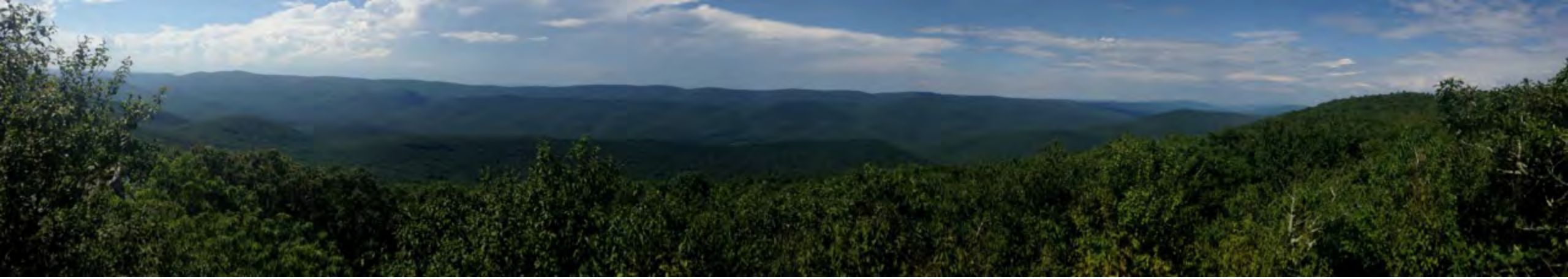


Energy Policy and Pellets

15th Annual Conference of the Virginia Loggers Association

Henry Quesada

August 2017

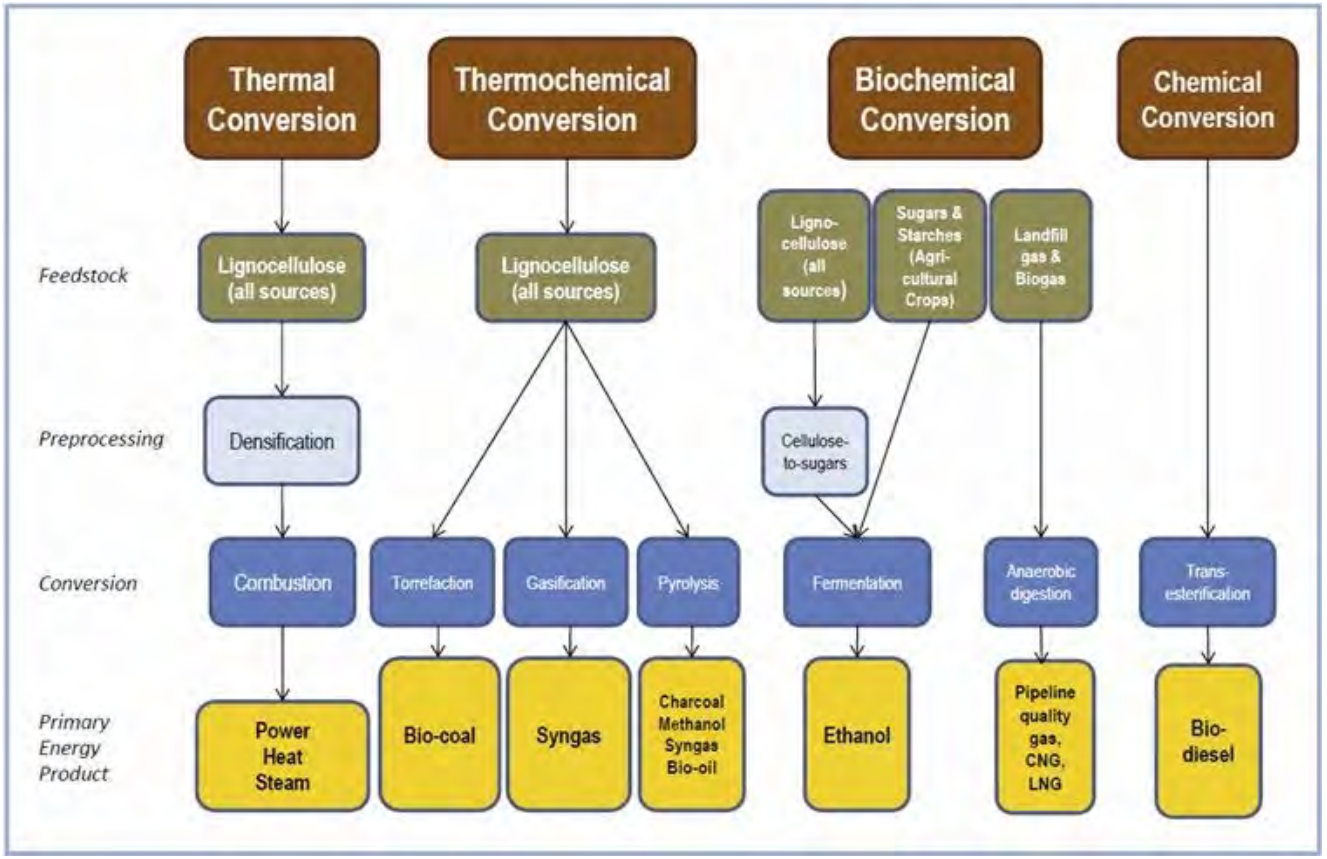
Blacksburg, VA

Agenda

- Biomass and Energy
- Current energy biomass projects in the US
- Biomass Prices and Costs
- Cellulosic liquid biofuel Market
- Wood Pellets Industry
- Insights and Conclusions

Biomass and Energy

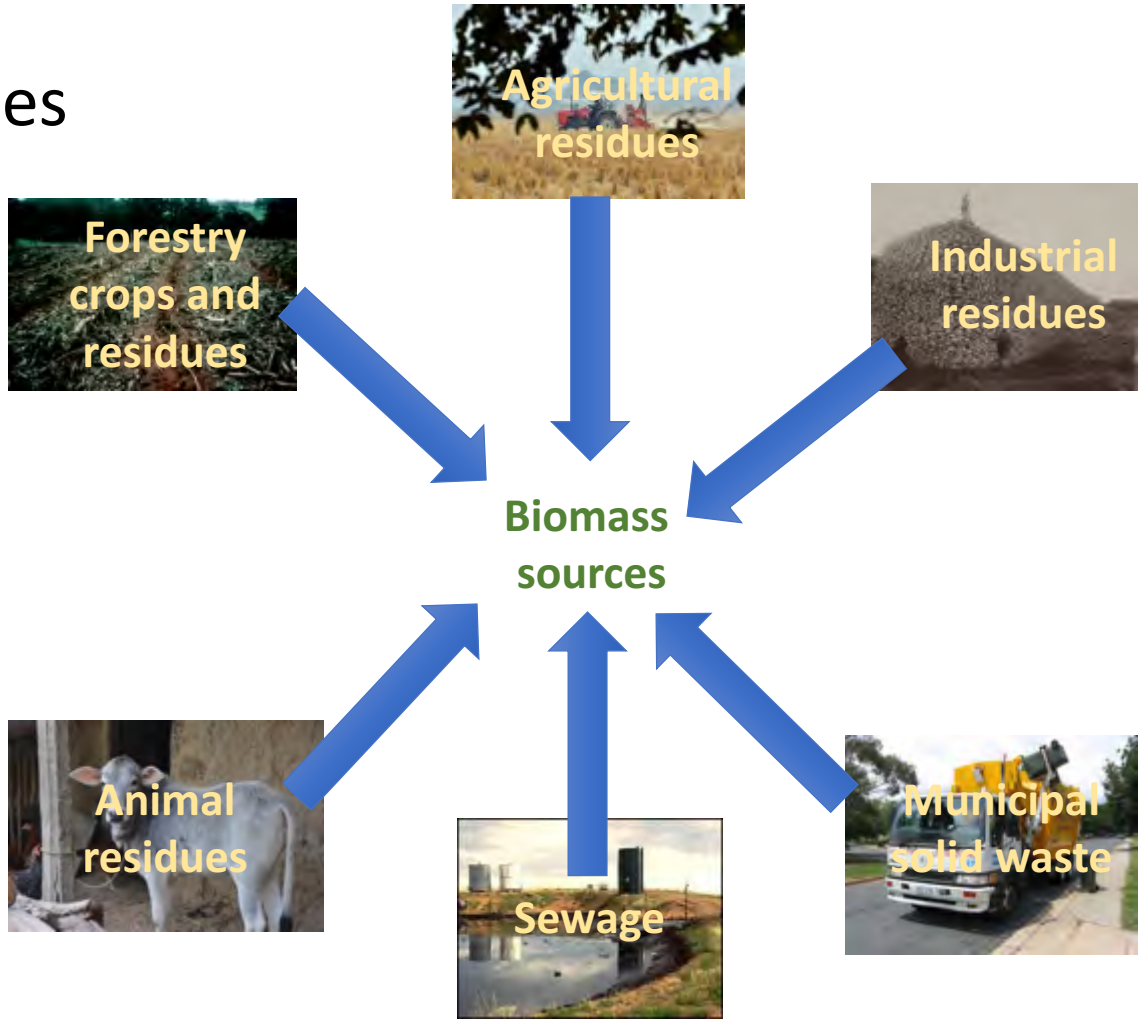
- Biomass Applications and Processes

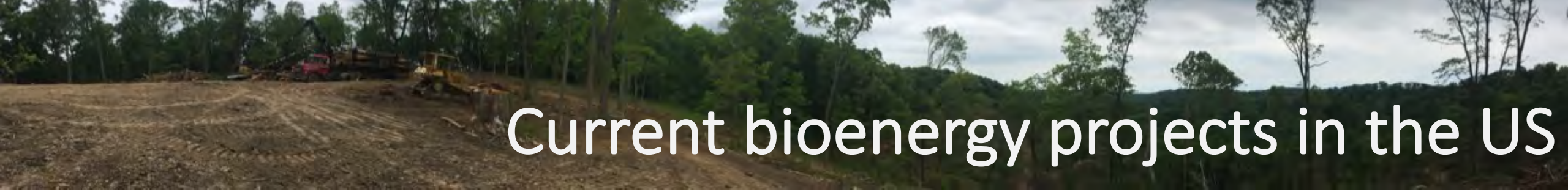


https://www.e-education.psu.edu/

Biomass and Energy

- Biomass sources





Current bioenergy projects in the US

- Wood bioenergy projects

Wood Bioenergy US

Forisk Research Quarterly
Q1 2017

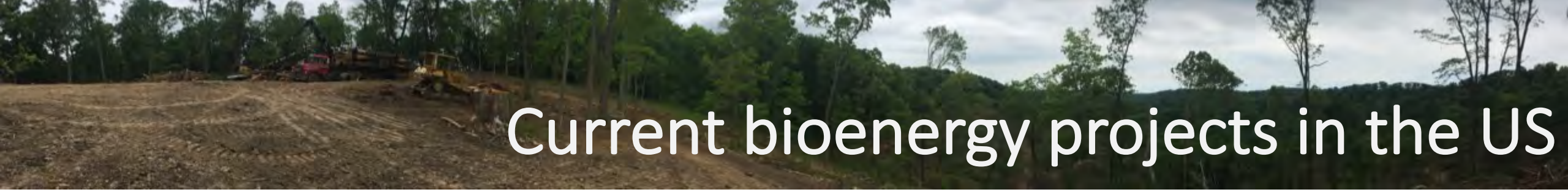
A publication by Forisk Consulting that tracks, screens, and analyzes the wood bioenergy sector in the United States.

Free Summary

Number and Wood Use of Announced and Operating Projects, 2026

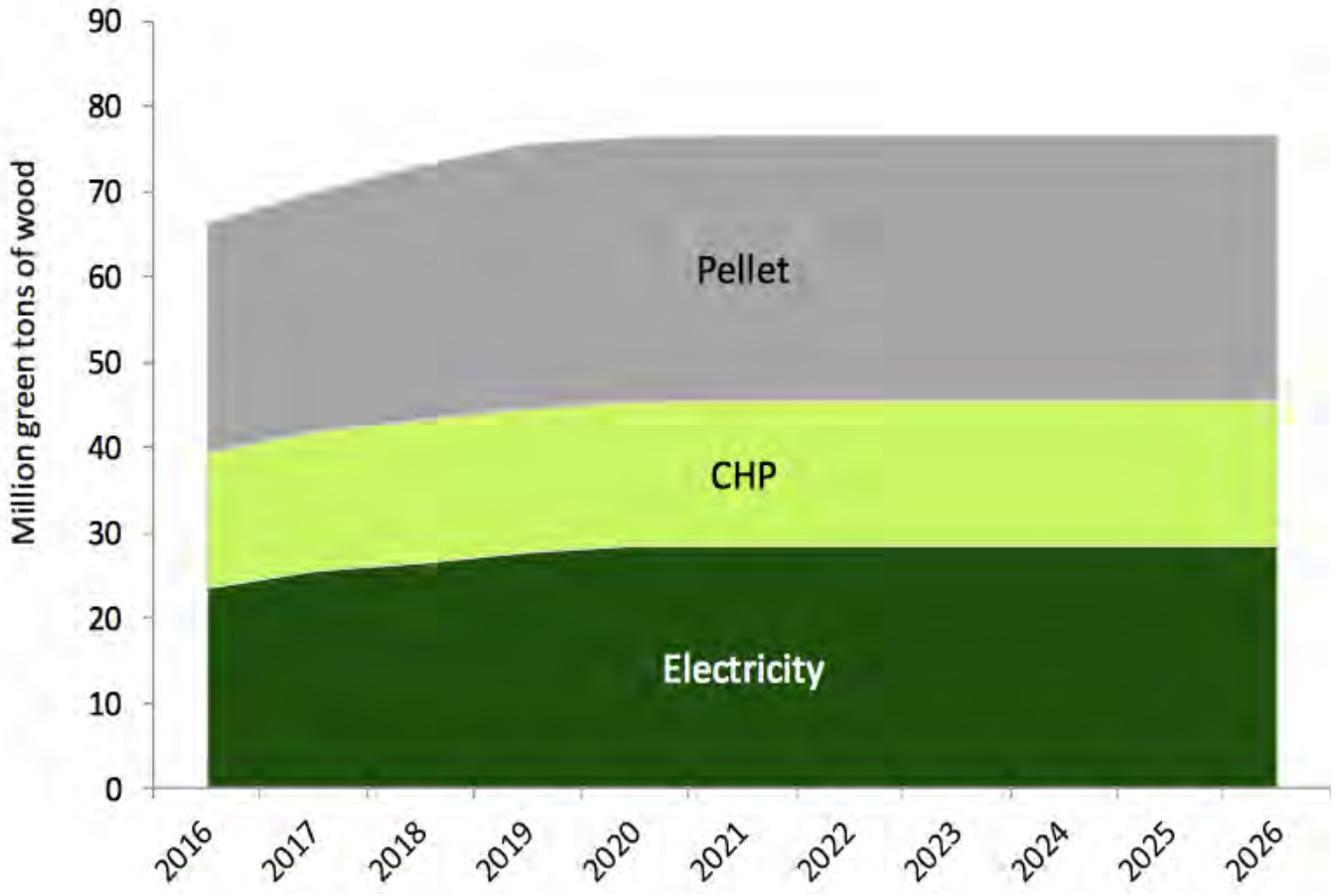
Region	Number of Projects by Type						Total	*Total that pass screens*	Wood Use of All Projects gtons	Wood Use of Projects that Pass Screens gtons
	Electricity	CHP	Thermal	Liquid Fuel	Pellet	Other				
North	47	25	9	13	90	0	184	*142*	33,208,614	25,898,614
South	30	22	9	16	81	2	160	*91*	69,014,263	39,813,863
West	31	18	1	4	38	3	95	*65*	15,078032	11,716,682
Total	108	65	18	33	209	5	439	*298*	117,300,909	77,429,159

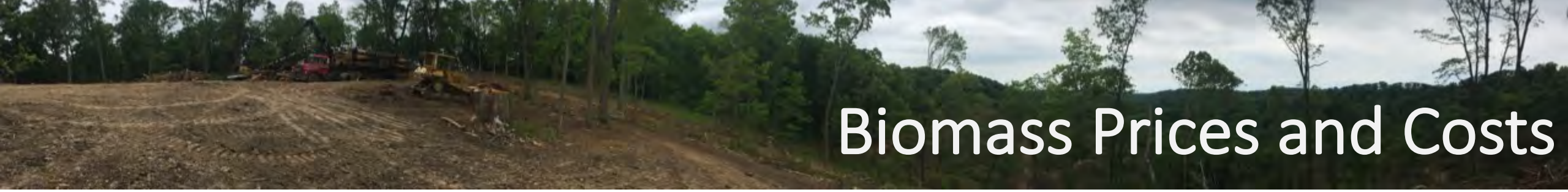
http://forisk.com



Current bioenergy projects in the US

- Estimated used wood
  - Cellulosic ethanol is still under development and it is not commercially operating
  - The US north has the largest share of viable wood energy projects (48%)
  - The US south accounts for 51% of the potential wood for bioenergy



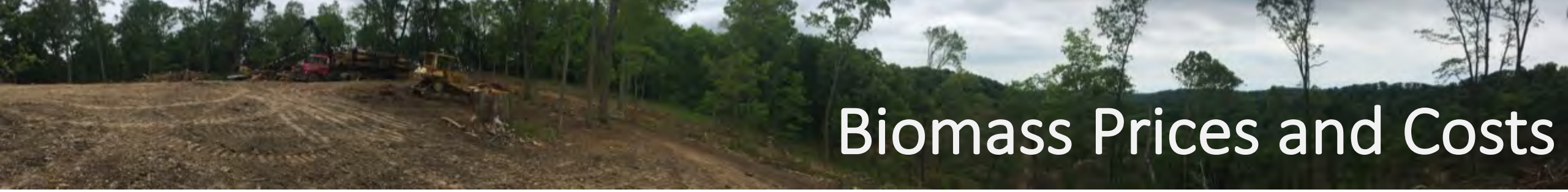


Biomass Prices and Costs

- Biomass Prices

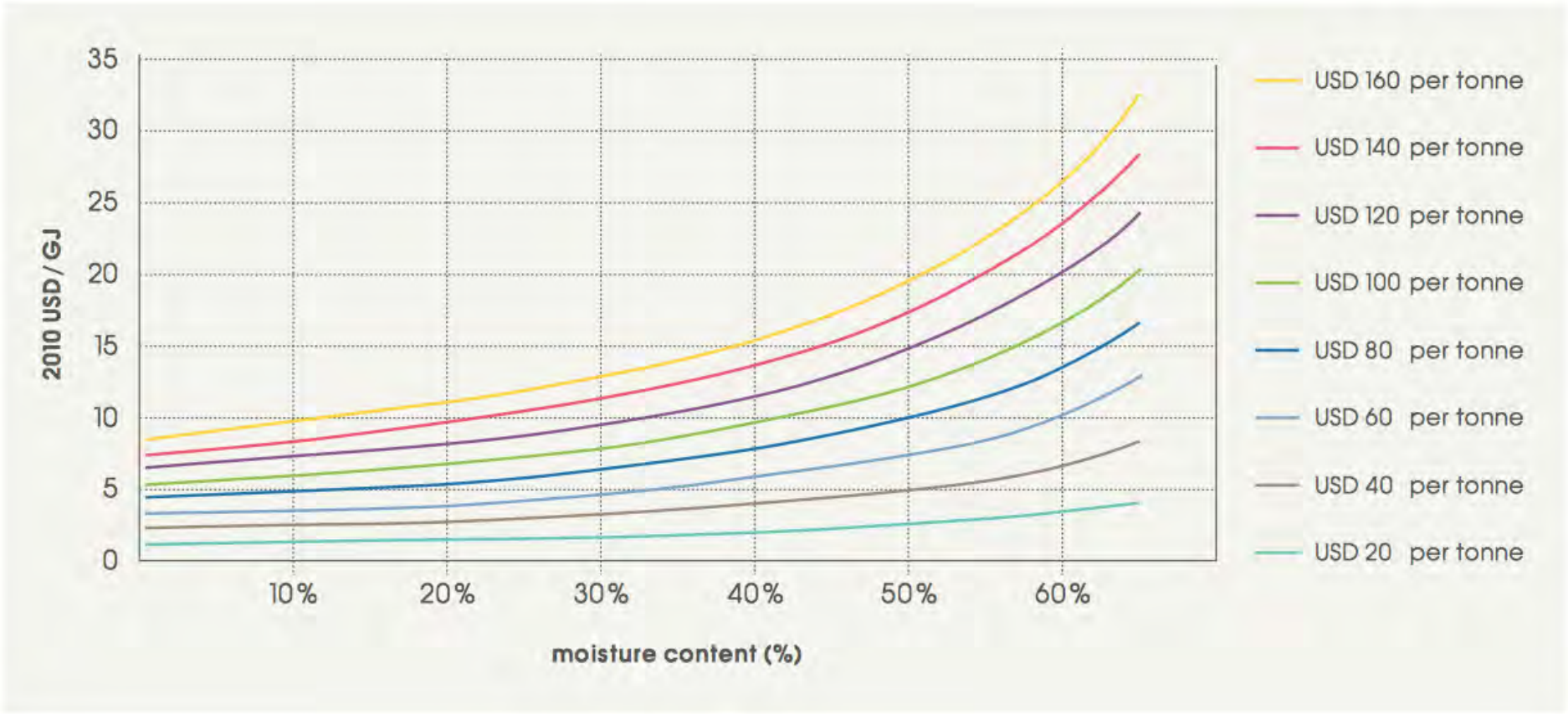
	Tyical Moisture content	Heat value MJ/kg (LHV)	Price (USD/GJ)	Price (USD/tonne)	Cost structure
Forest residues	30% - 40%	11.5	1.30 - 2.61	15 - 30	Collecting, harvesting, chipping, loading, transportation and unloading. Stumpage fee and return for profit and risk.
Wood waste [a]	5% - 15%	19.9	0.50 - 2.51	10 - 50	Cost can vary from zero, where there would otherwise be disposal costs, to quite high, where there is an established market for their use in the region.
Aricultural residues [b]	20% - 35%	11.35 - 11.55	1.73 - 4.33	20 - 50	Collecting, premium paid to farmers, transportation.
Energy crops [c]	10% - 30%	14.25 - 18.25	4.51 - 6.94	39 - 60	Not disclosed.
Landfill gas		18.6 - 29.8 [d]	0.94 - 2.84	0.017 - 0.051 [d]	Gas collection and flare.

IRENA. 2012. Renewable Energy Technologies: Cost Analysis Series

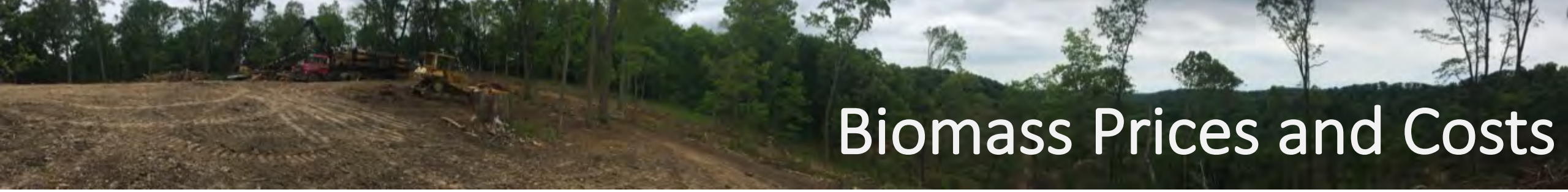


Biomass Prices and Costs

- Moisture and biomass



IRENA. 2012. Renewable Energy Technologies: Cost Analysis Series



Biomass Prices and Costs

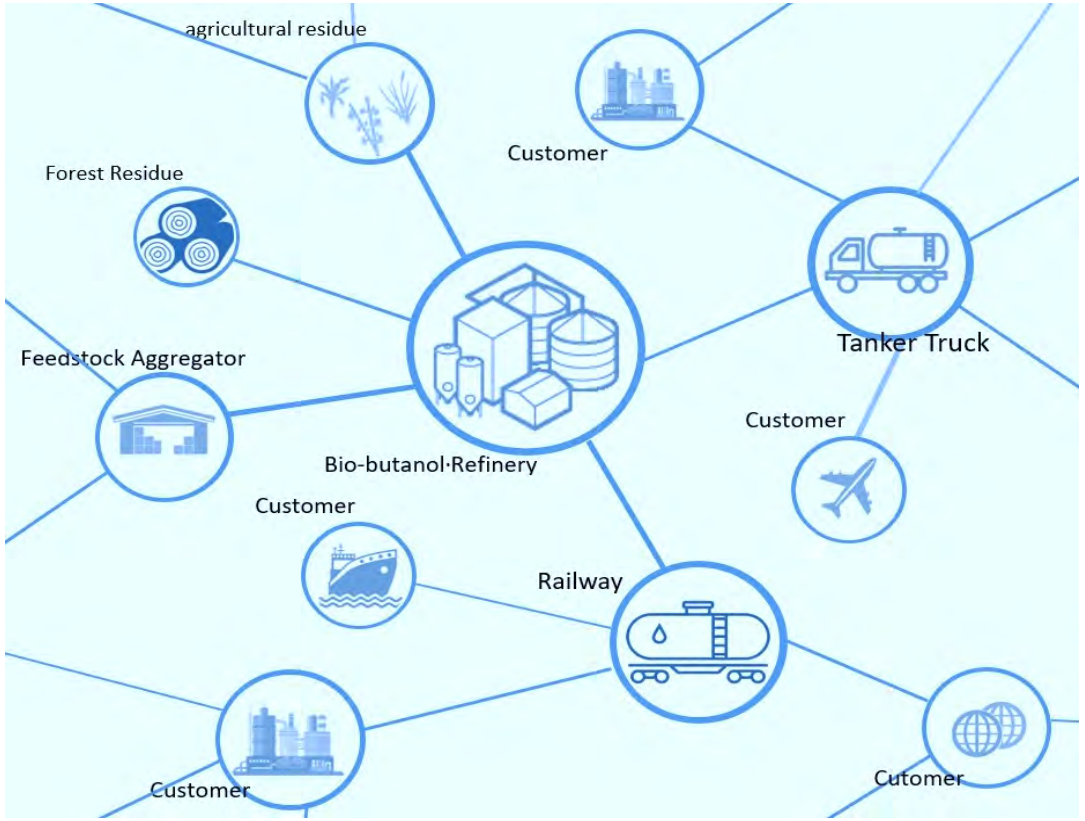
- Equipment, feedstock, and installed capacity cost of different technologies

	Equipement type	Feedstock type and cost (2010 USD/tonne)	Total investment costs (2010 USD/kW)
Case 1	Stoker, 50 MW	Forest residues @ 25/tonne	4 264
Case 2	Stoker boiler, 40 MW	Bagasse @ 11/tonne	3 280
Case 3	CFB boiler, 20 MW	Pellets @ 110/tonne	3 118
Case 4	BFB boiler, 40 MW	Energy crop @ 50/tonne	4 400
Case 5	Stoker boiler, 20 MW	Agricultural residue local @ 50/tonne	2 296
Case 6	Gasifier GT, 50 MW	Woodchip local @ 80/tonne	5 255
Case 7	Gasifier ICE, 4MW	Woodchip EC local @ 60/tonne	2 470
Case 8	LFG ICE, 5MW	Biogas @ 0.030/tonne	2 460
Case 9	Digester, CT 1MW	Biogas @ zero	3 580
Case 10	Digester ICE, 1 MW	Manure slurry @ zero	5 053
Case 11	Digester ICE, 1 MW	Energy crops @ 40/tonne	6 603
Case 12	Stoker CHP, 5 MW	Energy crop @ 40/tonne	4 920
Case 13	Stoker CHP, 25 MW	Agricultural residue local @ 40/tonne	5 904
Case 14	Gasifier CHP 600 kW	Woodchip local @ 70/tonne	7 560
Case 15	Co-firing, separated feed	Woodchip local @ 60/tonne	984
Case 16	Co-firing, mixed injection	Pellets @ 110/tonne	820

IRENA. 2012. Renewable Energy Technologies: Cost Analysis Series

Cellulosic liquid biofuel

- Cellulosic Bio-butanol Supply chain network



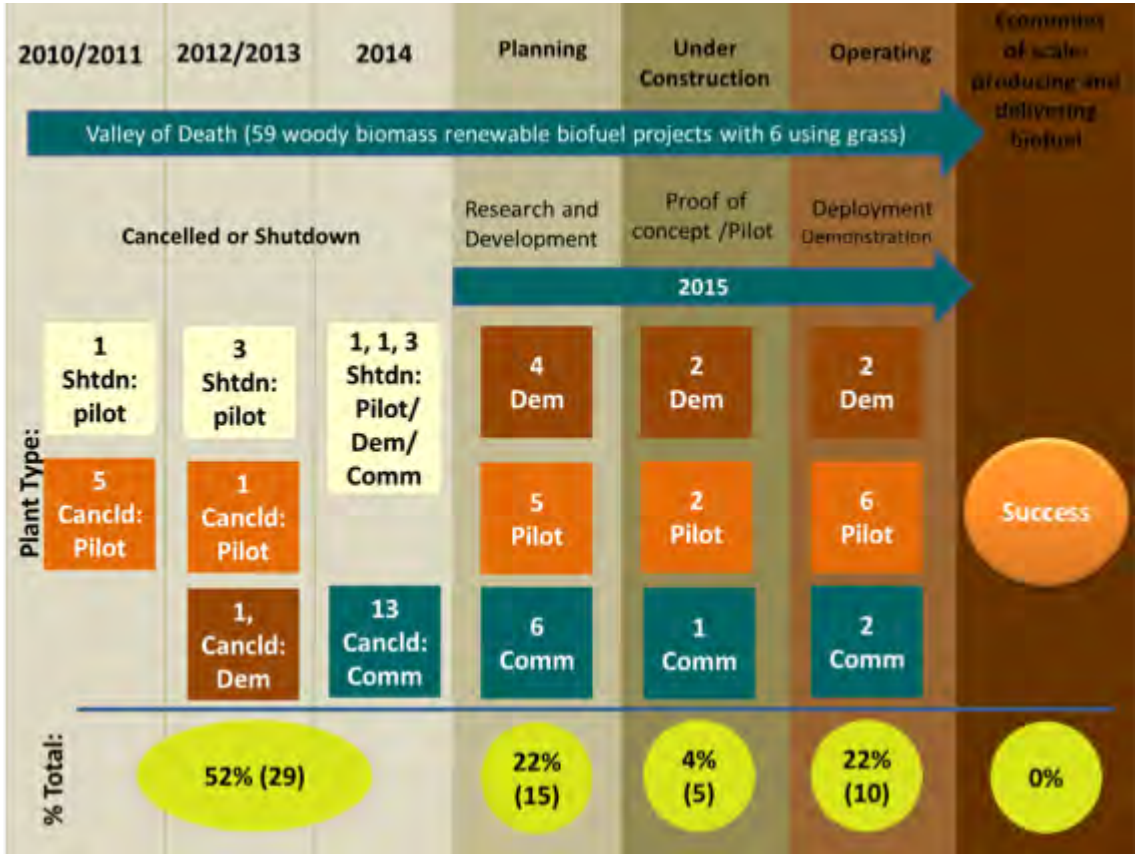
Liang, L. 2017. Green Design of a Cellulosic Bio-butanol Supply Chain Network with Life Cycle Assessment. Doctoral Dissertation. Virginia Tech

Cellulosic liquid biofuel

- Location of production facility: mathematical modeling

Liang, L. 2017. Green Design of a Cellulosic Bio-butanol Supply Chain Network with Life Cycle Assessment. Doctoral Dissertation. Virginia Tech

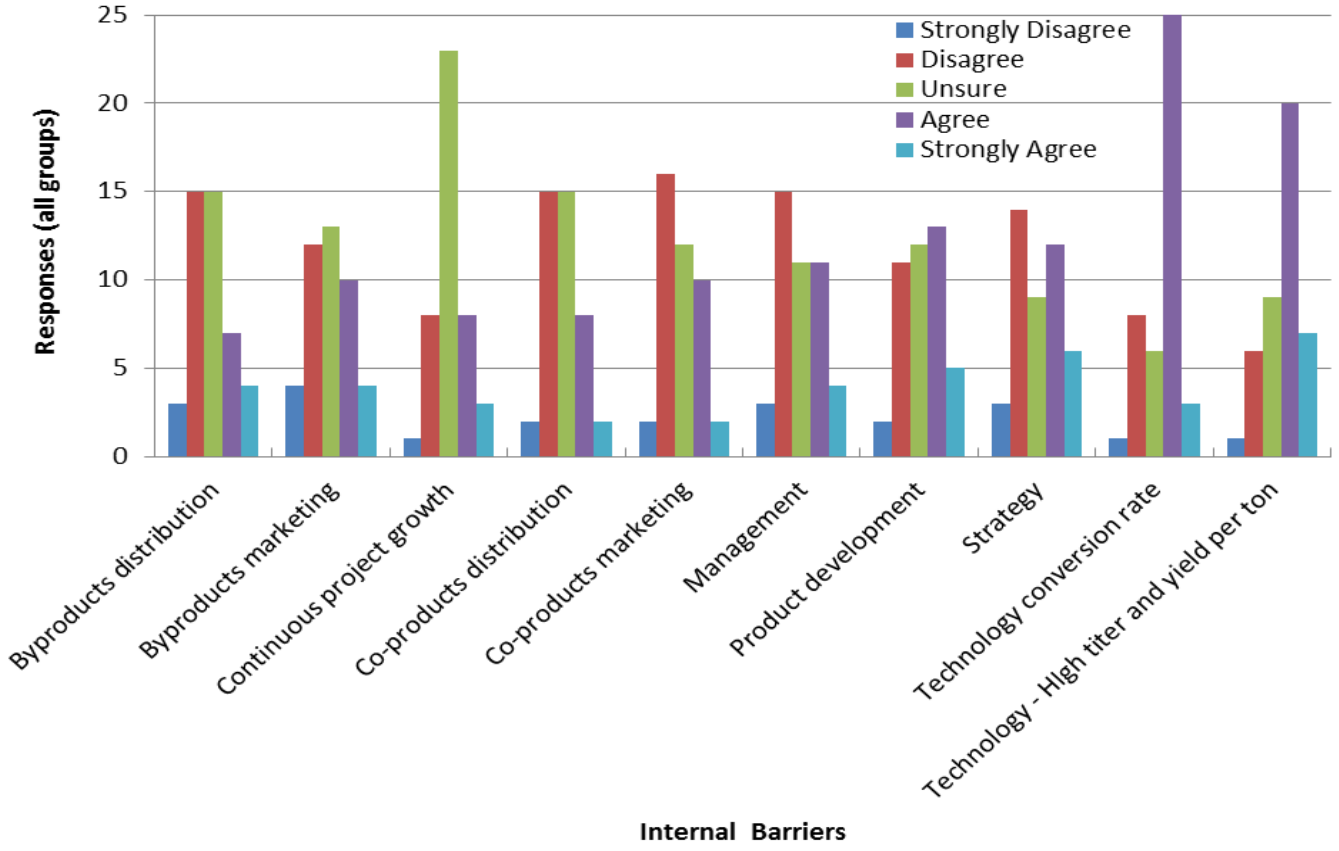
Cellulosic liquid biofuel



Withers, J. 2016. Sustainability Factors Impacting The United States Advanced Biofuel Projects. MS thesis. Virginia Tech

Cellulosic liquid biofuel

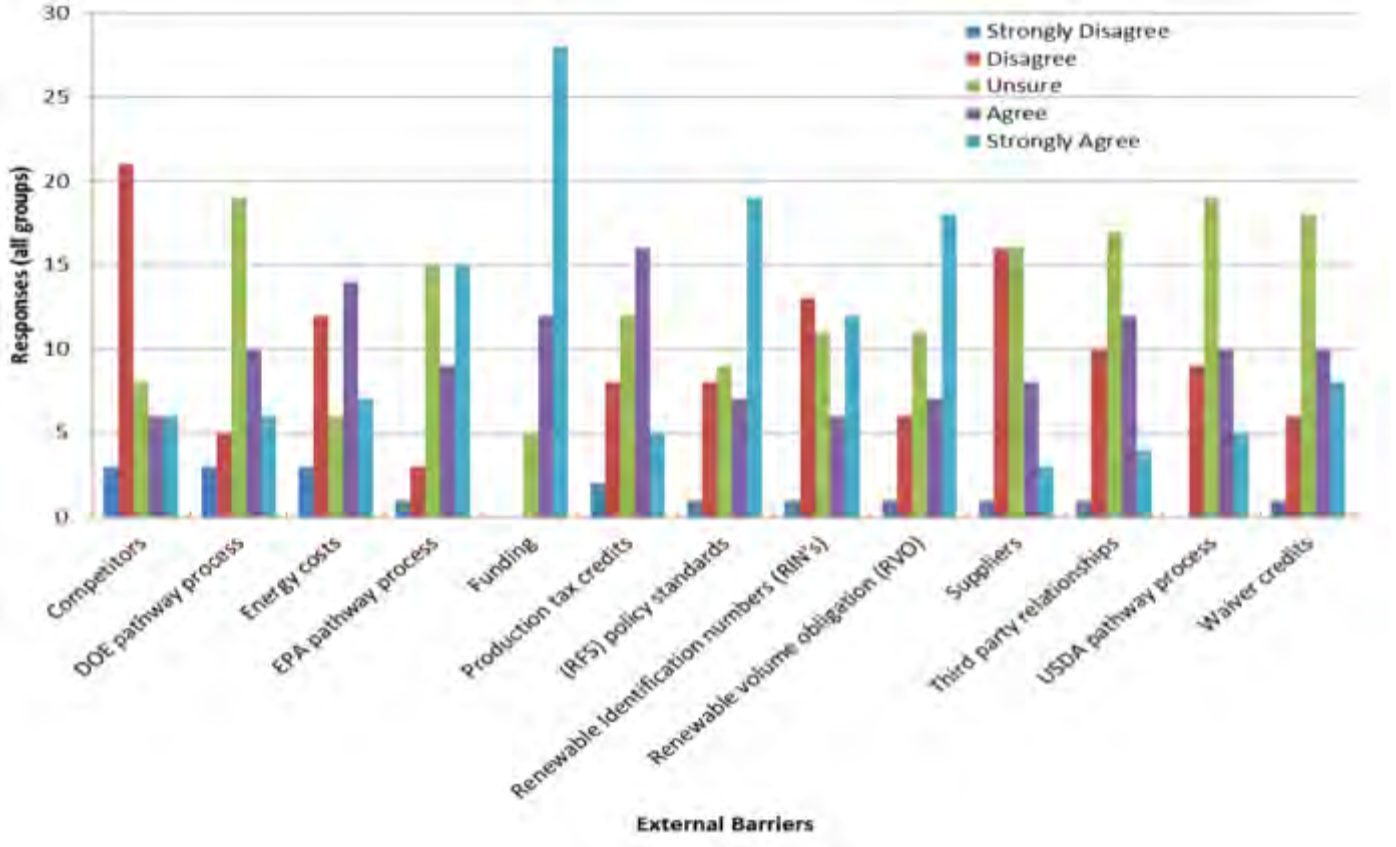
- Internal barriers



Withers, J. 2016. Sustainability Factors Impacting The United States Advanced Biofuel Projects. MS thesis. Virginia Tech

Cellulosic liquid biofuel

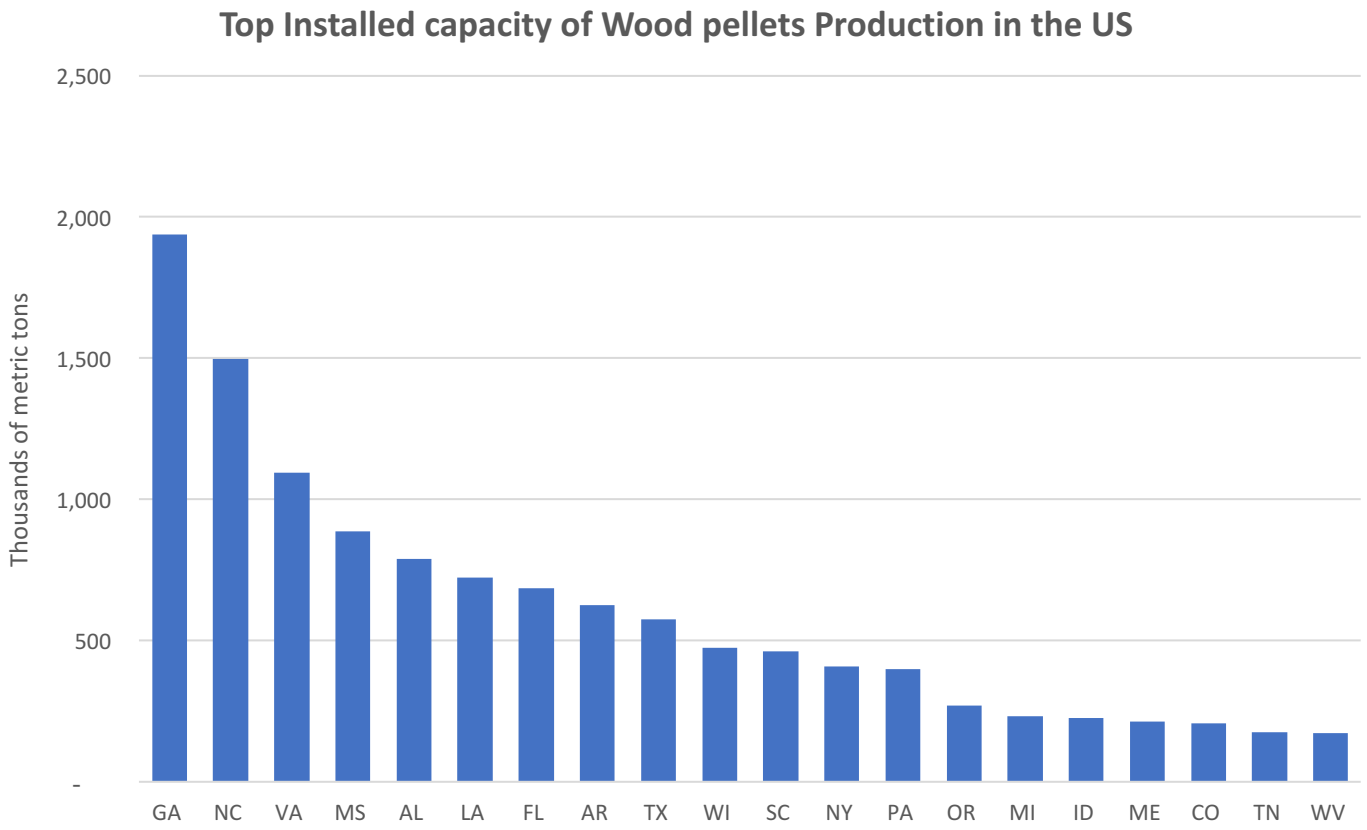
- External barriers



Withers, J. 2016. Sustainability Factors Impacting The United States Advanced Biofuel Projects. MS thesis. Virginia Tech

Wood Pellets Industry

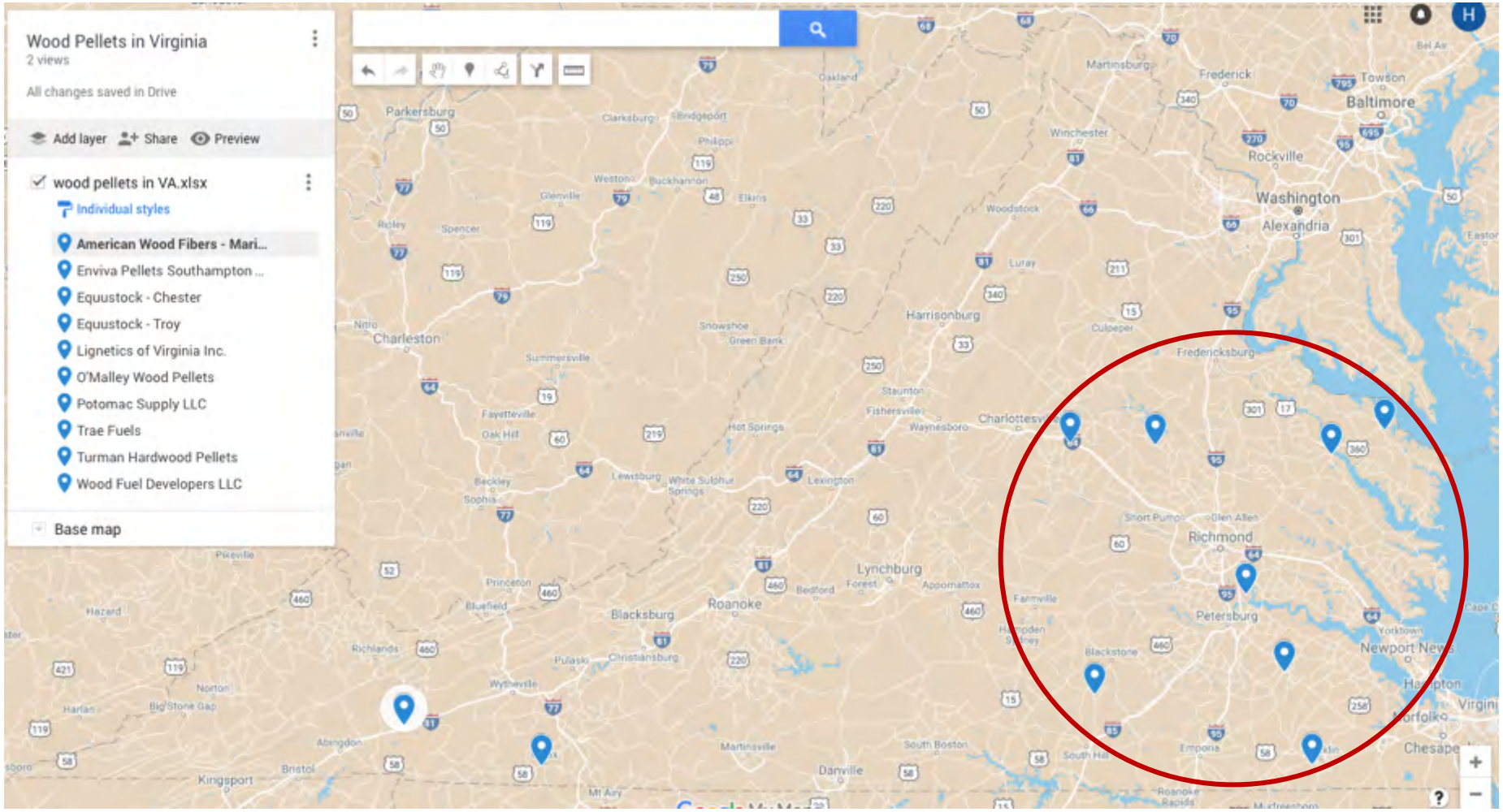
- 2017 wood pellets installed manufacturing capacity in the US is 13.3 MMT
  - 140 mills in the US
  - 10 mills in VA, 8 in GA
- 1 MMT under construction
- 2.3 MMT proposed



http://biomassmagazine.com/

Wood Pellets Industry

- Wood pellets in VA
- 8 out 10 pellet mills within 65 miles from Richmond



Wood Pellets Industry

- Woody biomass competition
  - Paper industry downturn means less market for low-grade wood
  - In spite of the renewable energy industry, low fossil fuel costs negatively impact the industry
  - Chipping wood into pellets requires a sizable investment

Loggers feel impact of paper industry downturn

Alexander Violo | The Lincoln County News

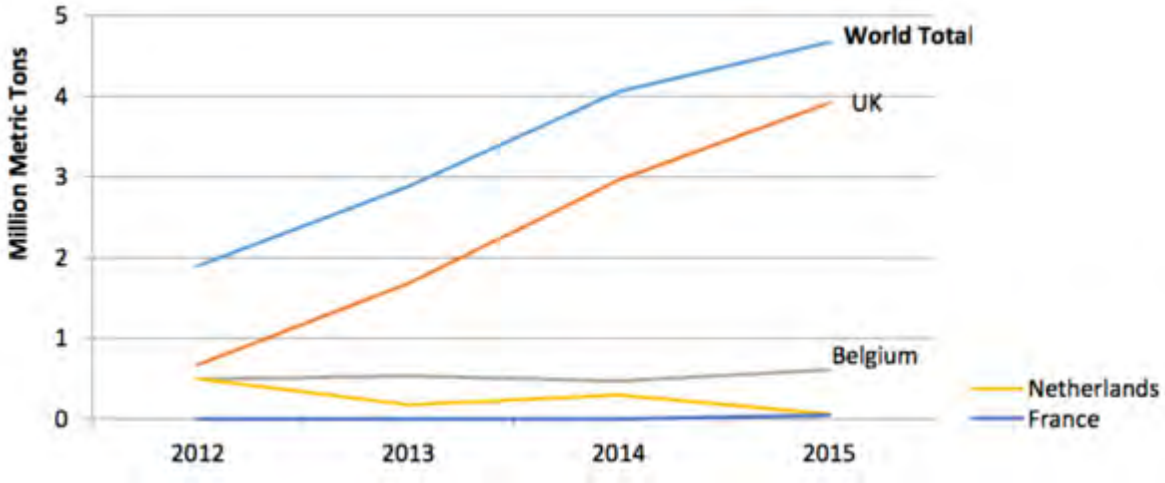
Norman Hunt, owner of N.C. Hunt, is concerned with the state of Maine's timber industry. Hunt hopes something can be done to revitalize the industry, keep mills running, and keep employees working across the state.

By Alexander Violo, The Lincoln County News
Posted Dec. 30, 2015, at 3:31 p.m.
Last modified Dec. 31, 2015, at 1:30 p.m.

Violo, A. 2015. Loggers feel impact of paper industry downturn. The Lincoln News. December 20.

Wood Pellets Industry

- Export Policy impacts
  - The EU's renewable energy directive (RED) provides the 20-20-20
    - 20% of GHG reduction, 20% reduction in energy consumption, and 20% of energy to be renewable. EU accounts for 80% of total consumption
  - UK mandates that 15% of total energy consumption should be from renewable sources by 2020
  - Denmark (NREAP): use of 100% of renewable energy in electricity and heating by 2035.
    - From 0.9 MMT in 2006 to 3 MMT in 2020, requires to import 90% of wood pellets. **US wood pellets imports in 2012 was only 0.38 MMT**

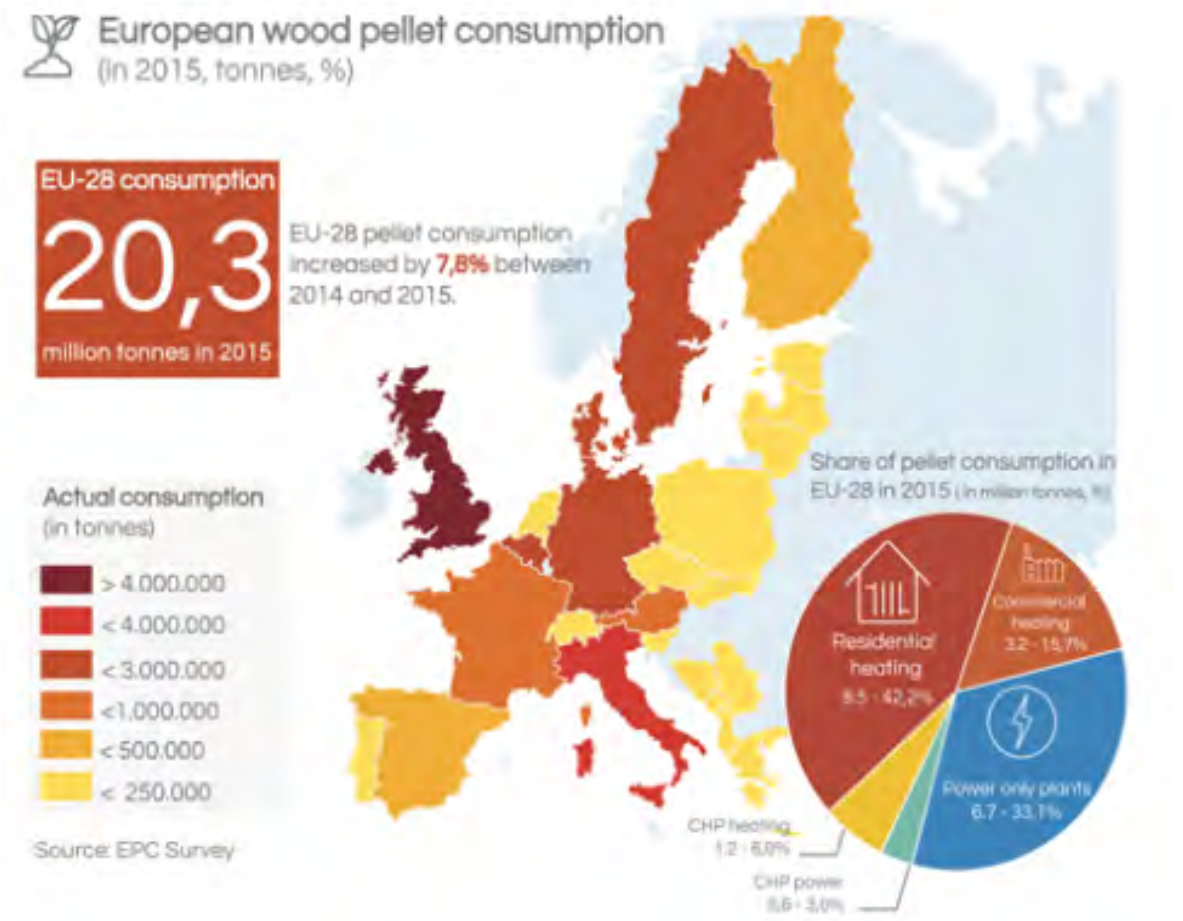


http://www.trade.gov/topmarkets/pdf/Renewable_Fuels_Top_Markets_Report.pdf

http://www.pelletheat.org/legislation-regulations

Wood Pellets Industry

- 2/3 of US pellet production is exported to EU
- EU pellet production (14.1 MMT) covered 70% of EU demand in 2015



https://bioenergyinternational.com/markets-finance/eu-pellet-production-covered-70-percent-of-eu-demand-2015

Wood Pellets Industry

- Internal Policy impacts
  - Oregon passed legislation for a $300 credit for purchasing a pellet stove and $10 tax credit per ton of pellets purchased
  - New Hampshire: 30% or $6,000 (whichever is less) rebate of installation costs of residential high-efficiency for wood-pellet indoor heating boilers and furnaces
  - BTU act: biomass heating appliances for tax credits available for energy-efficient building property
  - Others?

http://www.pelletheat.org/legislation-regulations

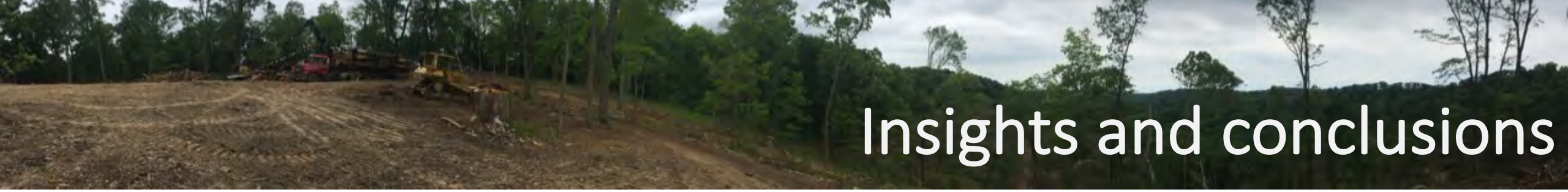
Wood Pellets Industry

- Environmental impact of pellets

Power plant capacity (MW) → / Steps present in the supply chain (1000 Mg CO_2e) ↓	20	40	60	80	100
Manufacturing of wood pellets	15.3	26.5	36.9	46.8	56.4
Transportation of wood pellets using railroads in United States	0.3	0.6	0.8	1.1	1.3
Transatlantic shipment of wood pellets	9.7	16.8	23.4	29.7	35.8
Transportation of wood pellets using railroads in United Kingdom	0.2	0.4	0.6	0.7	0.9
Burning of wood pellets at Selby, United Kingdom	3.4	5.8	8.1	10.3	12.4

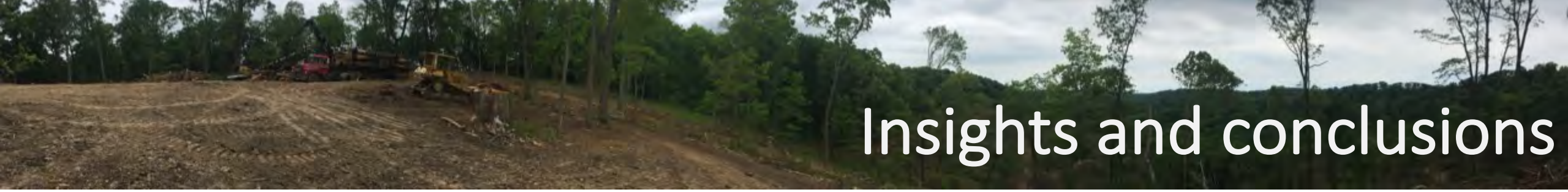
- Relative **SAVINGS** in green house gas (GHG) emissions with respect to a unit of electricity derived from fossil fuels in the United Kingdom range between 50% and 68% depending upon the capacity of power plant and rotation age.

Dwivedi, P., Khanna, M., Bailis, R. and Ghilardi, A. 2014. Potential greenhouse gas benefits of transatlantic wood pellet trade. Environment Research Letters. 9(2): 1-11.



Insights and conclusions

- Current installed wood pellet manufacturing capacity in the US is 13.3 MMT, with 140 mills in the US
  - 10 plants in VA (1.09 MMT). Eight within 65 miles from Richmond
- Consumption of current projects and the ones that have passed viability screening is 77.4 MMT/year
  - Expected of wood for bioenergy projects is 117 MMT per year by 2026
- Demand for US pellets in Western Europe economies impacted by renewable energy policy will continue to grow
- Cost of KW depends on technology to be used and choice of biomass



Insights and conclusions

- Supply chain costs are critical:
  - Harvesting, chipping, transportation, and storage
- Wood chipping operations could be prohibited for small logging operations
- Paper industry downturn reduces the market for low-grade wood
- Moisture content is an important driver for biomass prices
- Main competitors for wood residues are:
  - Energy crops and agricultural waste
- According to recent research, savings in GHG emissions when using US pellets instead of fossil fuel in UK ranges from 40% to 60%

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