

The 2016 Billion-ton Report: overview and implications for jet fuels

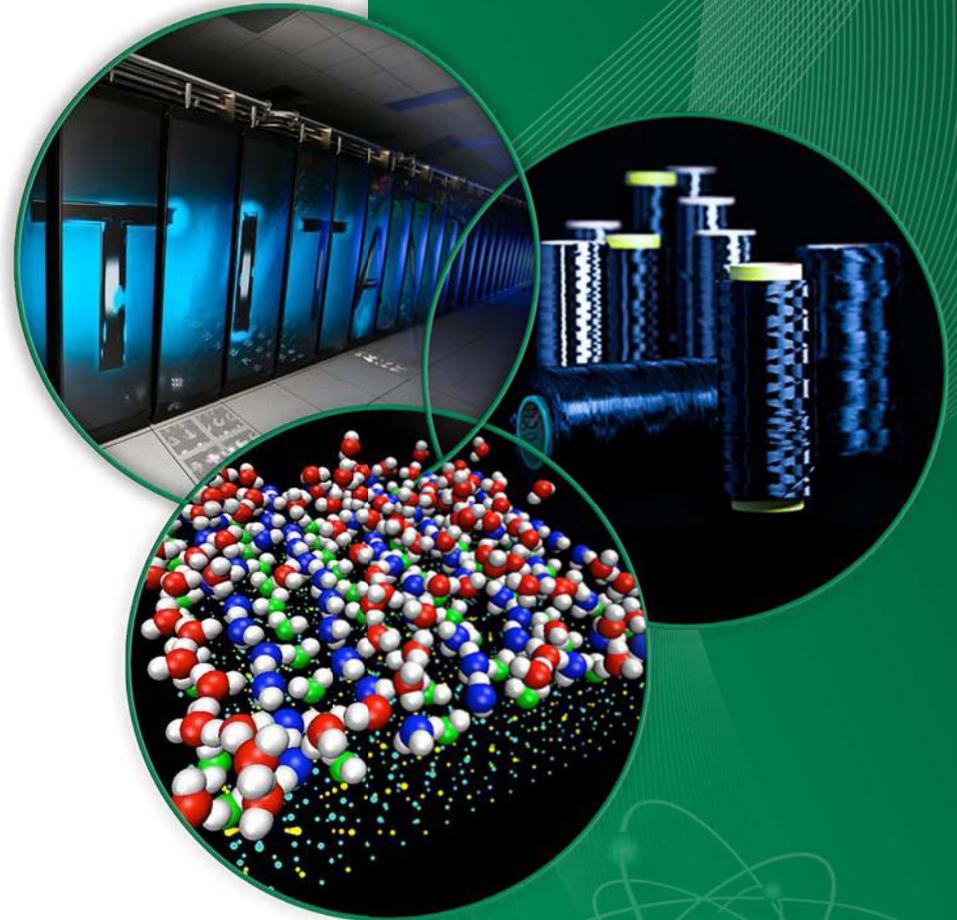
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September 14, 2016

Alternative Aviation Fuel Workshop

Macon, Georgia

Disclaimer: Comments presented are my own and neither constitute nor imply policy of the U.S. Department of Energy.

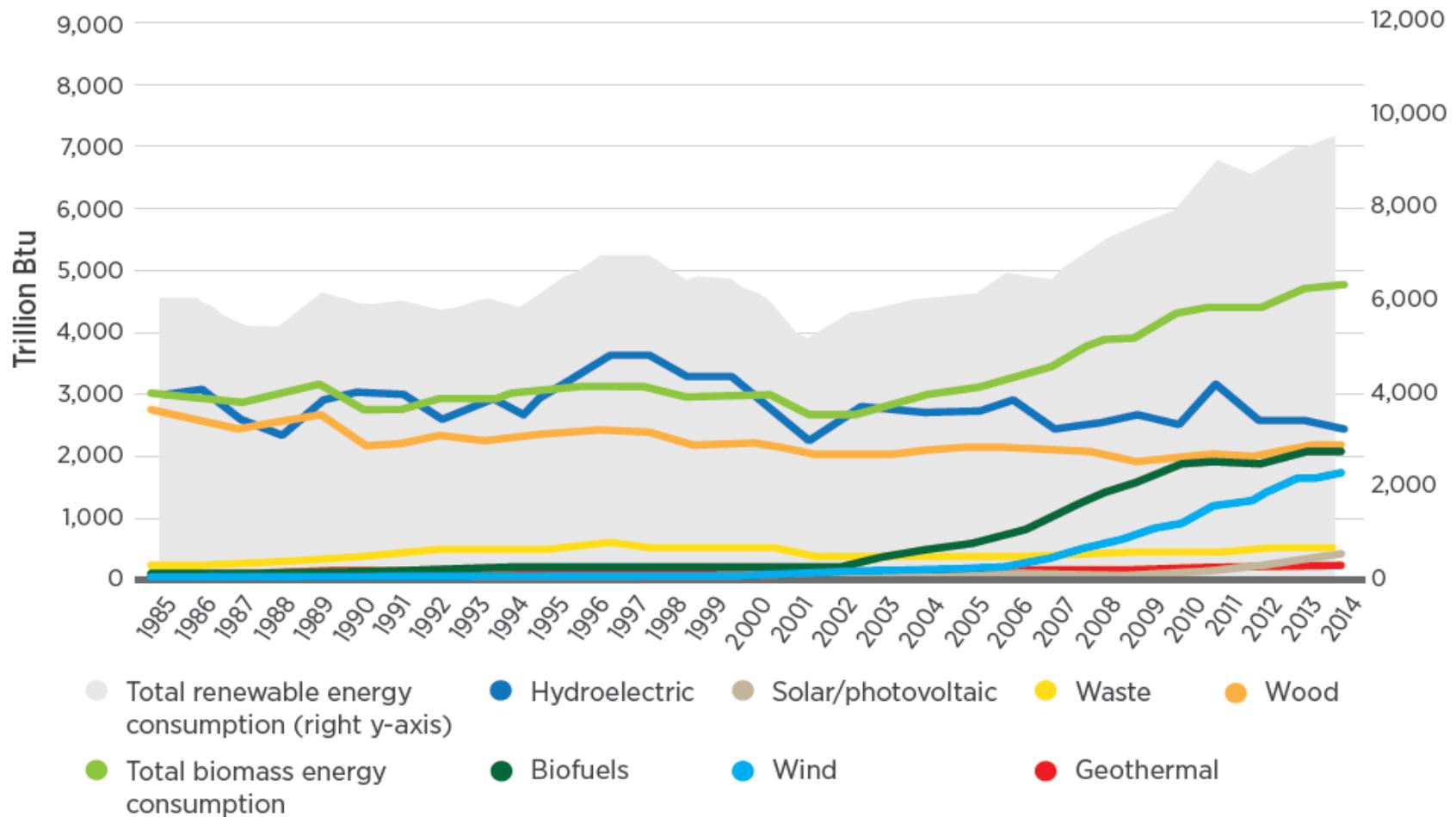


Outline

- Overview of report
 - Motivation for a third assessment
 - What is new from 2005 and 2011 assessments
 - High level results
- Implications for aviation biofuels
 - Farmgate/forest landing
 - Delivered

Biomass is largest source of domestic renewable energy

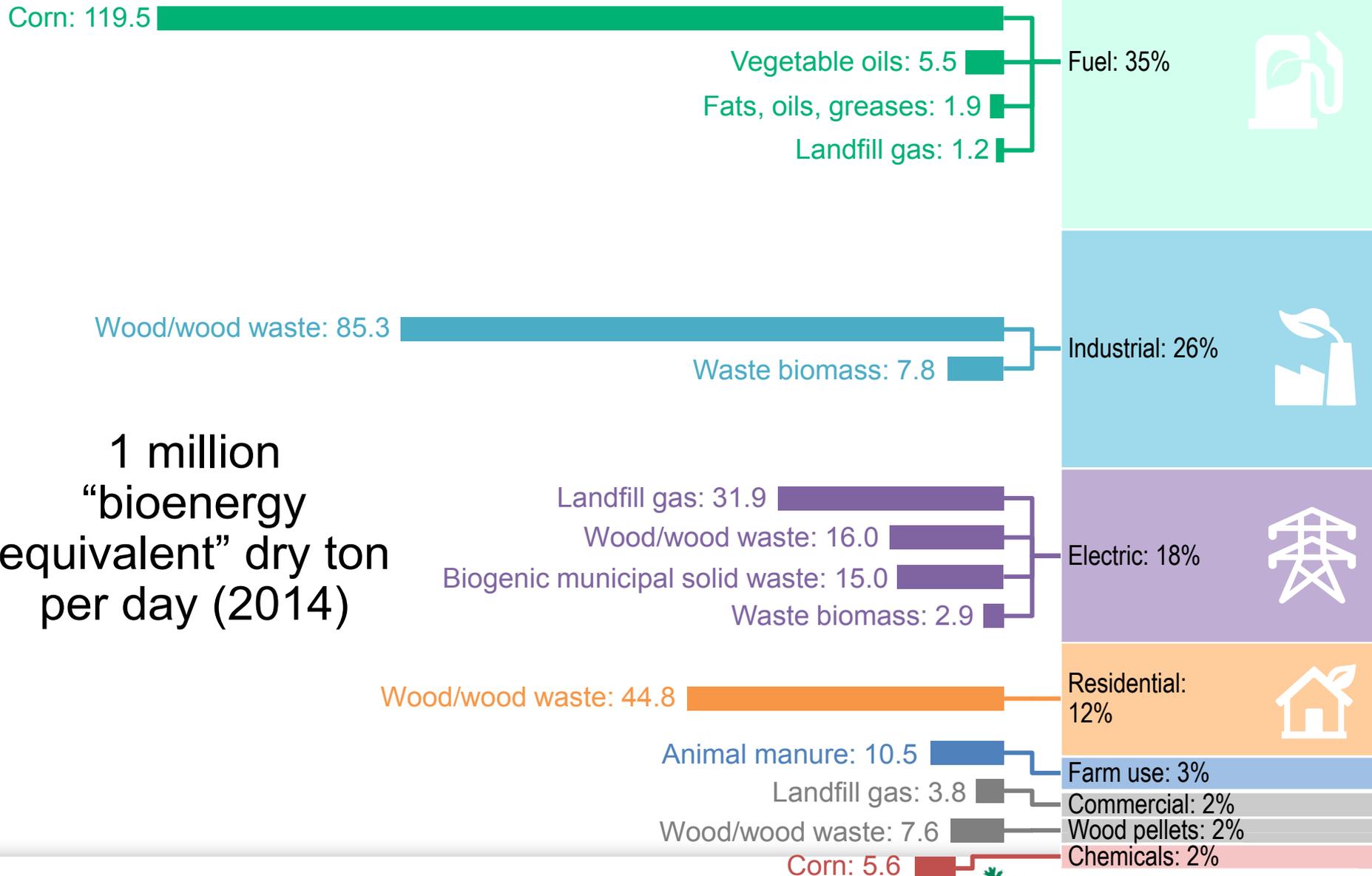
Figure 2.2 | Primary renewable energy consumption by source and total consumption (1985–2014)



Source: Data from EIA (2015d).

How biomass is currently used

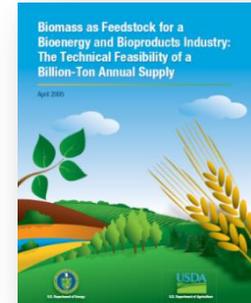
(million tons per year)



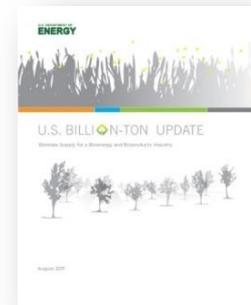
1 million
“bioenergy
equivalent” dry ton
per day (2014)

Motivation

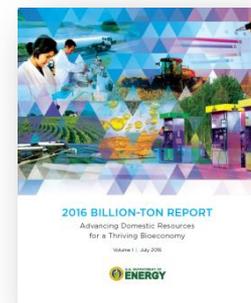
- Enormous U.S. domestic biomass potential
 - 2005 and 2011 reports identified > 1 billion ton annual supply
- Understanding and quantifying biomass supply fosters commercialization to increase
 - Energy security,
 - Energy independence, and
 - Environmental stewardship
- Sustainable production is critical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



2005 BTS

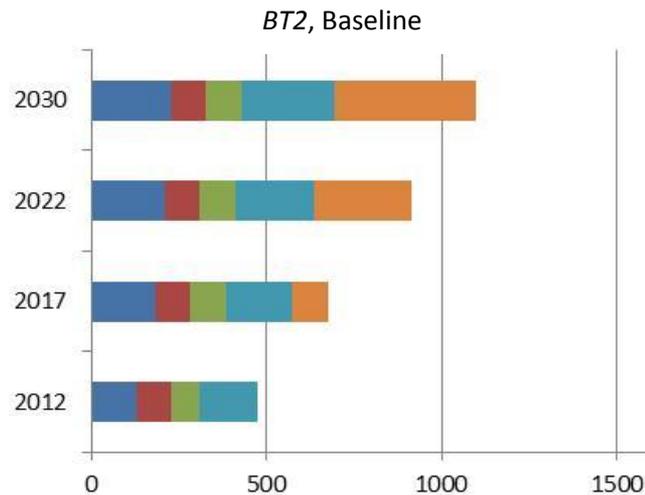
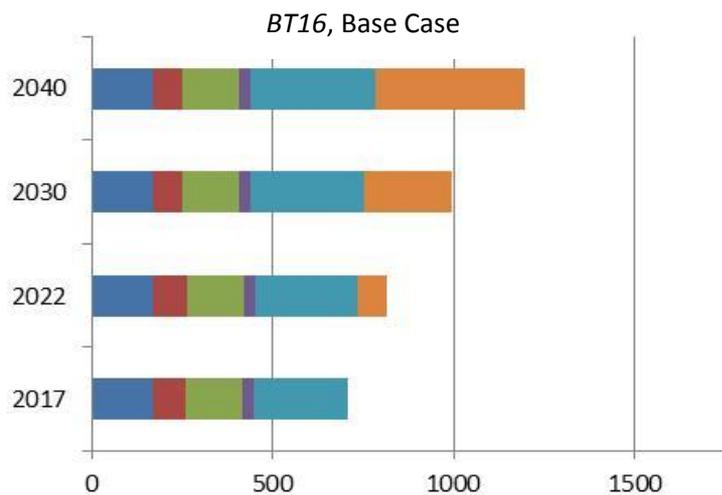


2011 BT2

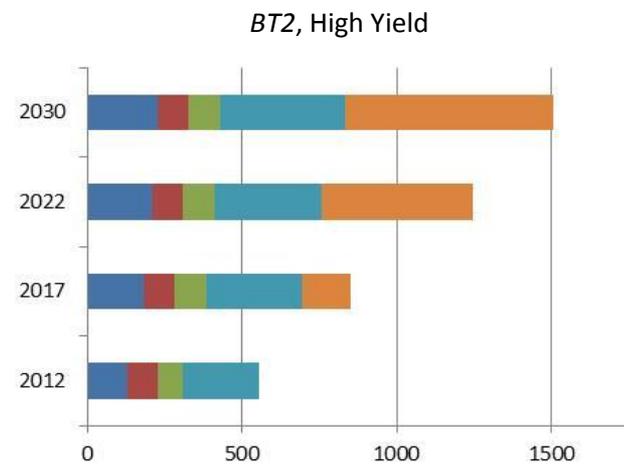
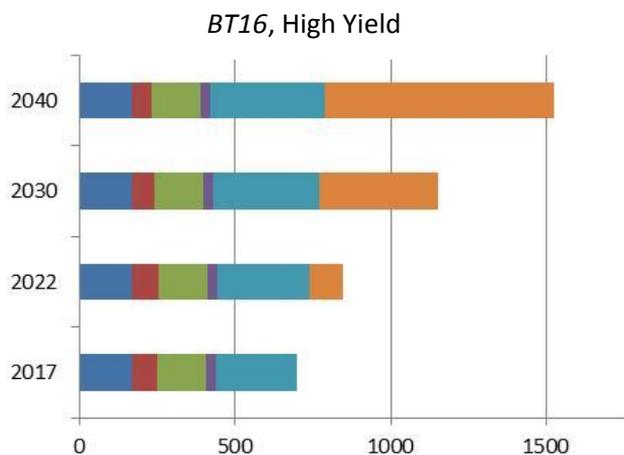


2016 BT16

Similar potential as 2011 BT2

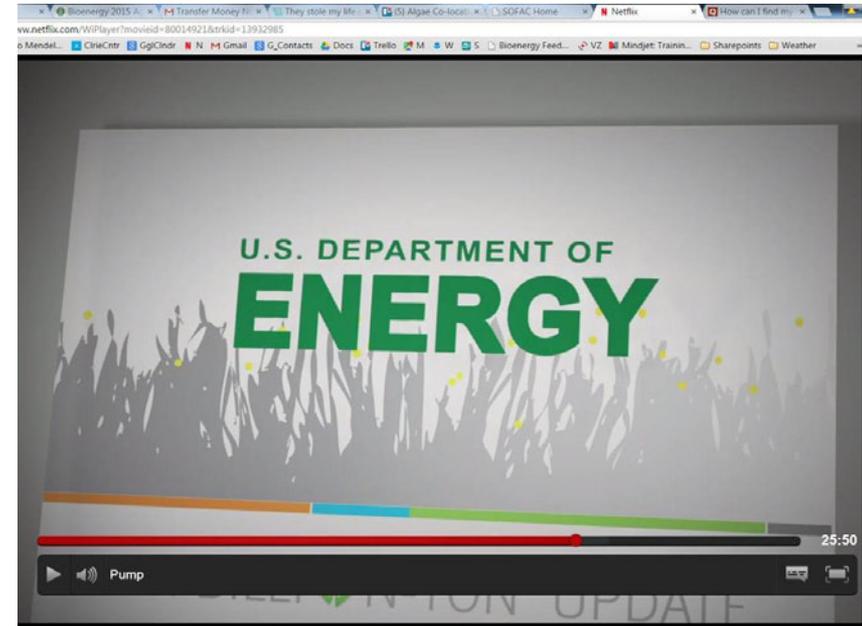


- Forestry Resources Currently Used
- Forestry Resource Potential
- Agricultural Resources Currently Used
- Waste Resources Current Used
- Agricultural and Waste Resources Potentially Available
- Energy Crops



Why a third assessment?

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



Pump (2014) documentary screenshot

Preamble

- Potential new feedstocks exclude 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

What's new in the third assessment?

- Expanded currently used analysis (previous slide)
- Assessment by feedstocks, expansion of energy crop supply and addition of algal feedstocks
- Delivered supply analysis
- Volume 2 to focus on sustainability effects of specified scenarios from Volume 1

Major terrestrial biomass sources, 2040



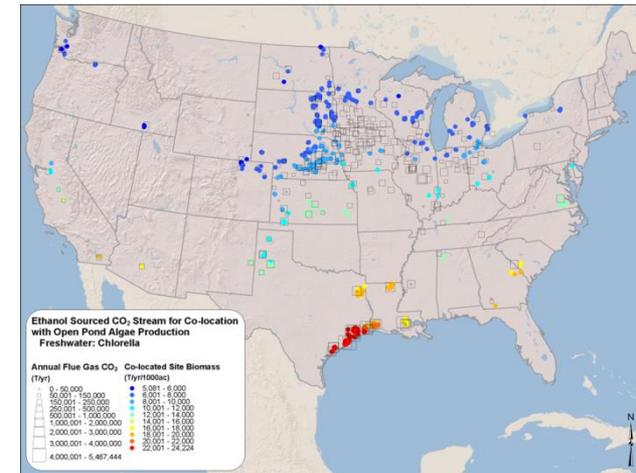
Base case scenario, 2040, \$60 per dry ton or less

Microalgae resources analysis

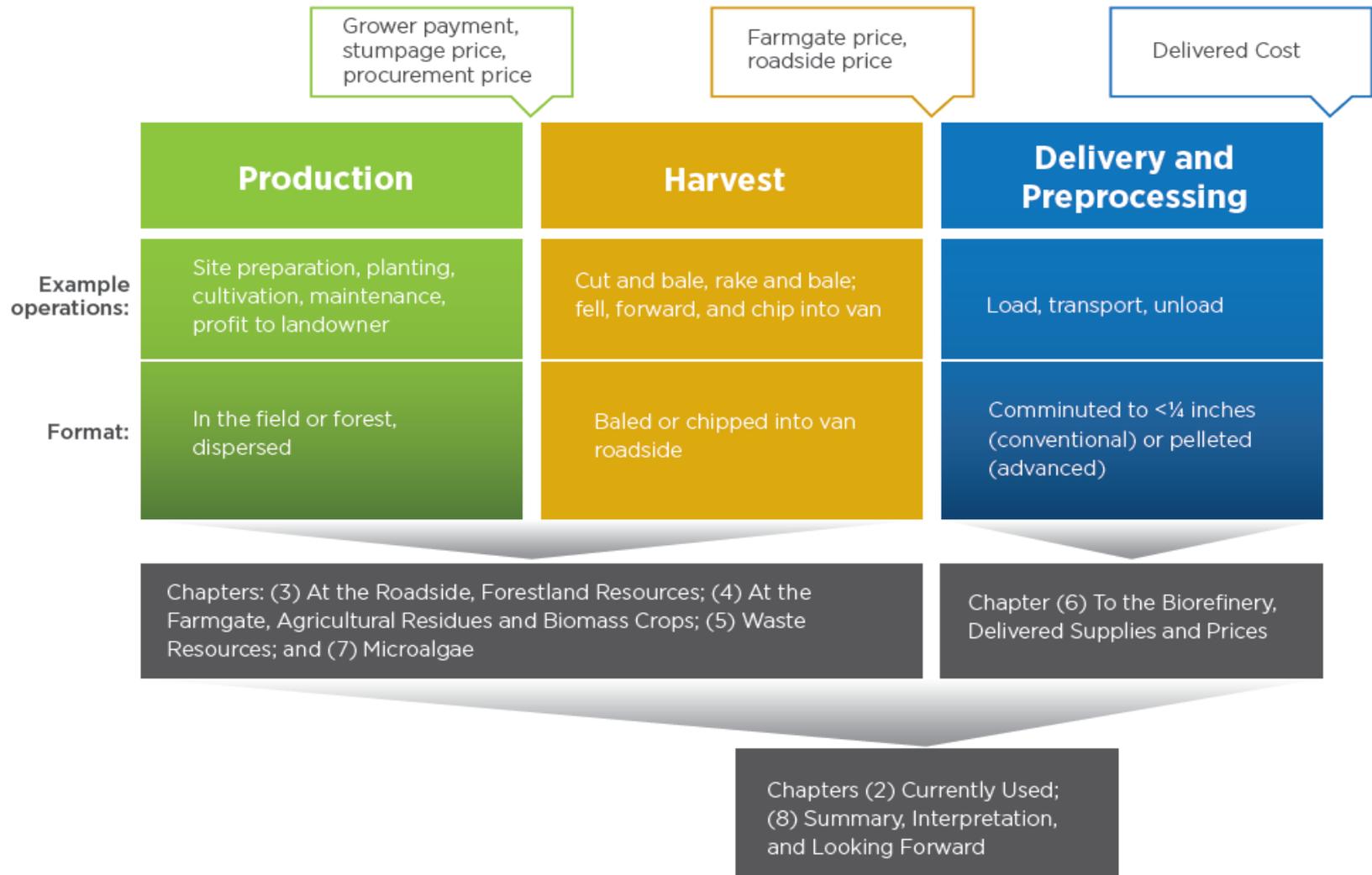
- Co-location near CO2 facilities
- Freshwater and saline culture
- Open ponds/raceways
- Lined and unlined ponds
- Present and future productivities



Scenario	Ethanol plant	Coal EGU	Natural gas EGU	Million tons	Prices per dry ton
Present productivities, freshwater	12	19	15	<46	\$719–\$2,030
Present productivities, saline	10	54	21	<86	\$755–\$2,889
Future productivities, freshwater	13	10	0	<23	\$490–\$1,327
Future productivities, saline	11	12	0	<24	\$540–\$2,074

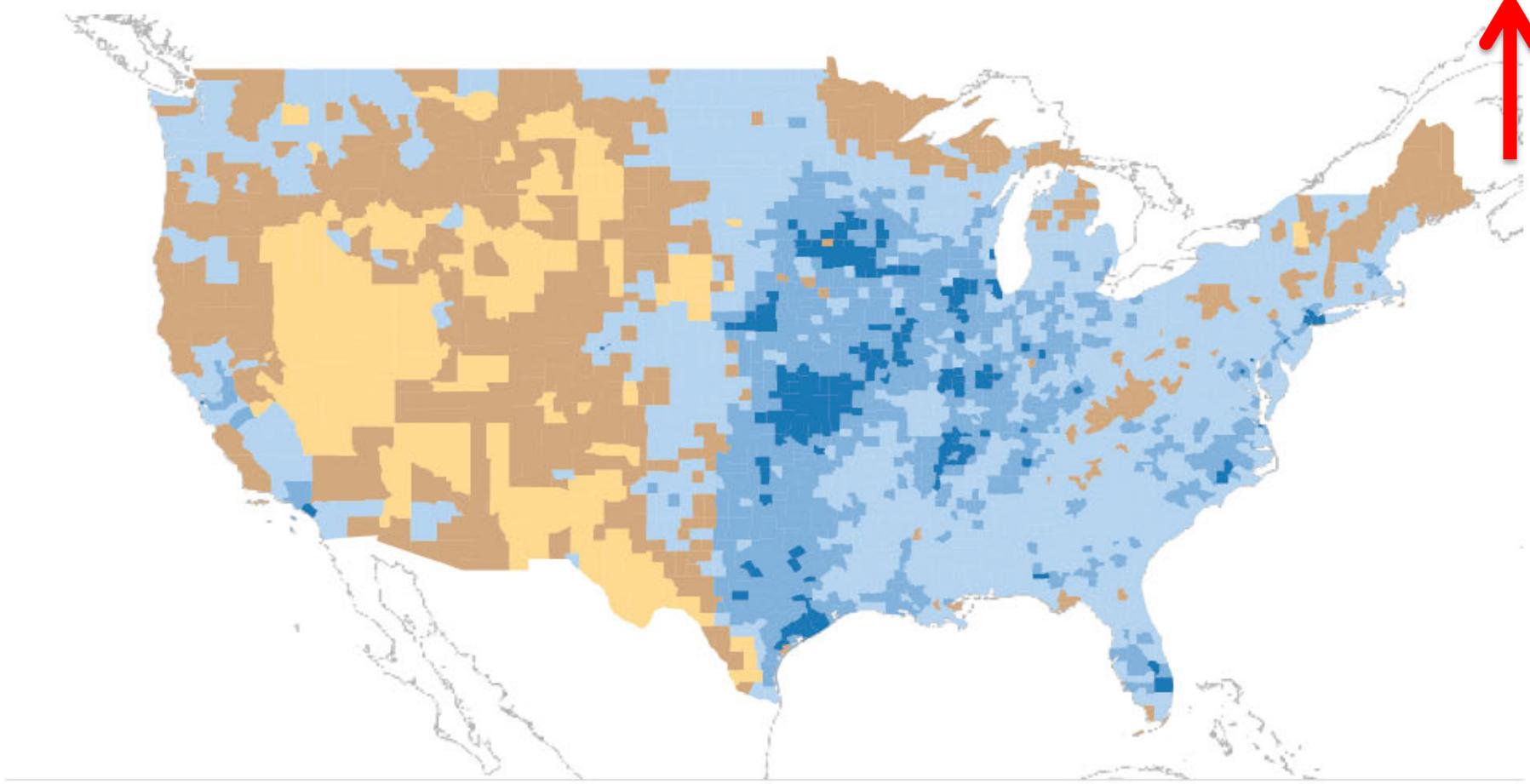


Schematic of biomass supply chain



Grand Map

Figure ES.4 | Combined potential supplies from forestry, wastes, and agricultural resources, base case, 2040¹⁰

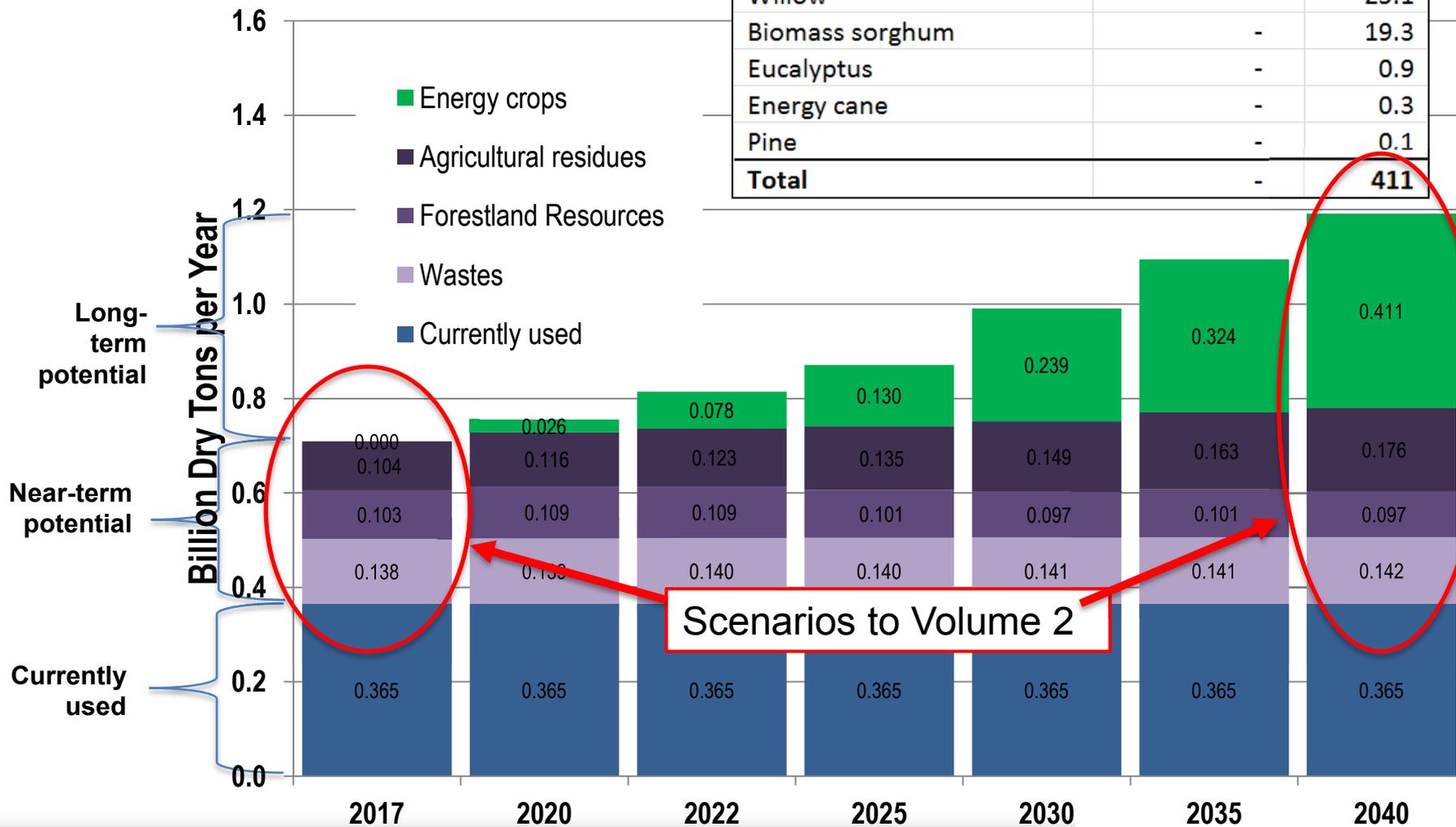


- Less than 10 dt/SqMile
- 10-100 dt/SqMile
- 100-500 dt/SqMile
- 500-1,000 dt/SqMile
- 1,000-5,000 dt/SqMile

<http://bioenergykdf.net/billionton>

Current and Potential, Base Case at \$60/dt

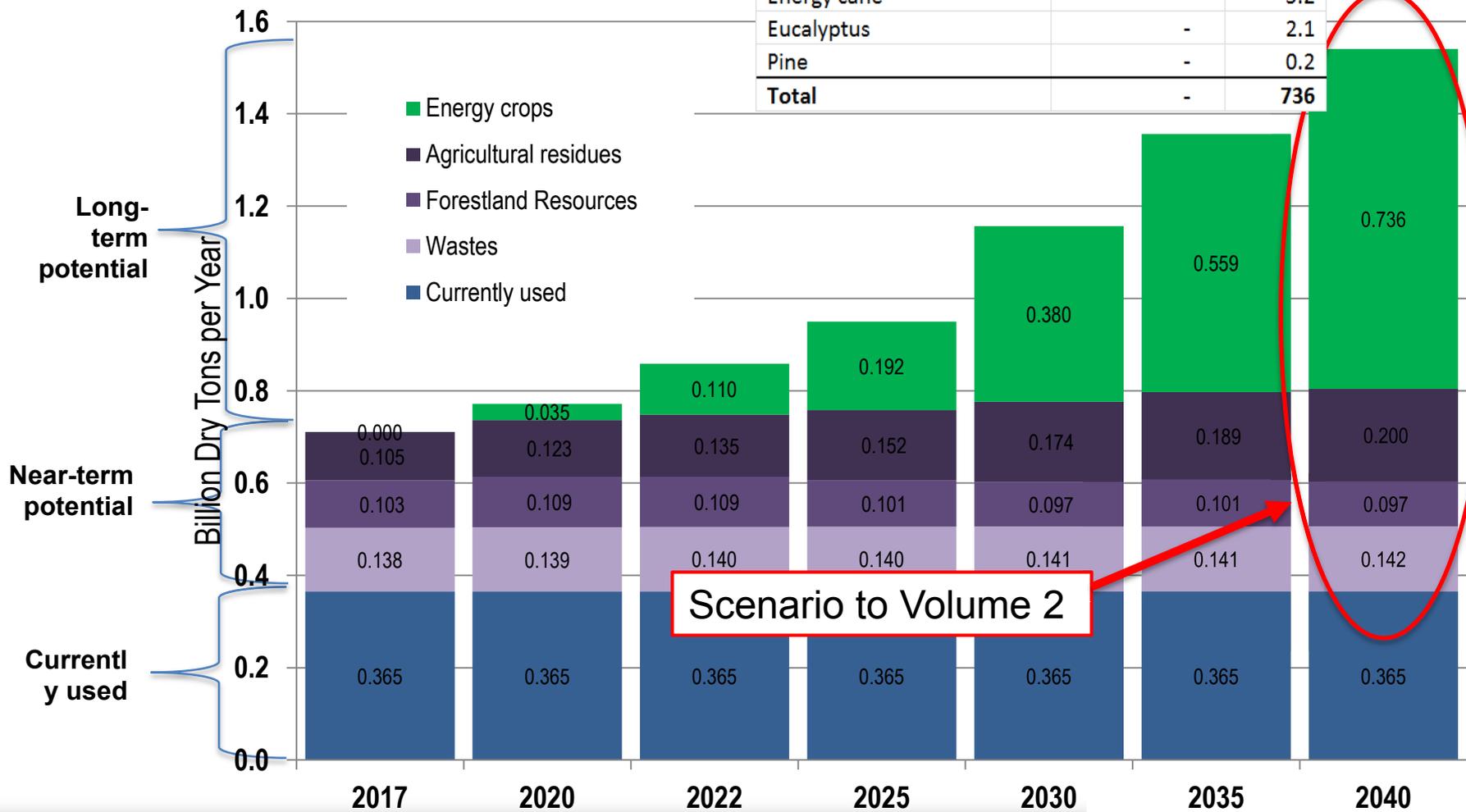
Energy crops	2017	2040
	(million dry tons)	
Switchgrass	-	160.5
Miscanthus	-	160.0
Poplar	-	44.9
Willow	-	25.1
Biomass sorghum	-	19.3
Eucalyptus	-	0.9
Energy cane	-	0.3
Pine	-	0.1
Total	-	411



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

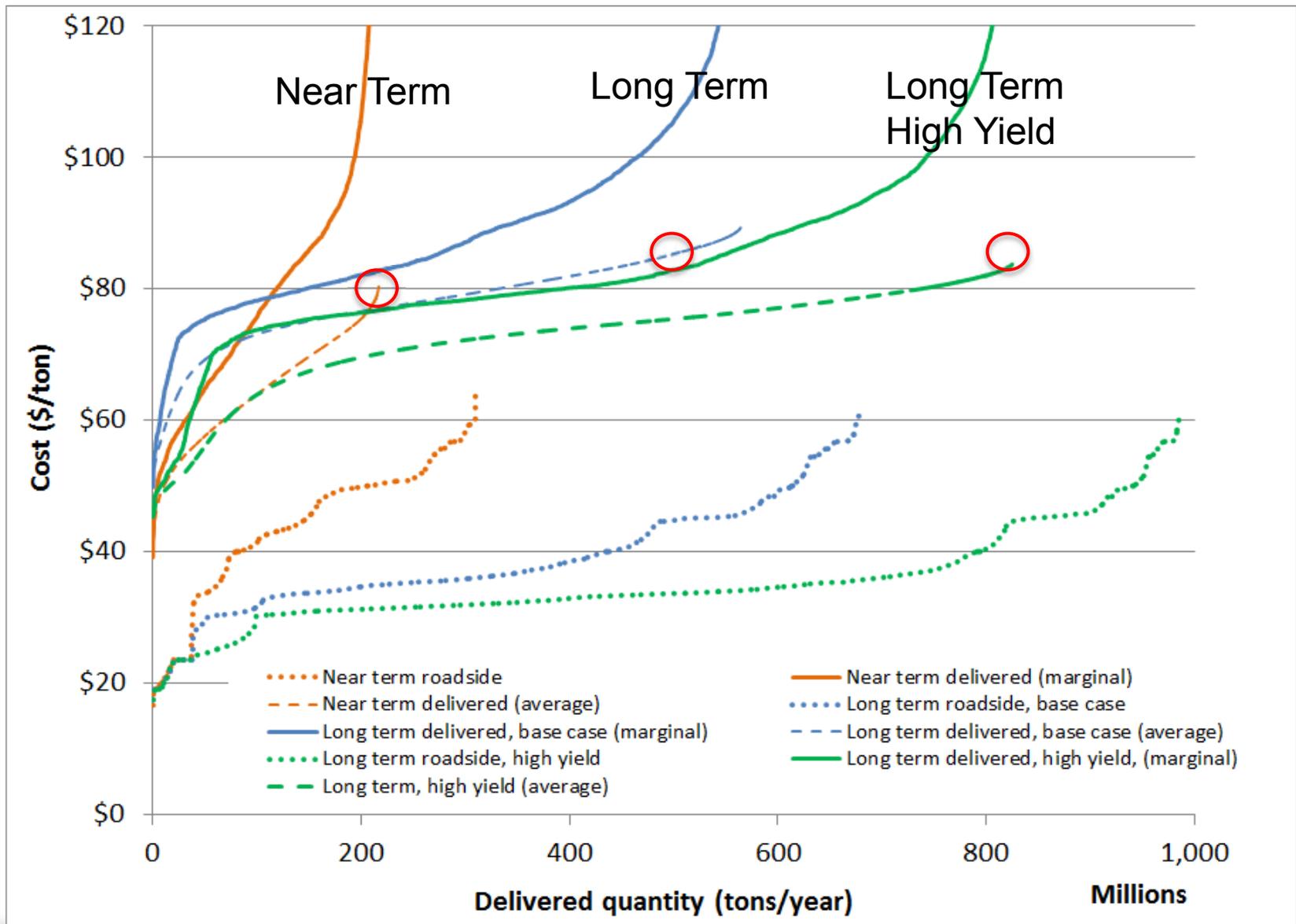
Current and Potential, High Yield Ag. at \$60/dt

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

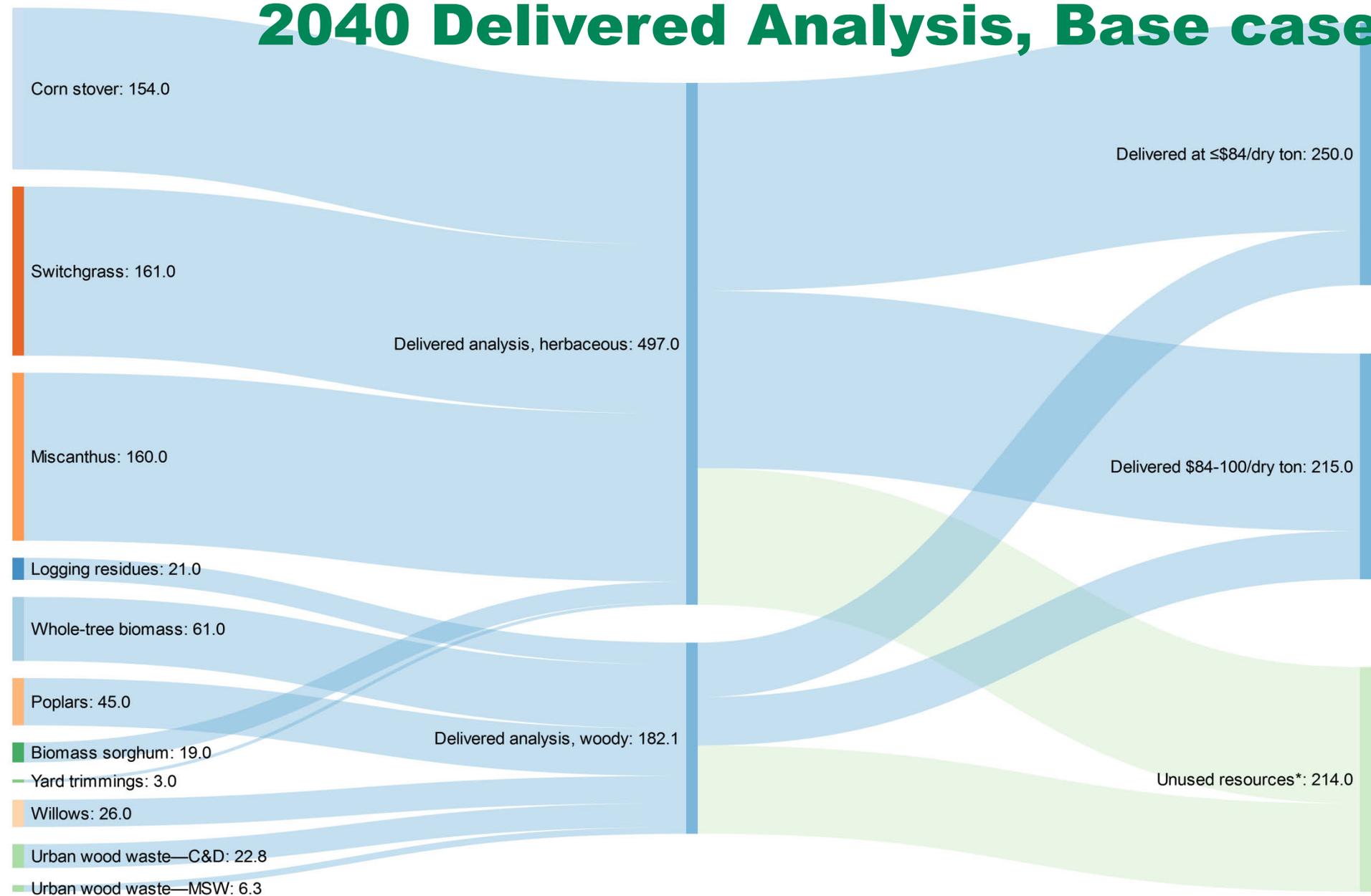


Currently used at market prices, potential supplies up to \$60/dt (2014\$)

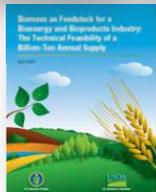
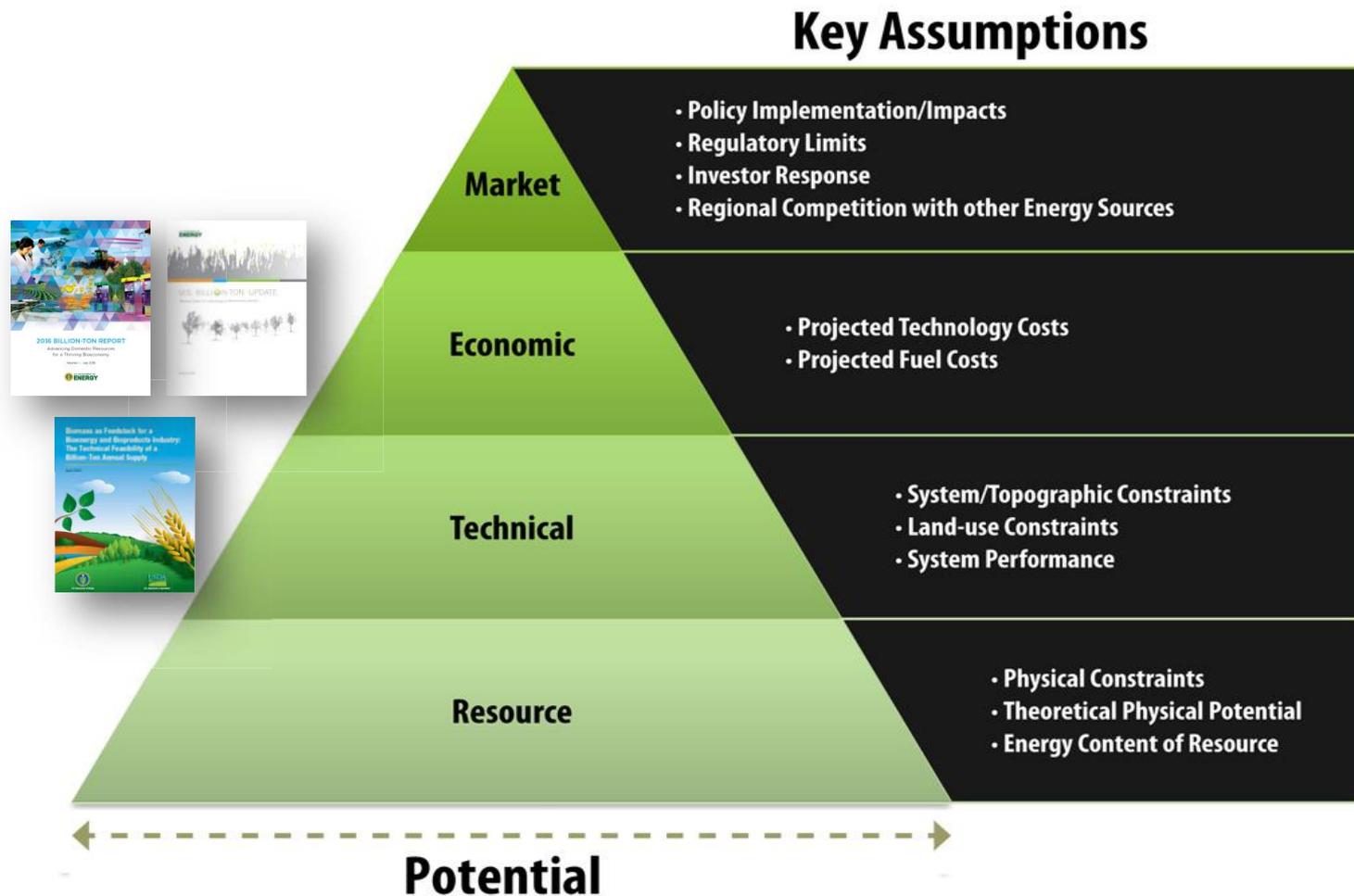
Delivered Scenario Analysis



2040 Delivered Analysis, Base case



What are the BT16's implications for advanced jet fuels? (1 of 2)



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

What are the BT16's implications for advanced jet fuels? (2 of 2)

- Not a “one-size-fits-all” resource assessment
 - Broad potential may not represent strategic potential for single pathway
- Acreage and supply as proxy for jet fuels crops
 - Annual energy crops
 - Perennial woody and herbaceous crops
- More analysis needed to assess adoption of new cropping models (oilseeds, double cropping, etc)
- Market effects may vary for feedstocks with existing uses

Interactive Resources



<http://bioenergykdf.net/billionton>

The screenshot shows the Bioenergy KDF website homepage. The browser address bar displays <http://bioenergykdf.net/billionton>. The page features a blue header with the Bioenergy Knowledge Discovery Framework logo and navigation links for Overview, Tools & Apps, Map, Bioenergy Library, and Contribute. The main content area is titled "2016 BILLION-TON REPORT INTERACTIVE VERSION" and includes a brief introduction to the report. Below the introduction are three buttons: "Access Report", "Data Explorer", and "Data Download Tool". The page is divided into seven numbered sections (01-07) with colorful backgrounds, each representing a different aspect of the report: 01 Executive Summary/Overview, 02 Biomass Consumed in the Current Bioeconomy, 03 Forest Resources, 04 At the Farmgate, 05 Waste Resources, 06 To the Biorefinery, and 07 Microalgae. A footer section contains links for "From the Bioenergy KDF", "Maps and Data", and "Questions".

The screenshot shows the Bioenergy KDF website with the Billion-Ton 2016 Data Explorer interface overlaid on a map of the United States. The browser address bar displays gistdrupaldev.ornl.gov/biokdf/r. The Data Explorer panel includes the following options: "Agriculture" (selected), "Forest", and "Wastes"; "Select Data Aggregation" with "County Data" and "State Data" buttons; "Select Result Type" with "Production", "Production Density", "Harvested Acres", and "Yield" buttons; "Select Scenario" set to "3% yield inc."; "Select Feedstock" set to "Miscanthus"; "Select Biomass Price (per dry ton)" with a slider from \$30 to \$100; and "Select Year" with a timeline from 2014 to 2040. The map shows a color-coded visualization of biomass production density across the United States, with green and brown areas indicating different levels of production. A "Data Grid (Click to Expand)" button is visible at the bottom of the map.

Thank you!

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