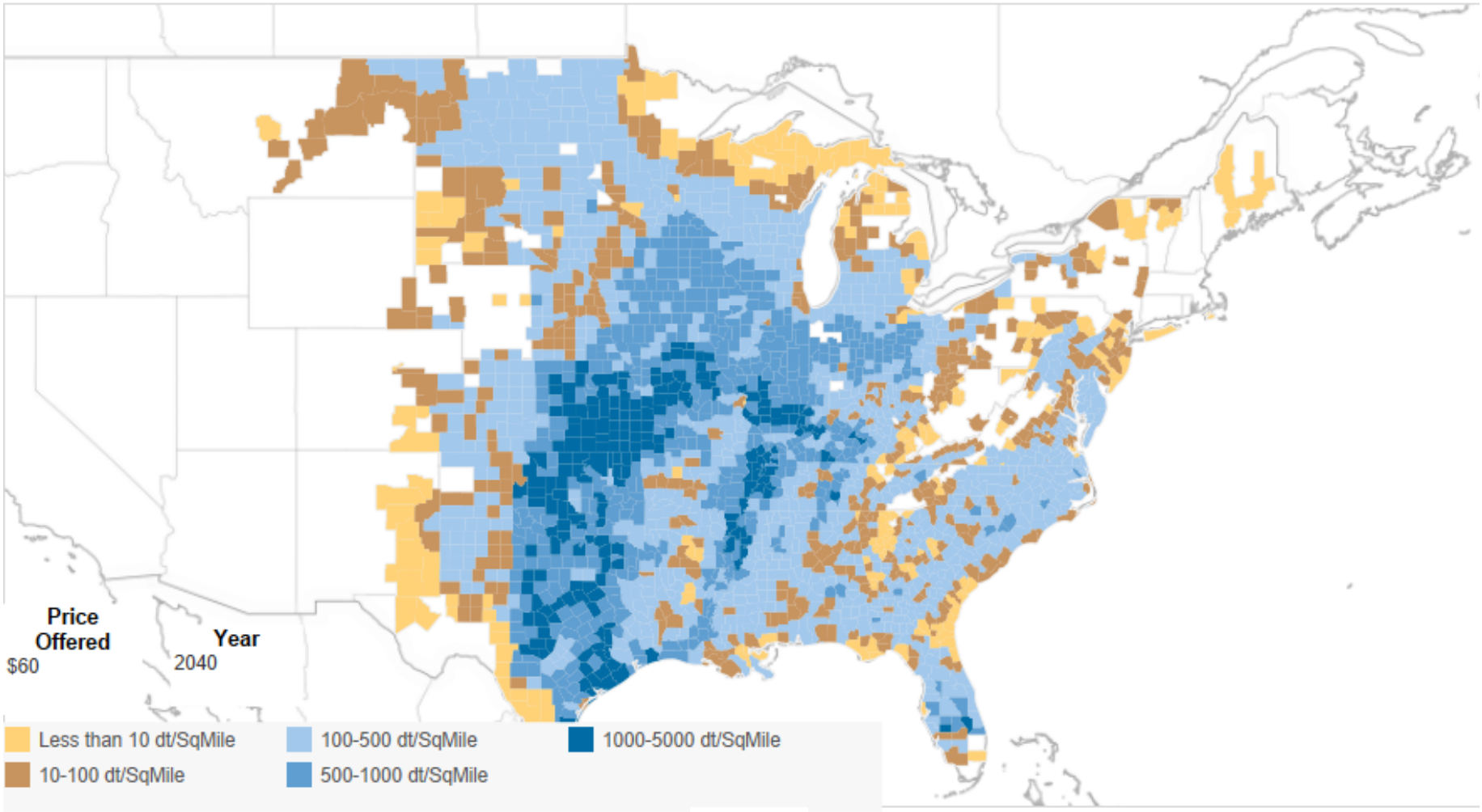
Results: Base-case (1%) $60, Residues: 176m dt by 2040



Results: herbaceous energy crops, 2035

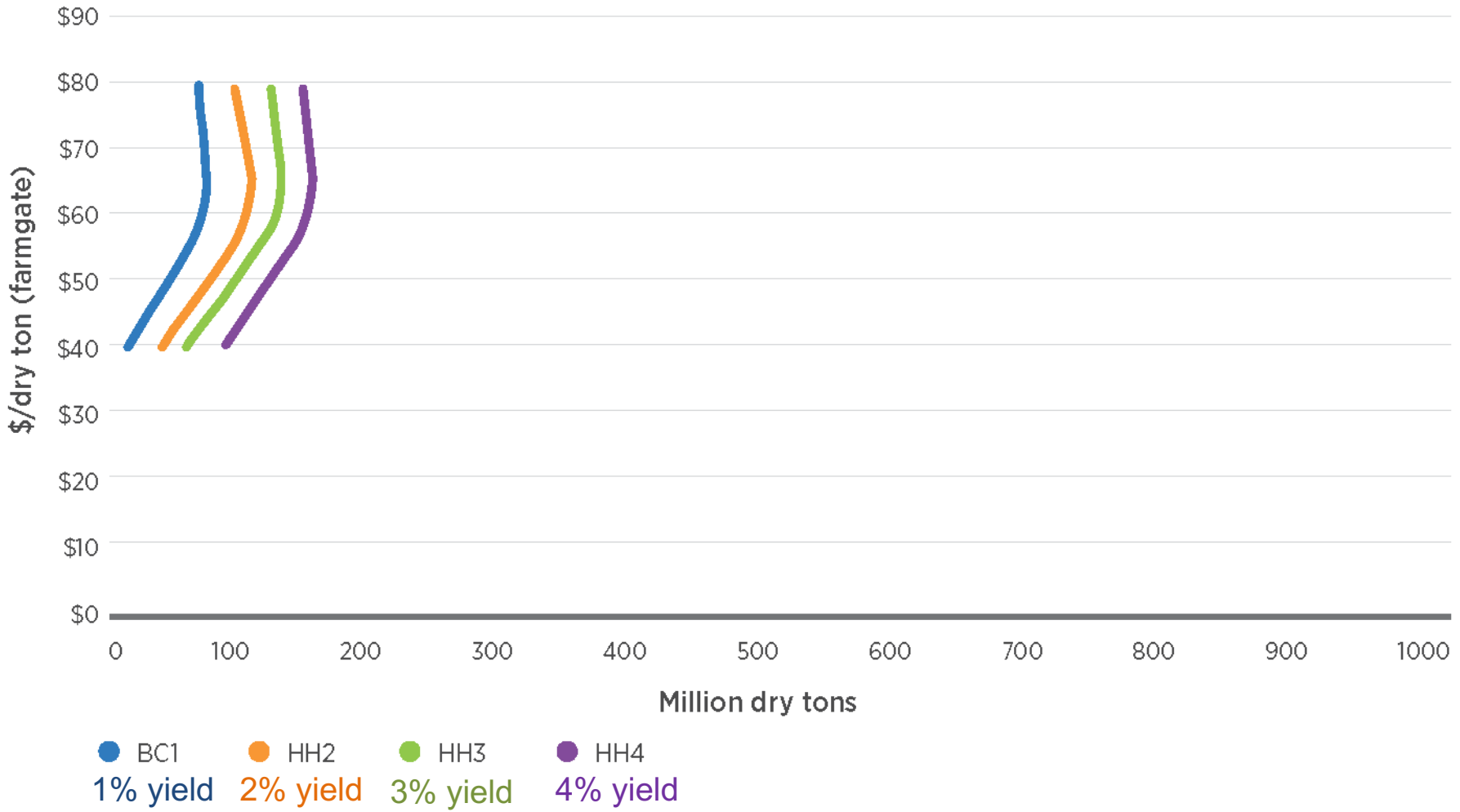


Results: High-yield (3%) $60, Herbaceous energy crops: 594m dt by 2040

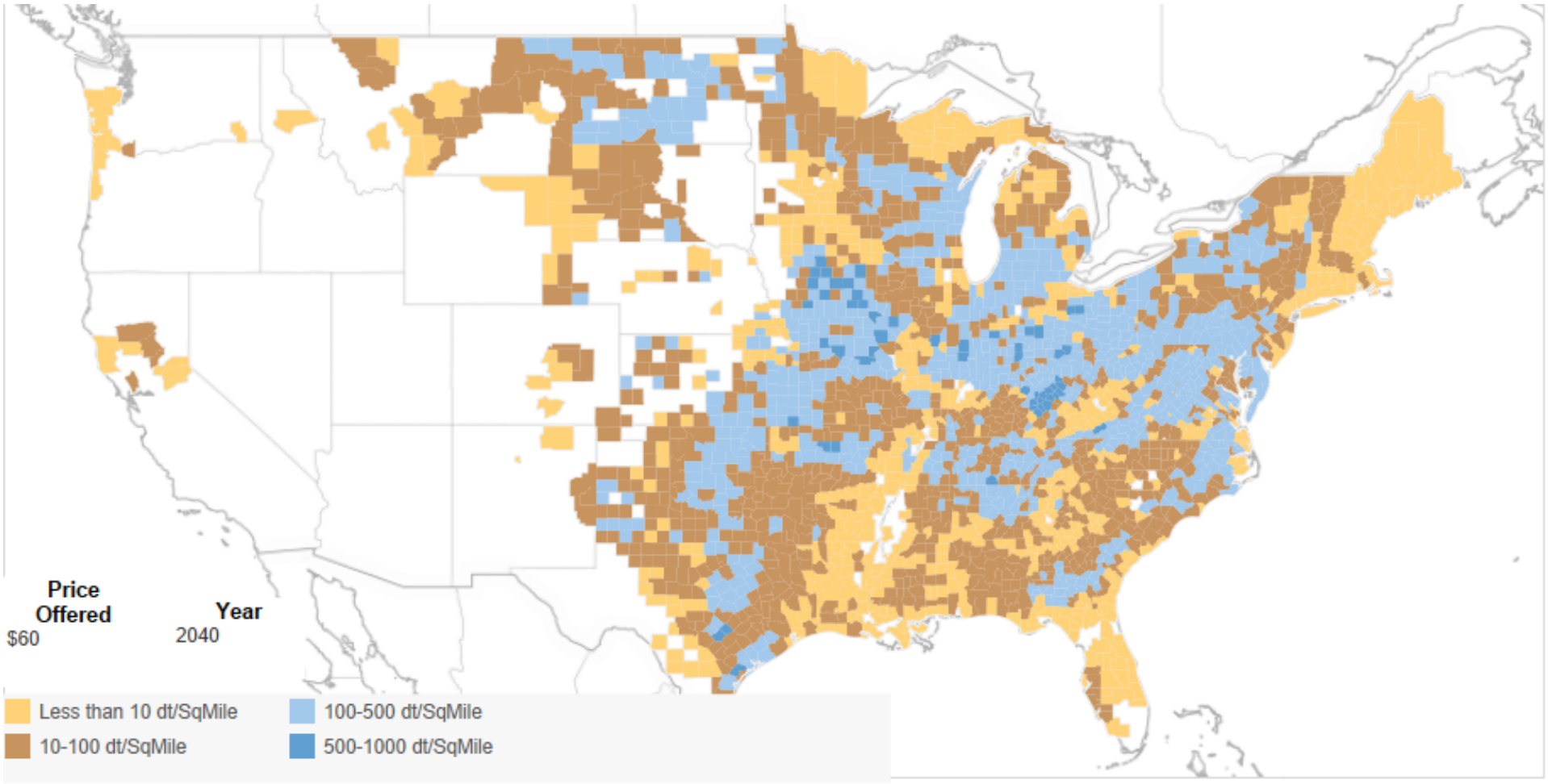


https://bioenergykdf.net/billionton2016/4/1/tableau

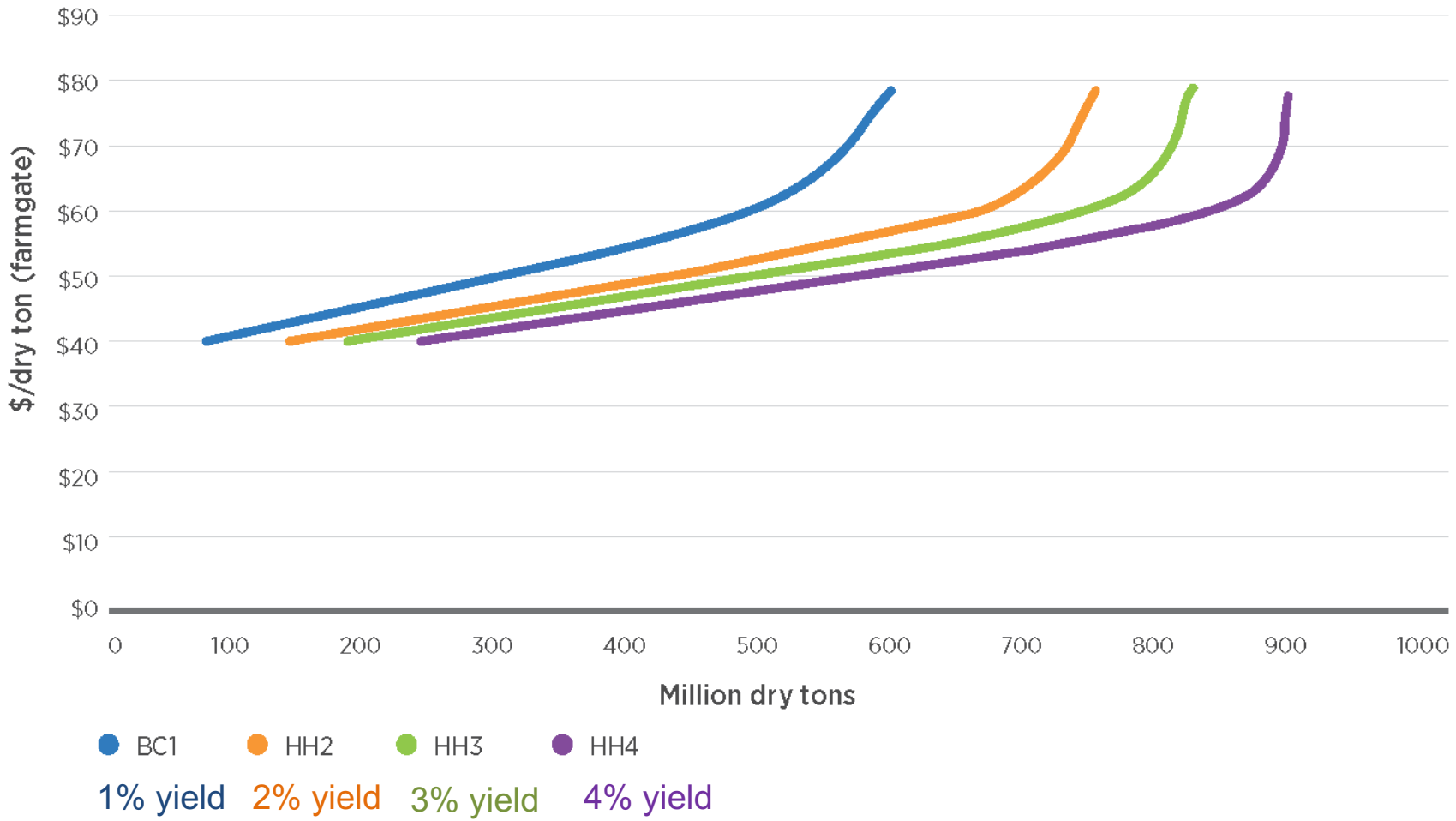
Results: SRWCs, 2035



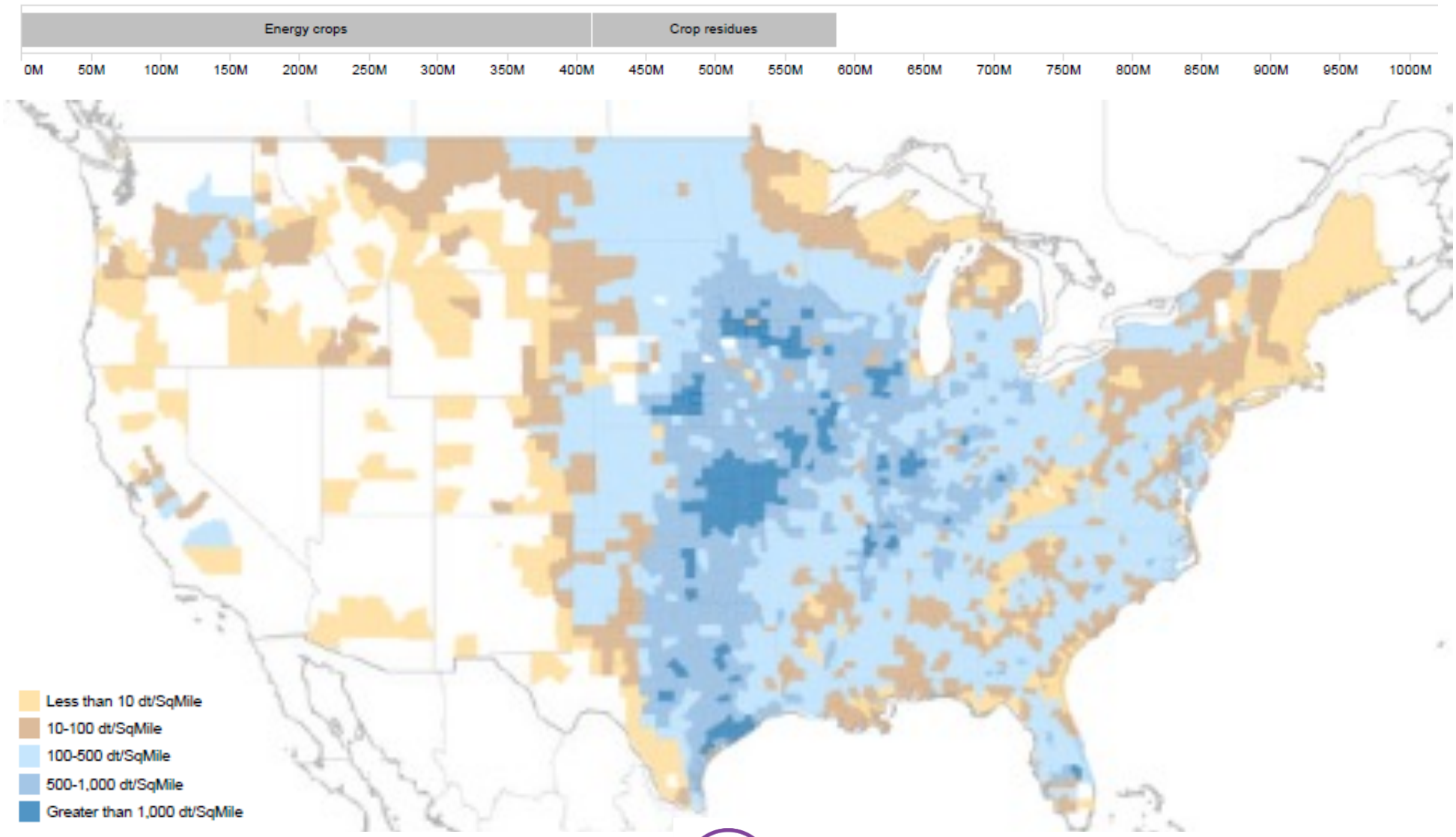
Results: High-yield (3%) $60, SRWCs: 142m dt by 2040



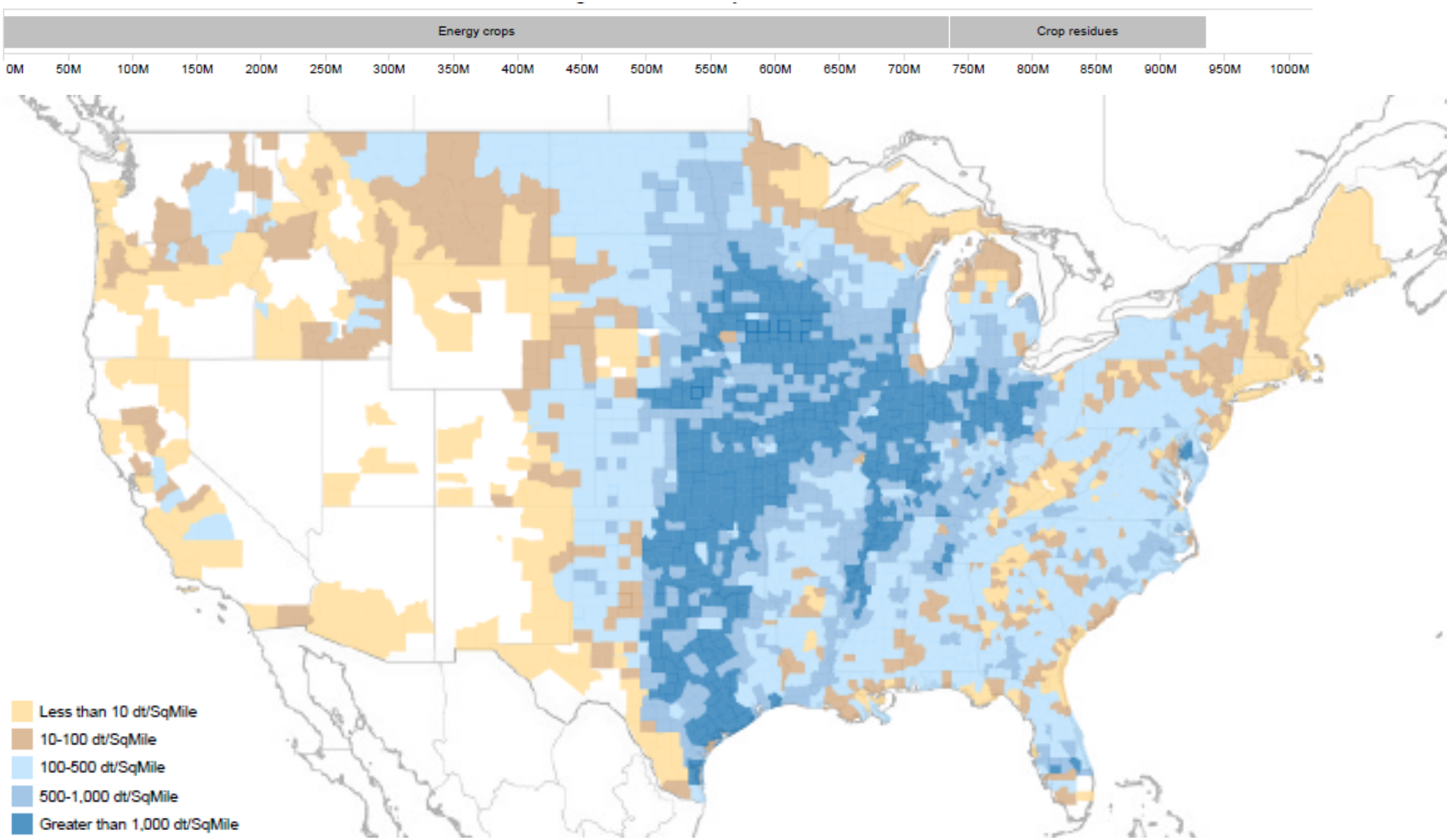
Results: All resources, 2035



Results: All resources, Base-case (1%) $60, 588m dt by 2040



Results: All resources, High yield (3%) $60, 937m dt by 2040



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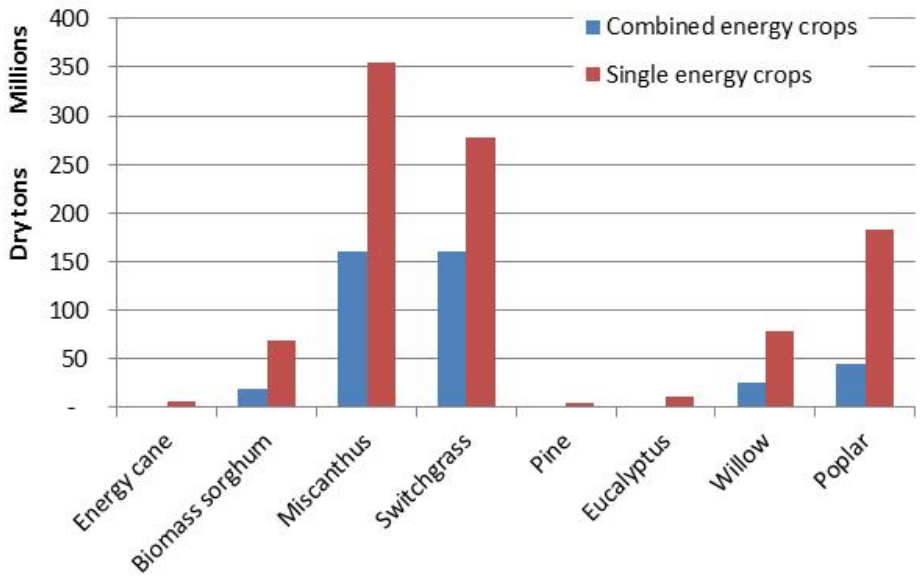
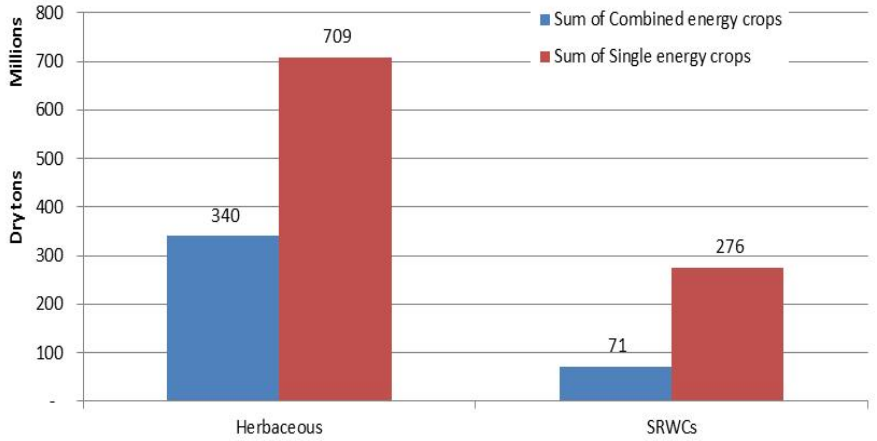
Interpretation of SRWC results

Combined vs Single Energy Crop Simulations, Base-case, 2040





Research Needs

- Eucalyptus yields into PRISM
- Optimal rotations
- Role of SRWCs in commercialization strategies
- Environmental services

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?”

Discussion

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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