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Isabel F. Peres

Timothy A. Slating

Jay P. Kesan

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Isabel F. Peres,* Timothy A. Slating** & Jay P. Kesan***

Abstract

For many countries, money grows on trees: woody biomass is one of the most important sources of renewable energy in the European Union. In the United States, biomass was the input for almost half of the renewable energy generated in 2000; of the energy generated by biomass, seventy-six percent was produced from wood.[1] Currently, biomass is the largest source of renewable energy in the country. The ability to secure a reliable and stable supply of biomass is therefore extremely important for the future of the renewable energy industry. According to the United States Department of Energy, the success of the domestic bioenergy industry relies on many factors, including reliable, adequate supply of high-quality biomass. In order for the bioenergy industry to continue to grow and provide energy and fuel to millions of American homes and vehicles, the organizational aspects of the biomass supply chain need to be clearly defined and efficiently arranged. Dedicated biomass crops, which significantly differ from traditional commodity crops, present unique characteristics that bring uncertainties and costs to transactions that parties must contract around. In this Article, we take a transaction cost economics approach to the relationships among biomass market players, and discuss organizational choices ranging from spot market transactions to vertical integration. One approach to vertical integration involves a firm controlling different stages of its input supply chain. Vertical integration internalizes

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* Research Associate, Biofuel Law & Regulation Project, Energy Biosciences Institute, University of Illinois.

** Regulatory Associate, Biofuel Law & Regulation Project, Energy Biosciences Institute, University of Illinois.

*** Professor and H. Ross & Helen Workman Research Scholar, University of Illinois College of Law; Project Leader, Biofuel Law & Regulation Project, Energy Biosciences Institute, University of Illinois. This work was funded by the Energy Biosciences Institute at the University of Illinois at Urbana-Champaign.

[1] Robert Wilson, *Biomass: The World's Biggest Provider of Renewable Energy*, ENERGY COLLECTIVE (Apr. 23, 2014), http://theenergycollective.com/robertwilson190/370286/biomass-worlds-biggest-provider-renewable-rnergy, *archived at* http://perma.cc/ZJ7K-N4GG.

incentives and helps to reduce opportunism. In a vertically integrated bioenergy industry, the biomass end-user would exercise substantial control over the planting, harvesting, transporting, and storage of its biomass feedstock. In this work, we argue that because the nascent bioenergy industry shows evidence of high asset specificity, parties would benefit from a vertically integrated structure rather than a contractual model. We draw our conclusions based on an analysis of model biomass contracts, and an empirical study of agricultural disputes resolved through arbitration. We conclude that at the outset of a dynamic bioenergy industry, vertical integration is the best organizational model to account for the asset specificity, uncertainties, and transaction costs that characterize supply chains for dedicated biomass crops.

INTRODUCTION

Renewable energy is not a new trend; in fact, more than 150 years ago, wood, which is traditionally the most common form of biomass, supplied up to ninety percent of the energy needs in the United States.[2] Today, the country relies heavily on coal, oil, and natural gas for its energy, all of which are non-renewable fossil fuels existing in finite quantities.[3] As the use of non-renewable fossil fuels increased, renewable energy use decreased. Now, there is a need to take a second look at renewable energy sources and how their markets are organized to find new ways to help the country meet its energy needs.[4] Biomass is a strong candidate to play an important role in our energy mix and is already responsible for most of the renewable energy currently used in the United States.[5]

Renewable energy resources, such as wind, solar energy, and organic matter, are naturally available and self-replenishing.[6] Biomass is

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[2] *Renewable Energy Explained*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/energyexplained/index.cfm?page=renewable_home (last updated Nov. 26, 2014), *archived at* http://perma.cc/S5E5-8SHR; *see* Bruce A. Babcock et al., *Opportunity for Profitable Investments in Cellulosic Biofuels*, 39 ENERGY POL'Y 714, 718 (2011) ("[F]orest residues include logging residues, and thinning, rough, rotten, or salvageable logs. It has been estimated that up to 45 million tons of such residues could be used economically in the U.S.").

[3] *Types of Renewable Energy*, RENEWABLE ENERGY WORLD.COM, http://www.renewableenergyworld.com/rea/tech/home (last visited Mar. 15, 2015), *archived at* http://perma.cc/VX63-9LCJ.

[4] *See Renewable Energy Explained*, *supra* note 2 (explaining the role of renewable energy in the United States and how renewable energy has grown in the last decades).

[5] Robert Wilson, *Biomass: The World's Biggest Provider of Renewable Energy*, BREAKING ENERGY (May 14, 2014, 10:00 AM), http://breakingenergy.com/2014/05/14/biomass-the-worlds-biggest-provider-of-renewable-energy/, *archived at* http://perma.cc/3JXH-9XZN.

[6] *Types of Renewable Energy*, *supra* note 3.

a term used to generally refer to any type of organic matter that serves as an input for energy production, and as a result of the large-scale production of biofuel from corn grain, it is currently the single largest source of renewable energy in the United States.[7] Biomass can be used to produce electricity, transportation fuels, and chemicals. The importance of renewable energy worldwide, and particularly in the United States, is expected to grow in the coming years. About 9 quadrillion BTUs—1 quadrillion is the number 1 followed by 15 zeros—of all energy consumed in the United States in 2012 was from renewable sources, accounting for 9% of all energy consumed, and the renewable share of total world energy consumption is expected to rise to 14.2% by 2035.[8] In addition, besides domestic developments in consumption of renewable energy, the country's biomass industry continues to enjoy a strong and positive demand from Europe, and, as a result, it is investing heavily in biomass pellet production facilities.[9] In the European Union, which holds three-quarters of the world's installed capacity of solar photovoltaic energy, wood has surpassed both solar and wind as a renewable energy input.[10]

The United States is also making renewable energy-related choices, which will likely determine if tomorrow's energy systems will be sustainable and reliable. Today's choices will direct the country on how to upgrade and expand its energy infrastructure.[11] In light of the increasing importance of renewable energy sources, and specifically the future prospects for the use of biomass powering the domestic energy economy, laws and regulations are trying to provide the right incentives to develop a strong bioenergy industry. For example, the Renewable Fuel Standard ("RFS") program was created under the Energy Policy Act of 2005, and established

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[7] U.S. DEP'T OF ENERGY, DOE/IG-0892, THE DEP'T OF ENERGY'S ADMIN. OF ENERGY SAVINGS PERFORMANCE CONTRACT BIOMASS PROJECTS 1 (2013).

[8] *Renewable Energy Explained, supra* note 2; *Renewable Energy*, INST. FOR ENERGY RES., http://www.instituteforenergyresearch.org/energy-overview/renewable-energy/ (last visited Mar. 15, 2015), *archived at* http://perma.cc/65EE-XFYC (explaining the consumption of renewable energy in the United States).

[9] Tim Probert, *Biomass Industry 2012 Review: A Mixed Bag*, RENEWABLE ENERGY WORLD.COM (Dec. 24, 2012), http://www.renewableenergyworld.com/rea/news/article/2012/12/biomass-industry-2012-review-a-mixed-bag, *archived at* http://perma.cc/5LXS-ZPKH.

[10] *The Fuel of the Future*, ECONOMIST (Apr. 6, 2013), http://www.economist.com/news/business/21575771-environmental-lunacy-europe-fuel-future, *archived at* http://perma.cc/PZ5S-CZEJ.

[11] Daniel Sosland & Jamie Howland, *Will the US Choose the Right Road to a New Energy Future?*, RENEWABLE ENERGY WORLD.COM (Mar. 20, 2014), http://www.renewableenergyworld.com/rea/news/article/2014/03/will-the-us-choose-the-right-road-to-a-new-energy-future, *archived at* http://perma.cc/NP3L-EUZ8.

the first mandate for the commercialization of renewable fuel in the United States.[12] The goal of the RFS is to increase the United States' use of biofuels to thirty-six billion gallons per year by 2022, as well as increase biorefining capacity in the country.[13] Most biofuels in the United States are currently derived from corn starch, which might have negative environmental consequences, as well as undesirable impacts on food prices.[14] In response to these concerns, the Energy Independence and Security Act of 2007 amended the RFS to require that approximately twenty-one billion gallons of the RFS's thirty-six billion gallon biofuel mandate must be comprised of advanced biofuels (i.e., those made from non–corn starch feedstocks).[15] The RFS program has also laid the foundation for further private investment in the domestic biofuels industry, and other federal and state policies further encourage renewable energy production, including biomass utilization.[16] For instance, the Feedstock Flexibility Program for Producers of Biofuel authorizes the use of funds to purchase surplus sugar for use as a biomass feedstock to produce bioenergy.[17] The Biomass Crop Assistance Program also provides financial assistance to owners and operators of agricultural and non-industrial private forestland who wish to produce and deliver biomass feedstocks to bioenergy conversion facilities.[18]

Despite all of these policy efforts, attempts to promote biofuels from a single perspective will likely not be successful, and government and private initiatives will become futile unless the bioenergy industry develops efficiently. As biomass supply chains develop, different obstacles may

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[12] *Renewable Fuel Standard*, U.S. ENVTL. PROTECTION AGENCY http://www.epa.gov/oms/fuels/renewablefuels/, *archived at* http://perma.cc/748T-9823 (last updated Oct. 2, 2014).
[13] Philip T. Pienkos & Al Darzins, *The Promise and Challenges of Microalgal-derived Biofuels*, 3 BIOFUELS, BIOPRODUCTS & BIOREFINING 431, 432 (2009), *available at* http://www.afdc.energy.gov/pdfs/microalgal_biofuels_darzins.pdf.
[14] Dajun Yue et al., *Biomass-to-bioenergy and Biofuel Supply Chain Optimization: Overview, Key Issues and Challenges*, 66 COMPUTERS & CHEMICAL ENG'G 36, 36 (2014).
[15] Pienkos & Darzins, *supra* note 13, at 432 (noting also that other advanced biofuels may contribute to achieving the mandate).
[16] *See* Wang Mingyuan, *Government Incentives to Promote Renewable Energy in the United States*, 24 TEMP. J. SCI. TECH. & ENVTL. L. 355, 361–64 (2005) (discussing some of the major laws for renewable energy in the United States); *see also Renewable Fuel Standard*, RENEWABLE FUELS ASS'N, http://www.ethanolrfa.org/pages/renewable-fuel-standard, *archived at* http://perma.cc/7GN9-GX97 (last visited Mar. 15, 2015).
[17] JIM BOWYER, POTENTIAL IMPACTS OF CLIMATE AND ENERGY POLICY ON FOREST SECTOR INDUSTRIES: PROVIDING INCENTIVES FOR BIO-ENERGY WHILE PROTECTING ESTABLISHED BIOMASS-BASED INDUSTRIES 20 (2011), *available at* http://www.dovetailinc.org/report_pdfs/2011/dovetailbiomasswercprojectreport.pdf.
[18] *Id.*

emerge, such as planning of storage and processing facilities for specific feedstocks, availability of cultivation technologies, transport constraints, infrastructure for the distribution of biomass, air and water quality issues, and wider issues of public acceptability and landscape quality.[19]

In this sense, the implementation of an efficient supply chain is paramount to the development of the bioenergy industry.[20] This is because the ability to supply a high volume of renewable energy will depend on a well-organized industry. The key players in the biomass supply chain are farmers that grow the biomass feedstock (i.e., biomass producers), intermediaries (e.g., cooperatives and aggregators), and the facilities that process this biomass into bioenergy (e.g., biomass processors or end-users, which are commonly referred to as biorefineries).[21] Whether biomass producers can meet the bioenergy industry's demand for biomass feedstock will depend on how efficiently they respond to market challenges. The question becomes how to organize the bioenergy industry: is market contracting for biomass feedstock the optimal choice? Alternately, would vertical integration be the preferred governance structure given the specific characteristics of this nascent industry? At one extreme there is complete vertical integration, in which a company internalizes all its biomass-related economic activities in order to reduce transaction costs and uncertainties, and take advantage of economies of scale. On the other extreme, there are spot market transactions, in which goods are bought and sold in the absence of production contracts.[22] The proper choice for the governance structure is important because how parties organize themselves will influence how efficient and sustainable the bioenergy sector will become as the industry progresses and technology advances. This is because the optimal governance structure for a transaction (e.g., selling biomass feedstock for the production of bioenergy) should be the one that incurs the least costs to the parties in the transaction.[23]

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[19] THE ROYAL SOCIETY, SUSTAINABLE BIOFUELS: PROSPECTS AND CHALLENGES 6 (2008), *available at* http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/publications/2008/7980.pdf.

[20] Mingyuan, *supra* note 16, at 364–65.

[21] *See The Biomass Supply Chain*, WIS. GRASSLANDS BIOENERGY NETWORK, http://www.wgbn.wisc.edu/biomass-supply-chain, *archived at* http://perma.cc/PU7S-UA4S (last visited Mar. 15, 2015).

[22] *Spot Market*, INVESTOPEDIA, http://www.investopedia.com/terms/s/spotmarket.asp, *archived at* http://perma.cc/6YEN-QAHL (last visited Mar. 15, 2015).

[23] *See* Oliver E. Williamson, *Transaction-Cost Economics: The Governance of Contractual Relations*, 22 J.L. & ECON., 233, 245 (1979) (noting that "[t]he criterion for organizing commercial transactions is assumed to be the strictly instrumental one of cost economizing.") [hereinafter *Transaction-Cost Economics: The Governance of Contractual Relations*].

In 2007, Altman and Johnson argued for the importance of organizing the market for the development of the bioenergy industry from a transaction cost perspective. The authors studied the biopower industry, and concluded that asset specificity should be considered in this industry, and that further studies are necessary to determine the most efficient option in individual cases. In 2009, Altman and Johnson showed that the biopower industry (i.e., the production of energy from biomass) in the United States is mainly vertically integrated.[24] Their study also found that after vertical integration, short-term and long-term contracts are most commonly used by power producers to purchase biomass, while spot market transactions are rarely used.[25] While spot markets may give more flexibility to buyers and sellers of biomass, the study found that contracting and vertical integration are the preferred options.[26] Similarly, there are many reasons why contracts and vertical integration may be preferred to spot markets in the current biomass industry. One that will be explored in this Article is the presence of asset specificity in biomass-related transactions. Asset specificity generally refers to the use of a good for a narrow and specific purpose.[27] The narrower the use of the good, the more specific the asset is considered to be.[28] Some authors have explored the influence of asset specificity on organizational structure and found that spot market transactions may be a good choice when parties are flexible in regard to quantity and quality of biomass, when there is low site asset specificity, or when investment in machinery is low.[29] On the other hand, in the presence of high asset specificity, spot markets are less efficient and a more integrated and coordinated organization of the industry will be desired to balance risks and costs involved in transactions.[30]

To date, few authors have specifically undertaken the study of what the most optimal arrangement would be between biomass producers and

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[24] Ira Altman & Thomas Johnson, *The Choice of Organizational Form as a Non-Technical Barrier to Agro-Bioenergy Industry Development*, 32 BIOMASS & BIOENERGY 28, 28–34 (2008); Ira Altman & Thomas Johnson, *Organization of the Current U.S. Biopower Industry: A Template for Future Bioenergy Industries*, 33 BIOMASS & BIOENERGY 779, 780 (2009).
[25] *Id.* at 783.
[26] *Id.* at 784 (the findings were based on a mail survey conducted by the University of Missouri Community Policy Analysis Center in 2003).
[27] *Asset Specificity*, INVESTOPEDIA, http://www.investopedia.com/terms/a/asset-specificity.asp, *archived at* http://perma.cc/B9ZJ-JAFF (last visited Mar. 15, 2015).
[28] *See id.*
[29] Ira Altman et al., *Contracting for Biomass: Supply Chain Strategies for Renewable Energy*, 2008 J. ASFMRA 1 (2008), *available at* http://ageconsearch.umn.edu/bitstream/189870/2/281_altman.pdf [hereinafter *Contracting for Biomass*].
[30] *Id.*

biomass processors.[31] We argue here that vertical integration is the most appropriate organizational choice at the current, developing stage of the bioenergy industry when biomass producers and processors remain faced with substantial uncertainties. In this Article, we address these uncertainties, add important empirical considerations to the literature, and integrate these findings with the importance of asset specificity in choosing the optimal organization structure for the bioenergy industry. We conduct an empirical analysis of model biomass contracts between producers and processors, and between producers and cooperatives. We undertake an empirical study of arbitration decisions involving typical agricultural disputes, and we contrast those with similar potential sources of disputes that will likely be encountered in the developing bioenergy industry. This work considers the economic realities of the bioenergy industry in pursuit of the most efficient equilibrium in the industry.

First, we provide a general background on renewable fuels and specify to which sector of the bioenergy industry we are referring. We also establish the analytical framework relevant to existing biomass organizational models and contracting, and the costs and benefits associated with the relevant organizational models.

Second, we discuss vertical integration and the importance of asset specificity in the organization of the bioenergy industry. We also provide general background on the main aspects of the biomass supply chain and discuss how miscanthus, a perennial grass used for biofuel production, is a prime example of the main challenges in this industry. Third, a review of common disputes in agricultural contracts shows that the areas where asset specificity is prevalent in biomass contracting are also the areas where non-performance disputes in contracts for traditional crops are the highest.

Finally, we contrast model biomass contracts with the biomass research literature, and explore the relevant aspects of the economic realities of contracting in the bioenergy industry. We also determine how these

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[31] Altman & Johnson, *supra* note 24, at 28–34 (discussing the study emphasizing the presence of asset specificity in the biopower industry and how the industry appears to have organized itself in light of different levels of asset specificity); *see, e.g.*, Altman & Johnson, *supra* note 24, at 780 (noting that most of the biomass literatures focus on technical questions, and there are few studies about the organization of future industries); L. Paul Goeringer et al., *The New Fuel Frontier: Biomass Contracting*, 5 KY. J. EQUINE, AGRIC. & NAT. RES. L. 71, 74 (2013) (arguing that while farmers have experience with crop and livestock contracts, biomass production contracts present contracting parties with currently unresolved legal issues); Xi Yang et al., *Optimal Contracts to Induce Biomass Production under Risk* 29 (Aug. 12–14, 2012) (Agric. & Applied Econ. Ass'n 2012 AAEA&NAREA Joint Ann. Meeting) (noting the impact of risk preferences, land quality and riskiness of the biomass production and prices on the optimal contract terms).

contracts address the issues associated with asset specificity and highlight their importance for the bioenergy industry. We then draw our conclusions on the most appropriate organization structure for the bioenergy industry. This work aims to assist the decision-making process of actors in the developing bioenergy industry in evaluating the most efficient supply chain strategy for their operations.

I. THE BIOENERGY INDUSTRY

In general, renewable energy is defined as energy derived from resources that are consistently and naturally replenished on a short timescale.[32] The most common types of renewable energy are those derived from biomass, water, geothermal heat, wind, and solar radiation.[33] We will focus here on bioenergy, which is a general term used to refer to renewable energy derived from biomass.[34] Bioenergy encompasses liquid biofuels derived from biomass (e.g., cellulosic biofuels), thermal energy derived from solid biomass (e.g., heating a home with biomass pellets), and electricity generated from the burning of biomass.[35] Biomass is a general term used to describe any plant-based organic material that contains stored energy from the sun and is used to produce bioenergy.[36] Biomass is therefore extremely abundant and includes all kinds of trees and plant-based crops, whether purposefully cultivated or not.[37]

In this work, we mainly focus on biomass crops that are either grown on agricultural land specifically for bioenergy-related purposes or exist as residues from traditional crops (e.g., commodity corn and wheat). If biomass is going to increase its participation in the world energy supply, cultivation of dedicated, purposefully grown biomass crops will become necessary.[38] This is because while some biomass may be obtained from wood wastes (e.g., saw mill waste) and crop residues (e.g., corn stover and

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[32] *See* Mingyuan, *supra* note 16, at 356 (discussing the different definitions of "renewable energy").
[33] *See Renewable Energy Explained*, *supra* note 2 (discussing U.S. energy consumption by energy source).
[34] *Bioenergy*, RENEWABLE ENERGY WORLD.COM, http://www.renewableenergyworld.com/rea/tech/bioenergy, *archived at* http://perma.cc/Q4DS-QNQT (last visited Mar. 15, 2015).
[35] *Bioenergy (Biofuels and Biomass)*, ENVTL. & ENERGY STUDY INST., http://www.eesi.org/topics/bioenergy-biofuels-biomass/description, *archived at* http://perma.cc/FTN3-8UCK (last visited Mar. 15, 2015).
[36] *Biomass Explained*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/energyexplained/index.cfm?page=biomass_home, *archived at* http://perma.cc/3HEF-GGP9 (last visited Mar. 15, 2015).
[37] Peter McKendry, *Energy Production from Biomass (Part 1): Overview of Biomass*, 83 BIORESOURCE TECH. 37, 37 (2002).
[38] *Id.* at 38.

wheat straw), dedicated biomass crops will be required to meet the RFS's advanced biofuel mandates.[39]

Nearly all plants and organic wastes can be used to produce heat, power, or fuel.[40] Some of the common types of biomass feedstock generally found in the industry are grain and starch crops, such as sugarcane, corn and wheat, and their agricultural residues, like corn stover.[41] Examples of dedicated energy crops include switchgrass, miscanthus, and hybrid willow trees.[42] Miscanthus will be discussed in detail in Section III. Currently, it is not possible to determine which dedicated feedstock would be the optimal feedstock for future biorefineries, because processing plants and conversion technologies in the bioenergy industry are still in the early stages of development.[43]

It is important to point out the different ways biomass can be processed into bioenergy. First, biomass can be directly combusted to produce thermal energy for heating applications.[44] An example of this would be heating a home with a furnace designed to burn biomass pellets.[45] Second, biomass can be burned to produce electricity in much the same way as traditional fossil fuels such as coal and natural gas (i.e., the biomass is burned to generate thermal energy, which is used to convert water to steam and drive electrical generators).[46] Finally, biomass can be used to produce biofuels through various processes that generally involve breaking the biomass down into its component sugars and then fermenting them into alcohols, which can serve as liquid fuels for internal combustion engines.[47]

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[39] Francis M. Epplin et al., *Challenges to the Development of a Dedicated Energy Crop*, 89 AMER. J. AGR. ECON. 1296, 1296 (2007).

[40] *Growing Energy on the Farm: Biomass and Agriculture*, UNION OF CONCERNED SCIENTISTS, http://www.ucsusa.org/clean_energy/smart-energy-solutions/increase-renewables/growing-energy-on-the-farm.html, *archived at* http://perma.cc/69P9-FVDF (last visited Mar. 15, 2015).

[41] *See Biomass Resources*, N. AM. RENEWABLE ENERGY DIRECTORY, http://nared.org/bioenergy/biomass-resources/, *archived at* http://perma.cc/95VF-8TYE (last visited Mar. 15, 2015).

[42] *Id.*

[43] Russell W. Jessup, *Development and Status of Dedicated Energy Crops in the United States*, 45 IN VITRO CELL. & DEVELOPMENTAL BIOLOGY PLANT 282, 284 (2009).

[44] *Why Use Biomass for Heating?*, BIOMASS THERMAL ENERGY COUNCIL, http://www.biomassthermal.org/resource/PDFs/Fact%20Sheet%201.pdf, *archived at* http://perma.cc/3BQC-ZY2V (last visited Mar. 15, 2015).

[45] Julie Maria Anderson, *Wood Pellet Stoves vs. Oil*, EHOW http://www.ehow.com/about_6728540_wood-pellet-stoves-furnaces.html, *archived at* http://perma.cc/K79Y-G69S (last visited Mar. 15, 2015).

[46] *See Why Use Biomass for Heating?*, *supra* note 44 (discussing the advantages of using biomass for heating).

[47] *See* Carol Williams, *Bioenergy Conversion Technologies*, WIS. GRASSLAND BIOENERGY NETWORK, http://www.wgbn.wisc.edu/conversion/bioenergy-conversion-technologies, *archived*

The biomass supply chain includes the market players and the operations that are necessary to move the biomass feedstock from the producer to the end user while ensuring that the delivered feedstock meets the specifications of the end user's conversion process.[48] The key parties in the biomass supply chain are the farmer, responsible for the biomass production, and the biomass processors who convert the biomass feedstock into bioenergy.[49] We generally refer to a biomass processing facility as a "biorefinery." A biorefinery can be defined as anything from a paper mill, which burns its waste lignin to provide heat and power, to a state-of-the-art cellulosic biofuel plant.[50] A biorefinery is where biomass production processes and equipment are integrated to produce fuels and generate heat and/or power.[51]

Other market players may be involved in the biomass supply chain, such as cooperatives and aggregators. In transactions involving these entities, the biomass is transferred to a central location where the feedstock is accumulated and later dispatched to the biorefinery.[52] While at the central location, the biomass may be pre-processed minimally or extensively.[53] The relationship between farmers, aggregators, cooperatives, and the biorefineries in the biomass market will be further developed in Section III.

Biorefineries have been receiving extensive government support, and a prime example of federal effort to further the bioenergy industry in the United States Department of Energy working in partnership with the industry to develop and validate integrated biorefineries around the country.[54] Integrated biorefineries generally produce different products seeking to optimize the use of the biomass feedstock and production economics, thereby employing various combinations of feedstock and

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at http://perma.cc/V84R-P87T (last visited Mar. 15, 2015) (discussing the fermentation process).

[48] Salman Zafar, *Logistics of a Biopower Plant*, BIOENERGY CONSULT (July 22, 2014, 7:37 PM), http://www.bioenergyconsult.com/biopower-logistics/ [hereinafter *Logistics of a Biopower Plant*].

[49] Goeringer et al., *supra* note 31, at 72, 74.

[50] *Definition: Biorefinery*, OPENEI, http://en.openei.org/wiki/Definition:Biorefinery, *archived at* http://perma.cc/4WPD-4E6V (last visited Mar. 15, 2015); *What is a Biorefinery?*, NAT'L RENEWABLE ENERGY LAB., http://www.nrel.gov/biomass/biorefinery.html, *archived at* http://perma.cc/P6NV-W9H8 (last updated Sept. 28, 2009).

[51] *See What is a Biorefinery?*, *supra* note 50 (analogizing the biorefineries concept to today's petroleum refineries).

[52] *Logistics of a Biopower Plant*, *supra* note 48 (noting the role of central distribution).

[53] *Id.*

[54] U.S. DEP'T OF ENERGY, DOE/EE-0912, INTEGRATED BIOREFINERIES (2014), *available at* http://www1.eere.energy.gov/bioenergy/pdfs/ibr_portfolio_overview.pdf [hereinafter INTEGRATED BIOREFINERIES].

conversion technologies.[55] Federal support for "first-of-a-kind" integrated biorefineries helps the industry to reduce both the costs, and the technical and financial risks associated with the deployment of technology necessary to accelerate growth in the United States bioenergy industry.[56]

While farmers can also receive government incentives to cultivate biomass,[57] they face many challenges in opting to grow biomass crops. For instance, most farmers are not familiar with the growing practices that are necessary to optimize the establishment and production of dedicated energy crops.[58] There are also logistical challenges, such as the lack of mechanized harvesting equipment and the lack of means to efficiently and economically transport biomass from its source to processing facilities.[59] As this Article will further demonstrate, an optimal biomass supply chain must assist in solving these problems and take advantage of economies of scale in the bioenergy industry.

II. THEORETICAL BACKGROUND

A. *Relevant Biomass Literature*

As the organization of the bioenergy industry is of the utmost importance, various authors have considered it through various perspectives. Koppejan and Loo address biomass combustion and how to improve combustion systems by emphasizing the importance of defining organizational issues.[60] Roos et al. present a framework for the analysis of the bioenergy market and identify "critical factors" that create barriers or drive market growth, thereby contributing to the choice of organization in the bioenergy market.[61] These critical factors are integration with other economic activity, scale effects, competition on bioenergy markets and other

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[55] *Id.*

[56] *Id.*

[57] *See, e.g.*, *Biomass Crop Assistance Program*, U.S. DEP'T AGRIC., http://www.fsa.usda.gov/FSA/webapp?area=home&subject=ener&topic=bcap, *archived at* http://perma.cc/Q6A3-92UC (last updated Dec. 16, 2014).

[58] *The Next Generation of Biofuels: Cellulosic Ethanol and the 2007 Farm Bill: Field Hearings in Brookings, South Dakota before the Subcomm. On Energy*, 110th Cong. 6 (2007) (statement of Anna Rath, Dir. of Bus. Dev., Ceres) http://www.ceres.net/PDF/2007_April4%20Senate%20Ag%20Comm%20Testimony.pdf.

[59] John M. Eustermann & Joe R. Thompson, *The Law of Biomass: Biomass Supply Issues and Agreements,* http://www.agmrc.org/media/cms/Biomass_Supply_Issues_and_Agreement_91109FF89D409.pdf (last visited Mar. 15, 2015).

[60] *See* Sjaak Van Loo & Jaap Koppejan, *Preface to* THE HANDBOOK OF BIOMASS COMBUSTION AND CO-FIRING (2008).

[61] Anders Roos et al., *Critical Factors to Bioenergy Implementation*, 17 BIOMASS & BIOENERGY 113, 113, 115 (1999).

businesses, national policy, local policy, and local opinion.[62] Costello and Finnell analyze other factors that also affect the organization of the biomass market and the development of new technologies.[63] They argue that the key to a successful implementation of biomass power technologies can be categorized as regulatory, financial, infrastructural, and perceptual. Rösch and Kaltschmitt also examine other industry characteristics that may cause a biomass project to fail.[64] The aspects raised by these authors are similar to the categories specified by Costello and Finnell, with the addition of the positive consequences of adequate flow of information and insurance risks in the organization of the industry.

Downing et al. specify conditions under which the cooperative model is an appropriate enterprise structure for the agro-bioenergy industry.[65] The authors acknowledge that there are challenges in operat-ing cooperatives, but they see potential for success in the biomass industry. Differently, the research conducted by Overend finds that the biomass industry should rely on short-term contracts or spot markets for the purchase of biomass fuel rather than other supply chains, such as those internalized through vertical integration.[66] That is because the author argues that biomass power will be a subset of the power industry, and only a few growers would dedicate their resources to a dedicated energy crop with a single end use.[67]

Altman et al. examine the choice of supply chain structure of Iogen Corporation and found that ethanol processors are considering the use of formal contracts for biomass procurement.[68] A survey by Altman and Johnson of the current biopower industry indicates that it is highly vertically integrated.[69] Their survey found that close to 75% of the industry

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[62] *Id.*
[63] Raymond Costello & Janine Finnell, *Institutional Opportunities and Constraints to Biomass Development*, 15 BIOMASS & BIOENERGY 201, 201–04 (1998).
[64] Christine Rosch & Martin Kaltschmitt, *Energy From Biomass—Do Non-Technical Barriers Prevent an Increased Use?,* 16 BIOMASS & BIOENERGY 347, 347–48, 350 (1999) (listing organizational difficulties as a reason for failure).
[65] Mark Downing et al., *Development of New Generation Cooperatives in Agriculture for Renewable Energy Research, Development, and Demonstration Projects*, 28 BIOMASS & BIOENERGY 425, 425, 432–33 (2005).
[66] NAT'L RENEWABLE ENERGY LAB., BIOMASS POWER INDUSTRY: ASSESSMENT OF KEY PLAYERS AND APPROACHES FOR DOE AND INDUSTRY INTERACTION, FINAL REPORT 1–2, 5 (1993) (arguing that the biomass power industry will probably never be vertically integrated).
[67] *Id.* at 5.
[68] Ira J. Altman et al., *Applying Transaction Cost Economics: A Note on Biomass Supply Chains*, 25 J. AGRIBUSINESS 107, 111–13 (2007) [hereinafter *Applying Transaction Cost Economics*].
[69] Altman & Johnson, *supra* note 24, at 779–80.

chose to vertically integrate the biomass and biopower production stages.[70] The research included industries using two categories of feedstock, wood and waste, and it was also found that companies using wood and non-wood have similar organizational preferences.[71] The authors suggest then that if the future bioenergy industry will be similar to the biopower industry, it will likely also rely on vertical integration. Moreover, similarly to the experience in the biopower industry, the development of biomass spot markets is unlikely, and contracting would be preferred in the bioenergy industry.[72] On the other hand, Jody M. Endres et al. suggest that a hybrid structure is likely to evolve in the biomass industry, where end-users (i.e., biorefineries) cooperate with producers through long-term contracting instead of end-users being direct owners or operators of the biomass producing farms.[73] The authors propose a "vertically coordinated" biomass industry model based on contracts between end-users and farmers and incorporating a socioeconomic perspective into risk and cost minimizing approaches in contract theory.[74]

Hi Yang et al. undertook an integrated analysis of the decision of farmers and biomass end-users to enter into biomass production contracts, in order to promote the development of the industry.[75] The authors consider the impact of risk preferences, land quality and riskiness of the biomass production, and prices on the optimal contract terms.[76] The authors argue that for a given land quality, the choice of how the contract is designed will vary according to the farmer's level of risk aversion.[77] Farmers owning low quality land, as well as farmers with smaller opportunity costs of crop production, are more likely to accept biomass production contracts.[78] The authors evaluated three types of contract arrangements between farmers and end-users: leasing, profit sharing, and fixed price contracts.[79] For instance, they argue that the farmer's choice of biomass contract design varies with their level of risk aversion.[80] The higher their level of aversion, the more likely the farmers are to prefer the fixed lease contract design. In

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[70] *Id.* at 783.
[71] *Id.* at 781, 783–89.
[72] *Id.* at 784.
[73] Jody M. Endres et al., *Building Bio-based Supply Chains: Theoretical Perspectives on Innovative Contract Design*, 31 UCLA J. ENVTL. L. & POL'Y 72, 72 (2013).
[74] *Id.* at 72–73, 117–19.
[75] Yang et al., *supra* note 31, at 29.
[76] *Id.*
[77] *Id.*
[78] *Id.*
[79] *Id.*
[80] *Id.*

connection to their findings, the authors suggest that a biomass end-user or biorefinery will prefer to be more vertically integrated in two situations.[81] First, a biorefinery will grow its own crop when biomass yield and price risks are high, which will allow the biorefinery to avoid paying a high risk premium to risk averse farmers.[82] Second, vertical integration would be preferred when the variability in returns to crop production is high, and risk averse farmers would be more willing to choose leasing the land for energy crop production.[83]

Finally, Dajun Yue et al. examined the challenges and opportunities in modeling and optimizing biomass to bioenergy supply chains and petroleum supply chains.[84] The authors highlight the supply chain design for biomass, and the key challenges involving the transportation network and the location of the biorefinery.[85] The authors also note that uniqueness of biofuel supply chains, given the raw material acquisition, and transportation and collection stages. The authors point out that, because biomass is cost-prohibitive and unstable for long-distance transport, given its low energy density and high water content, a "circle around the biomass supplier is often specified as the feasible region for building biomass processing facilities."[86]

B. *Organizational Forms in the Bioenergy Industry*

In considering the different costs and benefits of choosing one organizational form over the other, the different theoretical approaches discussed above intend to identify the costs and benefits of the choices existing in the spectrum between producing a good yourself, or turning to the market to purchase it at a certain price and risk. In like manner, the theory of transaction cost economics ("TCE") emphasizes transaction costs as principal determinants of an industry's organization and operations, asserting that firms exist to minimize transaction costs.[87] Transaction costs consist of ordinary production costs, such as those associated with land, materials, and supplies, but they also include costs related to administering ongoing business relationships, such as the costs of negotiating

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[81] Yang et al., *supra* note 31, at 29–30.
[82] *Id.*
[83] *Id.* at 30.
[84] Yue et al., *supra* note 14, at 36.
[85] *Id.* at 43.
[86] *Id.* at 45.
[87] Oliver E. Williamson, *The Economics of Organization: The Transaction Cost Approach,* 87 AM. J. SOCIOLOGY 548, 556–58 (1981) [hereinafter *The Economics of Organization*].

and writing efficient contracts, and the costs of monitoring and enforcing the implementation of such contracts.[88] TCE suggests that there are circumstances where costs associated with market transactions may favor hierarchies (or in-house production), while in other cases, such costs may favor "going to the market" as an economic governance structure.[89]

The most relevant feature of TCE is the notion that parties will align transactions with different attributes and different alternative governance structures to achieve a transaction cost economizing result.[90] TCE suggests that when contracting costs exceed external procurement costs, parties are more likely to vertically integrate.[91] One of the reasons is because vertical integration can meet the contractual needs of the parties without posing hold-up problems.[92] Consequently, the choice of the optimal governance structure emerges to reduce the cost of participating in the market, meaning to reduce the costs incurred in making an economic exchange.[93]

Some of the following characteristics should be considered when identifying the nature of transaction costs: (1) the extent of uncertainty present; (2) whether one or more of the parties involved are required to make specific investments in the transaction (i.e., sunk investments); (3) the economies of scale and scope associated to the transaction; and (4) the reputational constraints.[94] The consequence of these factors in contracting and vertically integrated models will be discussed below.

1. Costs and Benefits Associated with Contractual Arrangements

Contracts facilitate parties' efforts in maximizing the "contractual surplus" from their transaction.[95] The contractual surplus can be defined

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[88] Paul L. Joskow, *Vertical Integration and Long-Term Contracts: The Case of Coal-Burning Electric Generating Plants*, 1 J. L. ECO. & ORG. 33, 36 (1985). *See generally The Economics of Organization*, *supra* note 87, at 552 (exemplifying the idea of transaction costs as "[t]he economic counterpart of friction," where relevant questions are whether "the parties to the exchange operate harmoniously, or are there frequent misunderstandings and conflicts that lead to delays, breakdowns, and other malfunction?").
[89] *See id.* at 558.
[90] *Id.* at 573–74.
[91] *Id.* at 558.
[92] Oliver E. Williamson, *Credible Commitments: Using Hostages to Support Exchange*, 73 AM. ECON. REV. 519, 524 (1983) [hereinafter *Credible Commitments*].
[93] Joskow, *supra* note 88, at 36 (noting that the different organizational choices are a consequence of firms seeking to minimize transaction costs).
[94] *Id.* at 36–37.
[95] Alan Schwartz & Robert E. Scott, *Contract Theory and the Limits of Contract Law*, 113 YALE L. J. 541, 544 (2003).

as the joint-gains of parties in connection with entering the contractual relationship, such as reducing risks associated with the market.[96] Likewise, contract theory focuses mainly on two functions of contracts: minimizing contract risks and risk sharing.[97] When transaction costs are low, contracts can minimize opportunistic behavior and the risk of default by controlling or encouraging certain actions within the framework of the contract.[98] Contracts allow parties to either enter into an inflexible relationship, meaning a contract where one party tries to address every possible outcome and eliminate risk, or more flexible relationships, where parties would be allowed to tailor transactions to their future needs.[99] Furthermore, long-term contracts, as opposed to short-term contracts or spot market transactions, help parties to reduce opportunism and hold-up problems.[100] A hold-up problem exists when parties to a future contract make *ex ante* "non-contractible specific investments" in order to prepare for the contracted transaction.[101] Since the precise terms for an optimal contract "cannot be specified with certainty ex ante," there is a possibility that one of the parties may act opportunistically.[102]

Long-term contracts alleviate hold-up problems because parties may amortize their investments throughout the duration of the contract.[103] Long-term contracts may also serve the needs of the parties involved when a reputation factor plays an important role, such as causing parties to fear losing future trade.[104] Consequently, reputational effects can also provide *ex ante* incentives, as well as *ex post* safeguards for contracts where specific investments exist.[105] Despite the benefits of entering a contractual relationship, diseconomies associated with contracts increase when

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[96] *Id.*
[97] JAMES MACDONALD ET AL., U.S. DEP'T OF AGRIC. AER-837, CONTRACTS, MARKETS AND PRICES: ORGANIZING THE PRODUCTION AND USE OF AGRICULTURAL COMMODITIES v (2004); *see* Schwartz & Scott, *supra* note 95, at 545 (noting that "contract law should [also] attempt to facilitate efficient trade and investment.").
[98] Endres et al., *supra* note 73, at 98.
[99] William P. Rogerson, *Contractual Solutions to the Hold-Up Problem*, 59 REV. OF ECON. STUD. 777, 777 (1992).
[100] Joskow, *supra* note 88, at 48.
[101] Rogerson, *supra* note 99, at 777.
[102] *Id.*
[103] Pierre Dubois & Tomislav Vukina, *Incentives to Invest in Short-term vs. Long-term Contracts: Evidence from a Natural Experiment* 1, 27 (Ecole d'economie de Toulouse, Working Paper No. 09-136, 2009) (arguing that increase in contract duration increases both investment and effort, and consequently production).
[104] Ola Kvaloy, *Asset Specificity and Vertical Integration*, 109 SCAND. J. ECON. 551, 552 (2007).
[105] *Id.*

uncertainty and complexity becomes a substantial part of the parties' relationship.[106] Real world contracts are intrinsically deficient, and parties may be able to take advantage of the agreed upon contract and appropriate some of the return on the transacting partner's relationship-specific investments.[107] When the risk of hold-up and parties acting opportunistically is present in a nascent market such as the bioenergy industry, and one side perceives the threat of hold-up from the other party before entering the contract, the party will likely not contract, or it will decide to underinvest, creating transaction costs and barriers to entry and efficient contracting.[108] In typical agricultural contracts, contracting may be a way of reducing risks that are inherent to agricultural production, such as the risk related to managing the machinery, and production risks, such as the quality of the crops and insurance in the case of weather-related conditions.[109]

Contracting for biomass production, however, involves several unique issues.[110] Dedicated bioenergy crops, such as switchgrass and miscanthus, require a large amount of multi-year capital investment by farmers in order to be established, and also require an initial establishment period for the crop, specific machinery, and appropriate management techniques.[111] The costs of producing biomass depend greatly on how this feedstock is managed and procured by the purchaser.[112] Additionally, the quality and quantity of biomass feedstock required may be specific for a certain locality or biorefinery, which will tie farmers to that specific biorefinery and buyer of the feedstock. When the farmer makes specific investments to supply the needs for a specific buyer of the feedstock, the buyer knows that the next best value for the biomass in the market will be lower.[113] Hence, another cost that should be accounted for is the cost related to the dependency of the biomass feedstock.

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[106] Joskow, *supra* note 88, at 37.
[107] Benjamin Klein et al., *Vertical Integration, Appropriable Rents and the Competitive Contracting Process*, 21 J. L. & ECON. 297, 310–13 (1978).
[108] Endres et al., *supra* note 73, at 116.
[109] Christopher R. Kelley, *Agricultural Production Contracts: Drafting Considerations*, 18 HAMLINE L. REV. 397, 401 (1995) (noting that production contracts "are an important device for acquiring supplies and reducing the risks inherent in agricultural production.").
[110] Goeringer et al., *supra* note 31, at 74.
[111] *Id.* at 73; *see* Yang et al., *supra* note 31, at 29 (discussing the need for larger investments in specific assets where uncertainty in a market exists).
[112] Abhishek Shah, *Costs of Biomass Energy and Biomass Plant Investment—Wide Range*, GREEN WORLD INVESTOR (Mar. 9, 2011), http://www.greenworldinvestor.com/2011/03/09/costs-of-biomass-energy-and-biomass-plant-investment-wide-range/.
[113] George W.J. Hendrikse & Cees P. Veerman, *Marketing Co-operatives: An Incomplete Contracting Perspective*, 52 J. AGRIC. ECON. 53, 54–55 (2001).

Likewise, biomass end-users, especially in this early stage of the bioenergy industry's development, need a reliable supply of feedstock.[114] Otherwise, the investment for producing the bioenergy will be simply lost. Therefore, while typical agricultural contracts and biomass production contracts may share similar terms, important differences between the two industries may cause biomass contracting to be suboptimal and not efficient enough to give participants in the industry the growth incentives it needs.

As noted above, Jody M. Endres et al. argue for a vertically coordinated, rather than a vertically integrated, bioenergy industry. The authors define "vertical integration" as the industry structure where one party "owns and operates all levels of the value chain," including the land.[115] For that reason, they first argue that vertically integrated industry models have limited feasibility, especially in the Midwest of the United States because of the high value and ownership dispersion of the land.[116] Differently, in this work, we consider vertical integration to also encompass the high levels of control an industry has over its supply chain. In other words, we consider vertical integration in different levels that would optimize an otherwise merely independent relationship between the seller and buyer of biomass. In this Article, we consider vertical integration as the situation where the firm (in this case the end-user of the biomass) exercises more extensive control over more than one stage of the supply chain.[117] Biomass crops are developed throughout the contiguous United States, where values and land ownership differ. In any case, there are alternatives to ownership of the land, in which biorefineries stand in a position of control similar to a pure vertically integrated industry. For instance, it may be the case that the biomass end-user rents the land (just as many small-scale farmers typically do), and produces the feedstock itself by employing farmers that either have the experience, or acquire the requisite knowledge, to produce biomass feedstock themselves. This means that, despite having control over the production, the end-user will not incur extensive investments in acquiring the *know-how* of how to plant, harvest, or collect the biomass feedstock. Nevertheless, because of vertical integration, extensive control is exercised to correct market imperfections. We will discuss market imperfections and the implications of vertical integration throughout this work.

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[114] Goeringer et al., *supra* note 31, at 73.
[115] Endres et al., *supra* note 73, at 81.
[116] *Id.*
[117] *Id.*; *see* Friedrich Kessler & Richard H. Stern, *Competition, Contract, and Vertical Integration*, 69 YALE L. J. 1, 2–4 (1959) (discussing how vertical integration improves coordination and reduces costs).

Second, Jody M. Endres et al. also argue that vertical coordination would be a better model because it "does not disturb traditional agricultural practices."[118] We will discuss findings from traditional agricultural contracts that show that many of the disputes today revolve around failure to deliver the crop for reasons that mainly cannot be contracted around. Management flexibility in the bioenergy industry may seem beneficial at first, but because of evidence of asset specificity and the uniqueness of the biomass feedstock in the short and long-terms, too much flexibility will result in large costs for both parties. As we will discuss, despite the benefits contracting arrangements bring to agricultural relationships, evidence from traditional industry disputes and current contractual efforts suggest that traditional contracting arrangements that may be adequate to traditional crops may not be the optimal choice for specialized investments in the bioenergy industry. That is because it is not only impossible to consider all the potential issues that could arise, but it is impossible to know the best responses to issues that do arise. Therefore, at least in the initial stage of the industry's development, contractual risks may move the organizational structure choice closer to a more vertically integrated model. Asset specificity is a crucial transactional cost variable in the contractual analysis, and will be discussed in detail below.[119]

2. Costs and Benefits Associated with Vertical Integration

Vertical integration is one of the options for supply chain organizations. According to Oliver Williamson, "[o]nly as market-mediated contracts break down are the transactions in question removed from markets and organized internally."[120] TCE suggests that costs and difficulties associated with market transactions sometimes favor hierarchies (or in-house production), instead of contracts, as an economic governance structure.[121] Vertical integration is a response to market transaction costs where different stages of the industry supply chain coordinate to align the interests and needs of the parties.[122] Vertical integration can be defined as the "firm's

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[118] Endres et al., *supra* note 73, at 81–82.
[119] *See The Economics of Organization*, *supra* note 87, at 555 (noting that "[a]sset specificity is both the most important dimension for describing transactions . . . .").
[120] OLIVER E. WILLIAMSON, THE ECONOMIC INSTITUTIONS OF CAPITALISM: FIRMS, MARKETS, RELATIONAL CONTRACTING 87 (New York: Free Press 1985).
[121] Daron Acemoglu et al., *Determinants of Vertical Integration: Financial Development and Contracting Costs*, 64 J. FIN. 1251, 1251–52 (2009).
[122] John Stuckey & David White, *When and When Not to Vertically Integrate*, MCKINSEY & CO. (Aug. 1993), http://www.mckinsey.com/insights/strategy/when_and_when_not_to_vertically_integrate, *archived at* http://perma.cc/E5S3-BBAZ.

ownership of vertically related activities."[123] Vertical integration can also be defined as the case where the firm controls more than one stage of the production process in order to reduce inefficiencies.[124]

Vertical integration combines a specific asset and the activity that utilizes the asset within a single firm in order to internalize and eliminate the incentives for *ex post* opportunism that contracts present.[125] In other words, "[v]ertical integration encourages specific investments and reduces holdup problems" in imperfect markets.[126] One of the reasons for integration is to respond to market risks where contracts designed to overcome such risks are costly and fail to operate as expected by parties. Studies have confirmed a preference for vertical integration when contracts are necessarily incomplete, and contracting costs are high.[127] Other reasons for integration are to enter and develop a new share of the market, and to guarantee supply of inputs.[128] In this sense, vertical integration in the bioenergy industry means that the biomass end-user or biorefinery will grow its own biomass feedstock. The degree of vertical integration is measured by the extent of the firm's ownership over successive stages of the supply chain for its input, and it may vary according to the type of industry, and parties and interests involved.[129]

When an industry faces the choice between contracting or vertically integrating, the latter will be desirable where transaction costs associated with this industry's input contracts increase, and correspondent incentives for contracting parties to act in accordance with the contract decrease.[130] The concern is that there is room for inefficient behavior when substantial specific investments are involved, and uncertainty makes it difficult to clearly stipulate important terms in the contract addressing these specific investments.[131] Through vertical integration, TCE argues

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[123] *See* ROBERT M. GRANT, CONTEMPORARY STRATEGY ANALYSIS: TEXT AND CASES, INKLING, 354 (7th ed. 2010).
[124] Endres et al., *supra* note 73, at 81; s*ee* Kessler & Stern, *supra* note 117, at 1–4 (noting the benefits of vertical integration in reducing transaction costs).
[125] Oliver E. Williamson, *The Vertical Integration of Production: Market Failure Considerations*, 61 AM. ECON. REV. 112, 112, 117 (1971) [hereinafter *The Vertical Integration of Production*].
[126] Acemoglu et al., *supra* note 121, at 1251.
[127] *See, e.g.*, Joskow, *supra* note 88, at 54 (finding that coal supply transactions for mine-mouth plants are much more likely to be integrated or make use of complex long-term contracts because of the presence of asset specificity).
[128] Stuckey & White, *supra* note 122, at 114.
[129] *See* Klein et al., *supra* note 107, at 301 (noting that "costs of contractually specifying all important elements of quality varies considerably by type of asset.").
[130] *See The Economics of Organization*, *supra* note 87, at 558.
[131] *Id.*

that internalizing the decision-making within the company is an efficient response to the asset specificity problem.[132] In the bioenergy industry, the certainty of an adequate supply of the biomass feedstock is a concern for the biomass end-user. Ownership of the biomass feedstock and control over the production are ways to decrease and remove any dependency on farmers. Another benefit of vertical integration is that it may mitigate the hold-up problem.[133] Parties will be discouraged from making specific investments if such investment may be wasted or expropriated.[134] Thus, with vertical integration, incentives to act opportunistically are mitigated, and costs of bargaining and asymmetric information are internalized to the firm. The importance of considering the possibility of opportunistic behavior when specific investments are made will be considered below.

While vertical integration encourages investments in industries that require specific investments and reduces such costs when contracts are imperfect, there are diseconomies associated with vertically integrated industries.[135] For instance, internalizing and managing transactions imposes administrative costs.[136] In the case of the bioenergy industry, from the perspective of the biomass end-user, integration means acquiring the land, the farmer's know-how, and the equipment and infrastructure to grow the crops. Such costs should be taken into consideration in the decision to integrate. Vertical integration is also less desirable when the assets are less specific.[137] In the absence of asset specificity, inefficiencies from administrative costs make production less efficient than buying the needed product in the open market.[138]

Another concern with vertical integration is related "to extend[ing] a monopoly position at one stage of an industry's value chain to adjacent stages."[139] Vertical integration limits the ability of new companies to enter

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[132] *Id.*

[133] *See* Kessler & Stern, *supra* note 117, at 2–5 (discussing the importance of control in vertical integration and how it eliminates the threat of non-renewal).

[134] *See* Klein et al., *supra* note 107, at 301 (noting that less specific investments will be made to avoid opportunism).

[135] *See* Michael H. Riordan & Oliver E. Williamson, *Asset Specificity and Economic Organization, 3* INT'L J. INDUS. ORG. 365, 375 (1985) (citing bureaucratic cost and entry impediments as examples of diseconomies vertical integration).

[136] *See* Grant, *supra* note 123, at 357–58 (discussing administrative costs imposed by vertical integration).

[137] *See* Riordan & Williamson, *supra* note 135, at 367 (noting that "[t]ransactions that are supported by non-specific (redeployable) investments are ones for which neoclassical analysis is well-suited to deal").

[138] *See* Grant, *supra* note 123, at 352, 356–58 (discussing when vertical integration may be an inefficient choice); *see also* Klein et al., *supra* note 107, at 298 (noting that as assets become more specific the costs of contracting in the market will increase).

[139] Grant, *supra* note 123, at 357–58.

the market.[140] Thereby, the anticompetitive effects are usually of two types: (1) price discrimination; and (2) barriers to entry.[141] Price discrimination can be exercised in any industry arrangement, but the argument is that it is the cost of enforcing terms of the contract that are at issue in vertical integration.[142] "Some commodities . . . have self-enforcing properties," meaning that reselling the commodity cannot be arranged unnoticed.[143] It is the absence of self-enforcing properties that would make vertical integration an attractive mechanism to accomplish discrimination.[144] In terms of barriers to entry, vertical integration is said to have the potential of increasing capital requirements, and companies may use vertical integration as a way to increase finance requirements and discourage potential entrants.[145] Finally, vertical integration may be disadvantageous in providing a quick response to a change in the industry, such as to promptly respond to requests from the market for a new product development that would require technical capabilities that were wiped out by the process of vertical integration.[146] At the same time, vertical integration, however, may allow for even better "coordination in achieving" more efficient "simultaneous adjustment throughout the vertical chain."[147]

Therefore, the contracting and vertical integration models provide different benefits and incentives, and they involve different costs. Whether ownership or stronger control over the supply chain is better than contracting, or, putting it a different way, whether vertical integration is the ideal choice, will depend on a different set of conditions related to given transactions, mainly the organizational benefits and costs of integrating. As we will argue below, transaction costs and asset specificity in the nascent bioenergy industry make it a prime candidate for vertical integration.

C. *The Dimensions of Asset Specificity*

As discussed above, contracts allow parties to share risks and reduce hold-up and opportunistic behavior. However, the parties cannot contract around every problem, nor foresee every problem. Vertical integration

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[140] *The Vertical Integration of Production, supra* note 125, at 118–19.
[141] *Id.*
[142] *Id.*
[143] *Id.* at 119.
[144] *Id.*
[145] *Id.*
[146] *See* Grant, *supra* note 123, at 358 (illustrating with the example that "[e]xtensive outsourcing has been a key feature of fast-cycle product development throughout the electronics sector.").
[147] *Id.* (noting the success of American Apparel in its coordinated vertical integration that allowed a fast design-to-distribution cycle).

eliminates inefficiencies related to contracts, but increases administrative costs. Both organizational arrangements present disadvantages in responding to market inefficiencies, and the objective becomes to select the arrangement that can better respond to the specific industry's needs. We argue here that the presence of asset specificity in the biomass industry makes vertical integration the optimal choice to respond to likely issues that asset specificity may create for biomass producers and end-users.

TCE highlights the importance of asset specificity, and suggests that the level of asset specificity involved in a firm's transactions is one of the main factors in its choice of governance structure.[148] That is because, as the assets necessary for a transaction become more specific, "the aggregation benefits of markets . . . are reduced and exchange takes on a progressively stronger bilateral character."[149] Asset specificity denotes the extent to which an asset that is deployed in a specific activity loses value when used in another activity than the one initially intended.[150] "[T]he existence of asset specificity means that [a market actor's] bargaining position will depend on which assets he has access to," which would make him more "sensitive to the allocation of asset ownership."[151] In other words, in the presence of asset specificity, more investments by the parties mean greater bilateral dependence between otherwise independent actors. However, if the transaction is characterized by low asset specificity, "parties can rely on low switching costs and the threat of market competition" to function as a constraint to *ex post* opportunistic behavior during the duration of the contract.[152]

Generally, asset specificity has been divided into six different dimensions: (1) site specificity; (2) dedicated asset specificity; (3) physical asset specificity; (4) human asset specificity; (5) temporal specificity; and (6) brand name capital.[153] Only the first five dimensions of asset specificity matter under our analysis because the bioenergy industry has yet to develop to the point where brand name capital is significantly important. First of all, site specificity is considered high when the location of the products necessary for a transaction is important. Location concerns create

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[148] Riordan & Williamson, *supra* note 135, at 366.
[149] *The Economics of Organization, supra* note 87, at 558.
[150] *See* Klein et al., *supra* note 107, at 298–99 (illustrating the concept with the printing press example).
[151] Oliver Hart & John Moore, *Property Rights and the Nature of the Firm*, 98 J. POL. ECON. 1119, 1122 (1990).
[152] Brian J.M. Quinn, *Asset Specificity and Transaction Structures: A Case Study of @Home Corporation*, 15 HARV. NEGOT. L. REV. 77, 82 (2010).
[153] Ritu Lohtia, *What Constitutes a Transaction-Specific Asset? An Examination of the Dimensions and Types,* 30 J. BUS. RESEARCH 261, 262–63 (1994).

dependency between parties because, when site specificity is high, trade partners tend to build their business close to each other.[154] In addition, site specificity is high when goods can only be moved at a significant cost.[155] Second, dedicated asset specificity is high when investments are made to meet the demands of specific trading partners and parties must make specific investments in order to produce and exchange.[156] Third, physical asset specificity exists when particular investments, such as machinery and design, are made to meet the demands of a specific trading partner.[157] Consequently, physical asset specificity is high when the transaction involves a unique product and assets are tailored to meet the needs of a particular partner. Fourth, temporal asset specificity means that timing is critical to the transaction.[158] Temporal asset specificity will be high when timing of the use of the product is important.[159] Finally, human asset specificity means investment in personnel, such as investments to learn how to make a new product.[160] Therefore, human asset specificity is high when parties must acquire specialized knowledge in order to produce to sell.

An asset specific investment has two primary characteristics. First, the investment is made in anticipation of the transaction.[161] Second, the assets created in consequence of the transaction have values attached to their specific use, location, the counterparty's hand, etc.[162] Consequently, in the presence of an asset specific investment, each party essentially has a monopoly over the other party with specific assets because the product has a value inside the relationship, but much lower or no value outside the transaction.[163]

Additionally, if parties make joint investments, meaning each makes asset specific investments, we have a situation where joint gains are contingent on the cooperation of all parties involved.[164] In this case, if parties can successfully coordinate the investments for a common goal, both will benefit. However, because parties have incentives to act

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[154] *Credible Commitments*, *supra* note 92, at 526.
[155] *Id.*
[156] Joskow, *supra* note 88, at 38.
[157] *Id.*
[158] *Applying Transaction Cost Economics*, *supra* note 68, at 109.
[159] *See id.*
[160] *See* Joskow, *supra* note 88, at 38.
[161] Quinn, *supra* note 152, at 79.
[162] *Id.*
[163] *See* Joskow, *supra* note 88, at 38 (noting that "transaction-specific sunk investments generate a stream of potentially appropriable quasi-rents equal to the difference between the anticipated value in the use to which the investments were committed and the next best use.").
[164] Quinn, *supra* note 152, at 80.

opportunistically and free ride off joint investments, the result in such situations is that no one cooperates.[165] Therefore, asset specific investments, either individually or jointly made in a specific transaction, appear to present more challenges than opportunities for the parties involved.

The notion of asset specificity helps us to identify the costs of the assets associated with a supply chain.[166] Predictions based on asset specificity are supported by data from existing contracts in the industry, facts concerning how the bioenergy industry works, and previous studies done on asset specificity.[167] For instance, after a review of 100 studies across a range of sectors, substantial evidence was found that the following factors increase the presence of vertical integration: (1) greater specificity of physical capital and human capital; (2) more dedicated and more complex assets; (3) greater site specificity; and (4) greater uncertainty about demand.[168]

In summary, the presence of asset specificity modifies the value of assets in alternative uses, and market competition cannot as efficiently combat potential *ex post* opportunism.[169] Whether a transaction involves asset specificity or not is a crucial determination so that the industry can better organize itself to capture efficiency gains in a transaction. In general, industries involving transactions characterized by high levels of asset specificity will benefit from higher levels of vertical integration.

III. THE IMPORTANCE OF ASSET SPECIFICITY IN THE ORGANIZATION OF THE BIOENERGY INDUSTRY

Before delving into our empirical analysis, it is important to consider some key issues affecting biomass supply chains and the impact of asset specificity on the developing bioenergy industry.

A. *The Biomass Supply Chain: Main Aspects*

The desired biomass supply chain is the one that most efficiently answers the question of "[h]ow many gallons of biofuel does it take to grow

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[165] *Id.*

[166] *See generally* Riordan & Williamson, *supra* note 135, at 366 (arguing that "production and transaction costs both need to be taken into account in any effort to realize a broadly conceived economizing result.").

[167] *See, e.g.*, Joskow, *supra* note 88, at 54 (finding that coal supply transactions for mine-mouth plants are much more likely to be integrated or make use of complex long-term contracts because of the presence of asset specificity); Altman & Johnson, *supra* note 24, at 28–34 (utilizing transaction cost economics to address organizational issues in this industry).

[168] Francine Lafontaine & Margaret Slade, *Vertical Integration and Firm Boundaries: The Evidence,* 55 J. ECON. LITERATURE 629, 653–59 (2007).

[169] *See Applying Transaction Cost Economics*, *supra* note 68, at 109.

and process enough biomass to make a gallon of biofuel?"[170] The biomass supply chain refers to the flow of feedstock from the land to its eventual end use, in which the biomass passes through a series of processes.[171] The different stages of the biomass supply chain require unique sets of knowledge and technology, encompassing the growing, harvesting, transporting, aggregating, storing, and conversion of biomass.[172]

In terms of producing and growing the biomass, different crops and types of biomass require different methods. Dedicated energy crops, such as perennial grasses, can be grown on farms in large quantities and as double crops that fit into rotations with food crops.[173] Woody biomass includes bark, sawdust, and other byproducts of milling timber and making paper, as well as shavings that are produced during the manufacture of wood products and organic sludge from pulp and paper mills.[174] Biomass material also includes residues, such as branches, treetops, and commodity crop wastes that can be collected for energy use.

As the bioenergy industry develops, the availability of and the demand for different types of biomass will vary in each region of the country, and will depend, in great part, on the logistics of transporting and storing the biomass material.[175] Transportation mainly involves the loading and unloading of the biomass feedstock, and its transfer from pre-processing sites to the plant or biorefinery.[176] Truck transport is most commonly used to move feedstock, but the quality of the biomass and its physical form will determine the type of equipment to be used to reduce delivery costs.[177] The reason why transport is usually costly is because most agricultural biomass feedstocks have a lower energy density than fossil fuels have.[178] This means that when the biomass is not processed, it often

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[170] James H. Dooley, *Engineering a Better Biomass Supply Chain*, BIOMASS MAGAZINE (Jan. 30, 2013), http://biomassmagazine.com/articles/8585/engineering-a-better-biomass-supply-chain, *archived at* http://perma.cc/4R52-BMFN.

[171] *See* Williams, *supra* note 47.

[172] *See id.*

[173] *See How Biomass Energy Works*, UNION CONCERNED SCIENTISTS, http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/how-biomass-energy-works.html, *archived at* http://perma.cc/ACK3-FYME (last visited Mar. 15, 2015).

[174] *Id.*

[175] *Logistics of a Biopower Plant*, *supra* note 48.

[176] Salman Zafar, *How is Biomass Transported*, BIOENERGY CONSULT (Dec. 23, 2013), http://www.bioenergyconsult.com/biomass-transportation/, *archived at* http://perma.cc/ARG2-ZGGS.

[177] *Id.* (noting that pipelines are another option that can also be employed to transport biomass).

[178] *See How Biomass Energy Works*, *supra* note 173 (discussing energy density in biomass energy systems).

will not be cost-effectively shipped more than 50–100 miles by truck before it is converted into fuel or energy.[179] For that reason, it is usually better to develop biorefineries closer to the location where the feedstock is generated.[180]

Additionally, biorefineries require sufficient volumes of feedstock throughout the year at a suitable quality specification, and because some of the feedstocks are not grown year around, biomass must be stored to accommodate the continuous need for energy production. The cost of storage is an essential element to the feasibility of the biomass supply chain, and the type of storage to be employed depends on the type and quality of biomass.[181] In the case of high-moisture biomass, wet-storage systems would likely be required in order to avoid the degradation of the feedstock.[182] Consequently, the biomass characteristics will also be affected by the storage method utilized by the party.[183]

Therefore, the biomass feedstock must be handled and transported along the supply chain, which must be done as cheaply as possible to limit overall costs of bioenergy.[184] Accordingly, whether the biomass comes from dedicated crops or woody materials, the cost of collection is always an important factor, and human effort, machinery, and energy inputs can have a substantial impact on the cost of the biomass that is delivered to the end-user.[185]

B. *The Biomass Supply Chain: Asset Specificity*

As previously discussed, it is argued that vertical integration is generally the optimal arrangement choice when the assets necessary for a transaction are highly specific.[186] When taking into account the five relevant dimensions of asset specificity, the bioenergy industry appears to be a suitable candidate for vertical integration. For example, in terms of site

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[179] *Id.*
[180] Zafar, *supra* note 48.
[181] *Id.*
[182] Salman Zafar, *Biomass Storage Methods*, BIOENERGY CONSULT (Oct. 14, 2013), http://www.bioenergyconsult.com/biomass-storage/, *archived at* http://perma.cc/ARG2-ZGGS.
[183] Williams, *supra* note 47.
[184] *Id.*
[185] *Logistics of a Biopower Plant*, *supra* note 48.
[186] Lohtia, *supra* note 153, at 262 ("[W]hen highly specific assets are present, inter-firm coordination costs increased tremendously, giving vertical integration a transaction cost advantage over markets or hybrids."); *see generally* OLIVER E. WILLIAMSON, THE ECONOMIC INSTITUTIONS OF CAPITALISM: FIRMS, MARKETS, RELATIONAL CONTRACTING (1985) (providing an extensive discussion of the role of asset specificity in the integration decision).

asset specificity, Ferchichi's study of the bioethanol industry in Europe[187] and Altman's study of the biopower industry in the United States[188] both show that shorter transportation distance leads to a higher likelihood of integration as opposed to contracting for biomass feedstocks. That is because, in the presence of dedicated energy crops, site specificity is high mainly because many biomass end-users or biorefineries are feedstock specific, and the desired characteristics of the feedstock will depend on local climate and the soil conditions of a particular area.[189] Because of considerable transportation costs, biorefineries would prefer to be in close proximity to the desired crops.[190] That is also because, in the current biomass industry, the feedstock tolerances for high or low moisture, weathering, mold, and other contaminants may vary significantly depending on the technology used to convert the biomass into energy.[191] Site specificity also determines transportation costs of dedicated crops, because such costs depend on the distance traveled, the energy density of the biomass, the type of biomass, and the form in which it is being transported.[192]

Another factor influencing site specificity for the bioenergy industry is current federal policy and the economic feasibility of transporting ethanol.[193] For instance, in order for biofuels to qualify for meeting the RFS's mandates, they must meet certain greenhouse gas emission reduction thresholds.[194] The RFS's regulatory regime accounts for emissions from

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[187] *See* Monia Ferchichi & Loïc Sauvée, *Modeling the Choice of the Organizational Form in the European Bioethanol Industry*, https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=CEA2010&paper_id=225, *archived at* https://perma.cc/ZZ3L-CEFW (last visited Mar. 15, 2015).

[188] *See* Ira Altman et al., *Scale and Transaction Costs in the U.S. Biopower Industry*, 5 J. AGRIC. & FOOD INDUS. ORG. 1, 15 (2007).

[189] *See* McKendry, *supra* note 37, at 38 (noting the characteristics of dedicated energy crops).

[190] *See id.* at 44.

[191] Susanne Retka Schill, *Organizing Biomass Farmers*, BIOMASS MAGAZINE, http://biomassmagazine.com/articles/1528/organizing-biomass-farmers, *archived at* http://perma.cc/THV9-JMDB (last visited Mar. 15, 2015).

[192] McKendry, *supra* note 37, at 44.

[193] COMM. ON ECON. & ENVTL. IMPACTS OF INCREASING BIOFUELS PRODUCTION, NAT'L RES. COUNCIL, RENEWABLE FUEL STANDARD: POTENTIAL ECONOMIC AND ENVIRONMENTAL EFFECTS OF U.S. BIOFUEL POLICY (2011), *available at* http://dels.nas.edu/resources/static-assets/materials-based-on-reports/reports-in-brief/Renewable-Fuel-Standard-Final.pdf (noting that some key factors that influence environmental effects from producing feedstocks for biofuels are site specificity and incentives created by greenhouse laws).

[194] *See* Sanya Carley et al., *Innovation in the Auto Industry: The Role of the U.S. Environmental Protection Agency*, 21 DUKE ENVTL. L. & POL'Y F. 367, 377 (2011) (discussing the Environmental Protection Agency's role in limiting the amount of greenhouse gases that are associated with the lifecycle of biofuels production and use).

all aspects of production of the biofuel, including transportation of biomass from the fields to the biorefinery. Additionally, biomass crops are used as fuel, so spending too much fuel to transport these plants to a conversion facility is economically unfeasible. Therefore, economic feasibility and the standards established by the RFS limit the feasible distance between a biofuel plant and the field the crops are grown on. Site specificity, however, is less strict for biomass crops not used for biofuels since the renewable fuel standard is no longer a factor.[195]

The level of dedicated asset specificity impacts both farmers and biomass end-users. For farmers, different types of biomass crops require more specific equipment than others. Dedicated bioenergy crops require long-term investments, and the harvesting of the biomass represents one of the most significant factors in the cost of production of biomass energy crops.[196] The harvesting costs will depend on the biomass and the costs necessary to produce a feedstock suitable for the biomass conversion process that is used by the biorefinery.[197] In areas where the equipment used to harvest, package, and transport the biomass is the same as for the crops farmers traditionally cultivate, the level and importance of dedicated asset specificity will be lower.[198] However, the opposite is true for areas where the equipment used to harvest, package, and transport the biomass will have to be specifically purchased for the purpose of cultivating and harvesting the energy crop.

For the biorefinery, dedicated asset specificity is influenced by how easily the biorefinery can be retooled and used to produce energy for alternate biomass feedstocks.[199] In general, dedicated asset specificity will likely be considered high for the biorefinery owner because even if it does retool to utilize other feedstocks, it would have to either use crops grown in the area or convince farmers to grow new crops. Biorefineries may also have other production issues as they need to also address sustainability concerns.[200]

The level of physical asset specificity depends on the particular type of biomass feedstock, as some may have more alternative uses than

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[195] *See id.*
[196] McKendry, *supra* note 37, at 44.
[197] *Id.*
[198] *Id.*
[199] *See* INTEGRATED BIOREFINERIES, *supra* note 54 (discussing efforts to diversify the feedstocks used in biorefineries).
[200] Eustermann & Thompson, *supra* note 59 (discussing the production issues in a biorefinery).

others.[201] For the biorefinery, physical asset specificity will be high if its conversion process is feedstock specific. Also, there is typically a high level of physical asset specificity because some biomass is easier to process into liquid biofuel than others, and climate and soil type varies and determines types and amounts of biomass that can be grown in different geographic areas.[202] As noted above, biofuel plants that use a particular type of feedstock, therefore, would need to be close to the area where that crop grows.[203] Currently, efforts are being made to make biofuel plants feedstock neutral so they can accept different types of feedstock, but until then, physical asset specificity remains high for most biofuel plants.[204]

Furthermore, it can be the case that farmers grow specialized crops that can only be used for the generation of biofuels.[205] When this is true, there is a high level of physical asset specificity. With dedicated energy crops, physical asset specificity will also be high for the farmer if the product is unique and has a very limited market. The lack of an appropriate supply-side industry brings risks to the development of biomass relationships, and can have a detrimental effect on the successful financing and operation of biomass processing facilities.[206] In such cases, if the biorefinery has tighter design specific conditions, the unexpected change of farmers will be costly, or even deadly, leading biomass end-users and biorefineries to idle capacity.

Finally, the level of human asset specificity also largely depends on the type of biomass crop being used. Some biomass crops are easier to grow than others and for novel biomass crops, optimal cultivation practices have yet to be developed. In cases where agricultural residue is used, there are low levels of human asset specificity.

In conclusion, the levels of asset specificity vary according to the circumstances of a given biomass transaction because different biomass

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[201] *See* THE ROYAL SOCIETY, *supra* note 19, at 11–13 (discussing some of the different feedstock available in the market).

[202] *Ethanol Feedstocks*, U.S. DEP'T OF ENERGY, http://www.afdc.energy.gov/fuels/ethanol_feedstocks.html, *archived at* http://perma.cc/P4QA-ZJKM (last updated Dec. 12, 2013).

[203] *See id.*

[204] *See* INTEGRATED BIOREFINERIES, *supra* note 54 (highlighting that a "crucial step" of the U.S. bioindustry is to develop "first-of-a-kind integrated biorefineries that are capable of efficiently converting a broad range of biomass feedstocks into commercially viable biofuels, biopower, and other bioproducts.").

[205] Other times the biofuel plants simply use agricultural residue from crops which are normally grown; and the farmer is simply selling the unharvested portions of the crop to the biofuel plant. In these cases there is a low level of physical asset specificity.

[206] Eustermann & Thompson, *supra* note 59 (discussing the problems generated by the lack of a supply side in the biomass industry).

products suit different situations. In general, however, the bioenergy industry has many of the characteristics that reflect the presence of asset specificity.[207] As noted above, there are costs related to biomass end-users cultivating their own feedstock, but in the presence of high asset specificity and uncertainties related to supply, the costs and risks of going to the market for biomass feedstocks may surpass the costs of vertically integrating. One of the factors to be analyzed is the presence or absence of asset specificity concerns. As we will see below, asset specificity will lead to important considerations for the overall organization of the nascent bioenergy industry, and in favor of a more vertically integrated structure.

C. *The Miscanthus Example*

Giant Miscanthus ("miscanthus") is a perennial grass that is one of the most promising energy crops for the production of cellulosic biofuels.[208] It makes efficient use of soil nutrients, and it is known for its high yields—up to fifteen tons of dry matter per acre.[209] Miscanthus has also been recommended for use in combined heat and power generation.[210] Additionally, researchers at the University of Illinois have found that miscanthus outperforms current biofuel feedstocks, meaning that using miscanthus for cellulosic biofuel production could significantly reduce the land use requirements necessary to accomplish the RFS's goals.[211]

Miscanthus has been studied in the European Union, and it has been commercialized there mainly for combustion in power plants.[212] However, research in the United States is still developing to demonstrate the true potential of miscanthus as a bioenergy feedstock.[213] The study of

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[207] *See* Altman & Johnson, *supra* note 24, at 33 (noting that data in the bioenergy industry is consistent with asset specificity features since firms with flexible technologies in this industry reported lower levels of vertical integration); *see* McKendry, *supra* note 37, at 44.
[208] Emily A. Heaton et al., *Miscanthus (Miscanthus x giganteus) for Biofuel Production*, EXTENSION (Jan. 31, 2014), https://www.extension.org/pages/26625/miscanthus-miscan thus -x-giganteus-for-biofuel-production#.U-5WcvldVVI, *archived at* https://perma.cc/6VWR -CJ47 (noting that miscanthus is a "new leading biomass crop in the United States.").
[209] Anna Simet, *Masterminding Miscanthus*, BIOMASS MAGAZINE (Jan. 25, 2014), http: //biomassmagazine.com/articles/9937/masterminding-miscanthus, *archived at* http://perma .cc/YZ9C-PFVA.
[210] EMILY HEATON ET AL., IOWA STATE UNIV. DEPT. OF AGRONOMY, AG201, GIANT MISCANTHUS FOR BIOMASS PRODUCTION (2010), *available at* https://store.extension.iastate.edu /Product/Giant-Miscanthus-for-Biomass-Production.
[211] Diana Yates, *Miscanthus Can Meet U.S. Biofuels Goal Using Less Land than Corn or Switchgrass*, NEWS BUREAU ILL. (Jul. 30, 2008), http://news.illinois.edu/news/08/0730 miscanthus.html, *archived at* http://perma.cc/UJ6Z-HW7Y.
[212] HEATON ET AL., *supra* note 210.
[213] *Id.*

miscanthus in the United States started at the University of Illinois in Urbana–Champaign in 2001, and researchers are still struggling to find the best method of propagation for miscanthus.[214] There are two main methods of establishing miscanthus in agricultural fields. First, rhizomes may be used, which are horizontal-growing roots that can be divided by the root and replanted to grow new miscanthus strands.[215] Second, propagation may occur through live plants (also called "plugs").[216] The difference between these two propagation methods for bioenergy is the cost.[217] Tom Voigt, who leads the feedstock production and agronomy program at the University of Illinois' Energy Biosciences Institute stated that, despite the fact that the cost of plugs are generally higher than rhizomes, tests have found that plugs have shown more uniform fields.[218] Planting of the plugs has been done with mechanical planters, which present similar characteristics to vegetable transplanters. But when comparing planting miscanthus to planting vegetables, miscanthus has proven to be "fairly labor intensive and expensive."[219] A mechanical planter especially developed for miscanthus plugs could reduce the labor involved, but to this date, none appears to have been developed.[220] It has also been found that the costs of producing miscanthus is high, especially in the first year, because of pre-harvest machinery costs, and harvesting costs account for sixty-nine percent of delivered cost of miscanthus from the third year on.[221] Just as with the lack of widely available machinery for the planting of miscanthus, there is very little machinery available that is specifically designed for the harvesting of miscanthus.

Miscanthus transactions provide a prime example of the high levels of asset specificity involved in biomass procurement for biorefineries. Imagine a new cellulosic biofuel production facility that is constructed in an area and intends to use miscanthus as a feedstock. If the facility contracts with biomass producers for its supply of miscanthus, asset specificity will be exceptionally high for both parties to a given transaction. Site specificity will be high because it will be necessary for the feedstock to be cultivated in relatively close proximity to the biorefinery as a result of the

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[214] *Id.*
[215] Simet, *supra* note 209.
[216] *Id.*
[217] *Id.*
[218] *Id.*
[219] *Id.* (noting Tom Voigt's comment about plot establishment in many states, including Illinois, Kentucky, New Jersey and Virginia).
[220] *Id.*
[221] Madhu Khanna et al., *Costs of Producing Miscanthus and Switchgrass for Bioenergy in Illinois*, 32 BIOMASS & BIOENERGY 482, 488–89 (2008).

logistical and cost issues discussed above. Dedicated asset specificity will be high because the biorefinery has been constructed and designed to utilize only miscanthus and the biomass producer might have to invest in storage facilities and will also have to invest in machinery designed specifically for the cultivation and harvesting of the miscanthus. Physical asset specificity will be high for both the parties because the product that is the focus of the transaction (i.e., the miscanthus) is a unique product, which the biorefinery will be unable to acquire outside of the transaction and for which the biomass producer also has no alternate market.

Likewise, human asset specificity will be high for both parties because the biorefinery will have to invest in hiring employees and training them to operate the plant, and biomass producers will have to acquire the requisite knowledge to cultivate and harvest this novel crop. Finally, temporal specificity will be high because the biorefinery will need a consistent, year-round supply of feedstock and the biomass producer will have timing concerns since its risk of loss will increase proportionally to the time it has to store the miscanthus prior to delivery.

IV. EMPIRICAL EVIDENCE FROM AGRICULTURAL DISPUTES AND EXAMPLE BIOMASS CONTRACTS

In order to further examine the optimal biomass supply chain organization for the developing bioenergy industry, we now undertake two distinct empirical analyses. First, we present an empirical study of agricultural contract arbitration cases collected from 2010–2013. While these cases do not include any biomass-related disputes, the common disputes litigated by farmers and respective contracting parties in agricultural contracts will emphasize what are the most common issues in agricultural contract disputes and provide important insight into what biomass producers and end-users may expect from their relationship. This study highlights the fact that even in well-established markets such as those for commodity corn and wheat, there are still difficulties in transacting relationships that conventional and typical agricultural contracts cannot resolve.

Second, we analyze five, real-life, model contracts illustrating different relationships in the bioenergy industry. We draw our analysis based on how differing levels of asset specify in the sectors inform their contractual provisions. This study will highlight the concerns that permeate the industry, and our analysis seeks to assist parties in evaluating the best way to organize the bioenergy industry in the United States.

A. Lessons from Common Disputes in Agricultural Contracts

1. Methodology

Initially, we researched court cases concerning agricultural disputes using Bloomberg Law.[222] Early on, we noticed that few reported court cases existed concerning agricultural disputes, and thus we decided to search for arbitration decisions since typical agricultural contracts contain arbitration provisions.[223] After expanding our research to incorporate secondary sources in the Bloomberg Law database, several references indicated that two main arbitrating bodies for crop production contracts exist. These arbitrators are: (1) the American Arbitration Association (AAA); and (2) the National Feed and Grain Association (NFGA). We were unable to find relevant public arbitration decisions at the AAA website, but the NFGA posts a large percentage of their decisions on their website, which enabled us to find relevant cases.

Thus, we expanded our research to arbitrations and used the NFGA Database to identify the relevant arbitration cases filed in three complete calendar years: 2010, 2011, and 2012. We selected arbitration cases from these three years because they reflect the most recent decisions, and therefore most accurately expose the current disputes in this market. Therefore, the dataset assembled for this research includes information from arbitration cases collected from the NFGA website. There were 52 reported arbitration decisions in 2010, 30 decisions in 2011, and 26 in 2012. We automatically discarded any references that awarded a default judgment due to one party not appearing. This was due to the fact that these cases provide no useful legal analysis and data for this research. The limitations of this research are that it only includes cases that went to judgment, we only analyzed dockets on non-state cases, and it excludes cases that are still ongoing. We also did not include the related counter claims or appeals because we only wanted to analyze final decisions.

After discarding the cases mentioned above, our arbitration dataset consists of 41 relevant arbitration decisions. For each case, we reviewed many variables.[224] The arbitration decisions are divided into three sections:

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[222] We used variations of the following search string: "grain or feed or soy or poultry or chicken or farmer or corn or bean or crop or pig or rancher or grower not bankruptcy not loan not insurance."

[223] *See* Matthew L. Benda & Edward E. Beckmann, *To Arbitrate or Not to Arbitrate: A Practitioner's Guide to Alternative Dispute Resolution in the Agricultural Context*, 2 DRAKE J. AGRIC. L. 315, 316 (explaining that some of the benefits for parties are the impartiality and quick results of arbitration procedures).

[224] The variables examined in the arbitration decisions are: Plaintiff and Defendant types,

Statement of the Case; the Decision; and the Award. We started by comparing each type of plaintiff and defendant. The "type of plaintiff" refers to their role in the agricultural industry, such as elevators, miller, supplier, and farmer. The majority of defendants were farmers. For the parties involved, we checked the Statement of the Case to determine what they were. For the reasoning analysis, we checked the Decision and the Award sections of the case. To determine the nature of the dispute, we checked the Statement of the Case.

2. Lessons from Agricultural Disputes

The types of parties involved in the disputes are: (1) large elevators, traders or processors (i.e., grain elevators owned by large corporations operating many facilities, typically worth hundreds of millions or several billion dollars, such as Cargill, Inc. or the Andersons); (2) local elevators (i.e., those that purchase large amounts of grain from local farmers for resale later); (3) millers (i.e., end-users that convert the crops into food, feed, or some other product); and (4) suppliers (i.e., entities that provide feed, food, or other products to farmers and end-users, which do not seem to have a location whose purpose is to buy grain from local farmers).

Our research found that plaintiffs won 73.17% of the time, especially when the plaintiff was a large elevator, trader, or processor. In such cases, the winning rates as plaintiff were more than eighty percent. Here, any finding where the defendant was at fault was considered a victory for the plaintiff, even if the damages requested were higher than the damages awarded. Additionally, damages recorded were the amounts calculated by the arbitrator for the alleged behavior and modifications due to withheld payments or obligations from unrelated disputes that were ignored. The following table summarizes these results:

TABLE 1

Type of Party	Party as Plaintiff	Party as Defendant	Wins as Plaintiff	Wins as Defendant
Large Elevator/ Trader/Processor	39.02% (16/41)	7.32% (3/41)	84.21% (16/19)	100% (3/3)
Supplier	4.88% (2/41)	2.44 (1/41)	100% (3/3)	0% (0/2)
Miller	7.32% (3/41)	0% (0/41)	0% (0/3)	N/A (0/0)

Complaint, Dispute, Crop, Amount, Requested Damages, Defense, Court Reasoning, Damages Granted and Damages Granted Reasoning.

Type of Party	**Party as Plaintiff**	**Party as Defendant**	**Wins as Plaintiff**	**Wins as Defendant**
Elevator	31.71% (13/41)	4.88% (2/41)	84.62% (11/13)	50% (1/2)
Farm: Company/Co-op	7.32% (3/41)	12.20% (5/41)	100% (3/3)	20% (1/5)
Farm: Individual/ Family Trust	7.32% (3/41)	63.41% (26/41)	0% (0/3)	15.38% (4/26)
Other	2.44 (1/41)	9.76% (4/41)	0% (0/1)	50% (2/4)

Table 1 shows that farmers are not the party, generally, bringing disputes under their contract to arbitration resolution. Table 1 also shows that elevators and large processors are commonly the plaintiffs in arbitration disputes, and farmers, mostly defendants, typically lose. In these disputes, Figure 1 illustrates the initial allegations brought by the plaintiff, which are: (1) failure to deliver (i.e., farmer allegedly did not deliver crops); (2) failure to accept delivery/pick up crops (i.e., buyer did not accept delivery or pick up the crops); (3) quality standards (i.e., crops did not meet quality standards); (4) withheld payment (i.e., buyer withholding either complete or partial payment); and (5) other (e.g., failure to use hydromilling technology as contracted). Failure to deliver accounts for most of the complaints, followed by failure to accept the contracted crop, and failure to meet contracted quality standards.

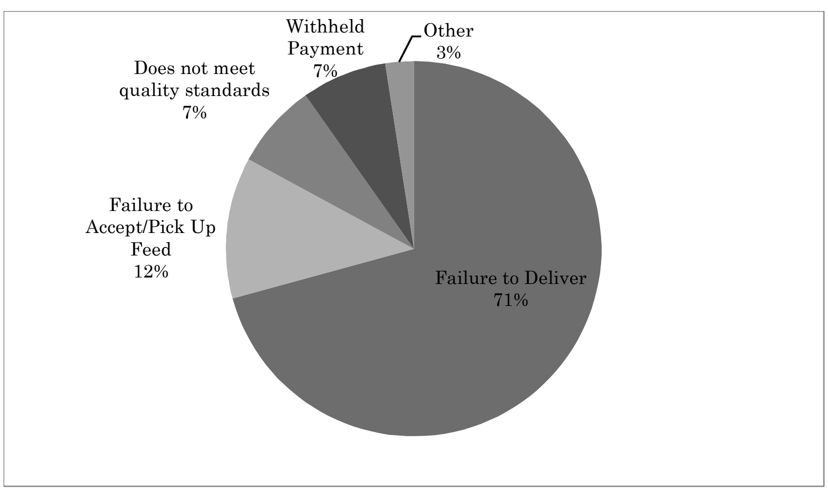

Figure 1

The areas that the arguments focused on and that the final decisions depended on are: (1) contract validity (e.g., existence of contract, unsigned confirmation forms, or authority to enter into a contract); (2) assurance of performance (i.e., whether a statement constituted cancellation or whether a cancellation was justified); (3) due diligence (i.e., whether previous activity constituted performance or whether or not the parties exercised due diligence for contract performance or validity); (4) cancellation date (i.e., damages related; the date the contract was cancelled and damage mitigation should have occurred); (5) cancellation cost validity (e.g., disagreements related to the application, calculation, or validity of contract cancellation penalties); (6) passing of title (i.e., when the crops changed title from one party to another); and (7) other (e.g., various issues related to different obligations such as the development of new technology). The distribution of the arguments are illustrated as follows in Figure 2:

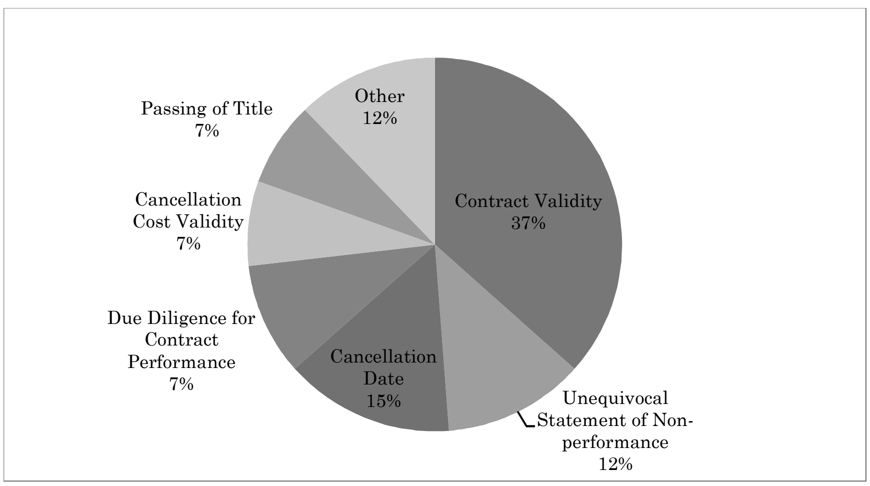

Figure 2

For instance, in Arbitration Case Number 2445, the defendant alleged that because of the extreme weather during the 2007 growing season, it did not produce sufficient quantities of wheat to meet the crop obligations.[225] The issue then became the 2008 season contracts, where

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[225] W.B. Johnston Grain Co. v. Parsons, Nat'l Grain & Feed Ass'n Arb. 2445 (2011) (Mathews, Fiebiger, & Moseman, Arbs.).

defendant informed plaintiff that no wheat would be delivered against the contracts. Plaintiff claimed $217,975 in damages, and defendant argued that it did not owe anything because no contract existed.[226] The arbitrators reasoned that based upon defendant's business practices, a contract for the 2008 crop had been entered into and "common sense would dictate that [plaintiff] had nothing to gain in entering into 'phantom' contracts with [defendant] given that wheat market prices could have declined . . . ."[227] The arbitrators awarded $208,725 in damages to the plaintiff.[228] In this case, therefore, a dispute over quantity developed into a dispute over the existence of the contract.

In Arbitration Case Number 2485, the defendant claimed that market conditions made it impossible for defendant to buy the corn gluten feed pellets under their existing contract with plaintiff.[229] During the contract period, defendant purchased the corn from plaintiff on a spot basis, after alleging that the volumes purchased on this spot basis should be applied towards the required volumes existing under the parties' long-term contracts.[230] Plaintiff argued that defendant defaulted under the contracts and there was no reason for defendant to believe that the corn purchased on the spot markets would be applied towards their obligations under the long-term contracts.[231] The arbitrators ruled in favor of plaintiff, holding that defendant had no reason to believe the corn purchased would be enough under the long-term contracts.[232] The arbitrators also decided that plaintiff failed to give proper notice about defendant being in default as specified in the terms and conditions of the contract. Plaintiff was awarded the sum of $61,964.[233]

Another common dispute revolves around a defendant not meeting the quality standard agreed upon in the contract. For example, in Arbitration Case Number 2469, defendant delivered inferior quality cottonseed meal pellets that did not meet heating and molding requirements in various shipments to plaintiff.[234] Plaintiff proposed a wash-out of the

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[226] *Id.*
[227] *Id.*
[228] *Id.*
[229] Tate & Lyle Ingredients Americas Inc. v. Garrett Enterprises, Nat'l Grain & Feed Ass'n Arb. 2485 (2011) (Reiff, Bunz, & Karlin, Arbs.).
[230] *Id.*
[231] *Id.*
[232] *Id.*
[233] *Id.*
[234] Network Trading Inc. v. Furst McNess Co., Nat'l Feed & Grain Ass'n Arb. 2469 (2011) (Reiff, Bunz, & Carlin, Arbs.).

quantities, but defendant requested an extension of the delivery period.[235] Further difficulties ensued (electrical problems and a fire at the supplier's plant) and defendant was unable to provide the deliveries.[236] Unless plaintiff would agree to extend the contracts again, defendant argued that it would declare *force majeure* on the contract and absolve it of the unfilled obligations.[237] Plaintiff refused to do so, and defendant declared *force majeure* on the contract, expressing "regret for any difficulty this actions [sic] has caused on the Buyer."[238] Plaintiff sought monetary damages in the amount of $619,200 against defendant and was awarded $139,568 after arbitrators calculated the differences between spot and contract values by "marking to the market" for the relevant months of the dispute.[239]

Another dispute involving quality revolved around contaminated soybeans. In Arbitration Case Number 2533, plaintiff asked for damages, including disposal and cleaning costs, resulting from a delivery of contaminated soybeans to plaintiff's facility.[240] In this case, defendant argued that plaintiff failed to meet its burden of proof that it was the defendant that had delivered the contaminated soybeans.[241] Defendant also argued that plaintiff failed to mitigate damages by disposing of the entire amount of beans rather than finding a market for the contaminated soybeans.[242] The arbitrators determined that, although the contaminated seed was not detected by plaintiff's initial sampling procedure, the source of contamination came from defendant, and defendant was liable.[243] Plaintiff's "zero tolerance" policy with reference to contamination allowed them to reasonably dispose of all the soybeans.[244] Plaintiff was awarded damages of $45,071.72.[245]

In Arbitration Case Number 2538 involving a dispute about the quality of the corn shipped to plaintiff, plaintiff alleged that defendant was in default because the corn did not arrive as specified under the terms and

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[235] *Id.*
[236] *Id.*
[237] *Id.*
[238] *Id.*
[239] *Id.*
[240] Bunge North America Inc. v. 21st Century Seed Co., Nat'l Grain & Feed Ass'n Arb. 2533 (2012) (Coppin, Balvin, & Coppage, Arbs.)
[241] *Id.*
[242] *Id.*
[243] *Id.*
[244] *Id.*
[245] *Id.*

conditions of the contract.[246] On the other hand, defendant argued that corn was sold F.O.B. and title passed when the cars left its facility, and that transit time to the unloading elevator was excessive and it probably caused the deterioration of the grain.[247] Additionally, defendant argued that plaintiff did not inform defendant of the rejection in a timely manner under the contract.[248] Arbitrators ruled in favor of plaintiff and provided an award in the amount of $48,497.71.[249]

3. Applying the Lessons to Biomass Contracting

As the agricultural disputes teach us, there are risks for both parties involved in negotiating and performing under traditional agricultural contracts, and one of the key risks is the risk of unenforceability of the contract. As a result, we have agricultural contracting partners using arbitration to resolve their disagreements. Parties to a contract will sign it, signaling an interest to follow the agreed terms, but the relationship often does not go as well as they predict. Following the breach, the opposite party may raise different defenses to it, or even allege that the contract was not valid from the beginning. Thereby, the argument becomes that the contract is not enforceable against them from the beginning of the relationship. Additionally, contracts invite expensive and lengthy litigation. Contracts also invite arbitration disputes with awards that either do not reflect the actual losses incurred by plaintiff, or cause great expense to defendant. Even if arbitration might provide a less costly way to resolve contractual disputes than the courts, arbitration disputes still take time, money, and effort, possibly ending further exchanges between the parties.

Many of the disputes also revolve around failing to meet notification and procedural requirements, and interpretation of the clauses in the contracts. For instance, in Arbitration Case Number 2485, the defendant failed to give proper notice about plaintiff being in default as specified in the terms and conditions of the contract.[250] In Arbitration Case Number 2538 the defendant's argument revolved around notification and delivery

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[246] Lansing Trade Group LLC v. Zolman Farms Inc., Nat'l Gran & Feed Ass'n Arb. 2538 (2012) (Coppin, Balvin, & Coppage, Arbs.).
[247] *Id.*
[248] *Id.*
[249] *Id.*
[250] Tate & Lyle Ingredients Americas Inc. v. Garrett Enterprises, Nat'l Grain & Feed Ass'n Arb. 2485 (2011) (Reiff, Bunz, & Karlin, Arbs.).

clauses in the contract.[251] The interpretation of clauses in the contract is another issue for arbitration. In Arbitration Case Number 2401, one of the questions to be decided was whether the "Act of God" provision's exception would excuse the failure to deliver under the contract in case of flooding.[252] In this case, the buyer was excused from performance under the contract, but not the seller (defendant).[253] Moreover, while the defendant argued that the plaintiff's field marketers may have said that "flooding" should be covered under the contract as an "Act of God," the contract included an item that excused plaintiff from opinions expressed by its field marketers.[254] In this case, the contract provided many rights to the plaintiff, but not the defendant.[255] Since the defendant signed the terms of the contract, the arbitrators ruled in favor of the plaintiff in the amount of $199,800.[256]

In deciding agricultural contract disputes, arbitrators often make references to "normal trade practice and protocol"[257] and "trade rules and practices."[258] At this point in time, common "trade practices" for dedicated energy crops are still being developed. Hence, we may eventually find that biomass contracting involves the same trade practice as traditional crops, but it may be the case that different trade practices are formed given the particularities of the bioenergy industry. Therefore, while the trade rules and practices in agricultural disputes in arbitration may guide parties when the case involves traditional crops, it is not clear yet whether the same practices will also be applied to dedicated energy crops.

The bioenergy industry may benefit from the lessons from common disputes in agricultural contracts because end-users of biomass will most

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[251] *Lansing Trade Group LLC*, Nat'l Grain & Feed Ass'n Arb. 2538.

[252] Cargill Inc. v. F.L. Wilson Inc., Nat'l Grain & Feed Ass'n Arb. 2401 (2010) (Brocklesby, Cropp, & Jones, Arbs.).

[253] *Id.*

[254] *Id.*

[255] *Id.*

[256] *See id.* (a similar argument was raised by defendant that non-delivery was exempt by an "Act of God" clause in the event of a natural disaster. The arbitrators found again that the signed contract did not provide for an "Act of God" in favor of defendant).

[257] *See id.* (noting defendant does not have a claim to require that plaintiff receive a written confirmation from defendant because this is not normal trade and practice).

[258] *See* Cargill Inc. v. Truckor, Nat'l Grain & Feed Ass'n Arb. 2328 (2011) (Krueger, Anderson, Elsea, Milbank & Young, Arbs.) (noting that defendant failed to follow trade rules and practices when it did not object to the notices from plaintiff with which he claimed to have been in disagreement); Markit County Grain LLC v. Anderson, Nat'l Grain & Feed Ass'n Arb. 2344 (2010) (Sutherland, Brammer, Potter, Arbs.) (arbitrators denied defendant argument that no contract was formed based on the fact that defendant's course of conduct would be inconsistent with trade practice).

likely encounter similar enforceability problems when contracting with biomass producers. For instance, we saw that failure to deliver is the most common dispute between parties, and it makes up more than seventy percent of all disputes between buyers and sellers.[259] However, we also saw in Figure 2 that counterarguments will not be limited to delivery issues, but parties may raise all kinds of arguments, ranging from failure to meet quality standards and changes in market conditions, to the validity of the contract to begin with.[260] Failure to meet quality standards is also a common source of dispute. The issue becomes that, if there are quality problems with traditional crops and a market and techniques that are very well known by both parties, dedicated energy crops may face even more problems. Hence, in a situation involving dedicated energy crops with higher levels of asset specificity than soybeans or corn, failure to deliver or failure to meet quality requirements will be more likely to occur. Disputes involving failure to deliver and to meet quality standards will also have more negative effects on parties to biomass transactions, especially the buyer of the biomass feedstock. The quality specifications make the feedstock contracted for with the breaching party a unique product. If the seller fails to deliver, the buyer cannot easily go to the market to purchase the exact same product. Similarly, if the buyer holds up and does not purchase the biomass hoping to appropriate a share of the production surplus, the seller cannot easily go to the market to sell that biomass because that biomass feedstock has little or no value outside the relationship with the original buyer.

In summary, our study of agricultural disputes reveals that basic disputes arise under contracts in well-established markets like those for commodity corn and soybeans. Failure to deliver and failure to accept agricultural products are the most common complaints in the arbitration cases examined. After the breach, parties seek arbitration to request damages for the losses incurred under the contract, such as damages for replacing the product elsewhere[261] and disposing of the low-quality crop.[262] It is interesting to note that large elevators are generally plaintiffs under

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[259] *See supra* Fig. 1.

[260] *See supra* Fig. 2.

[261] *See* Cargill Inc. v. Philen Farm P'ship, Nat'l Grain & Feed Ass'n Arb. 2361 (2012) (Schwinke, Breedlove, & Katovich, Arbs.) (plaintiff argued a loss of $57,300 as the result of defendant's alleged breach of the contract and the significant increase in market prices that occurred thereafter); US Commodities LLC v. Kottschade, Nat'l Grain & Feed Ass'n Arb. 2341 (2009) (Burke, Prickett, & Williams, Arbs.) (Plaintiff sought to collect damages representing differences in market prices which totaled $155,096.11).

[262] *See* Bunge North America Inc. v. 21st Century Seed Inc., Nat'l Grain & Feed Ass'n Arb. 2533 (2012) (Coppin, Balvin, & Coppage, Arbs.).

the arbitration cases, and they win some kind of award more than eighty percent of the time.[263] Farmers, on the other hand, are generally defendants in these cases. If we had a vertically integrated model in this industry, these agricultural disputes would have been eliminated, because large elevators and processors would grow their own corn and wheat. However, for traditional commodity crops, the costs involved in internalizing this process are higher than purchasing the products on the open market from independent parties.

The issue is that there is a probability that these same agricultural disputes will replicate in biomass transactions. Given the higher concern with quality and reliable supply, and in light of the unique characteristics of the bioenergy industry, these disputes are likely to be even more frequent. Whether arbitrators will borrow the "normal trade practices and protocols" of traditional agricultural crops and apply them to biomass contracts is still to be decided. The model contracts analyzed below reflect some of the tensions in biomass contracting that anticipate the occurrence of common disputes in traditional agricultural contracts.

B. Analysis of Model Biomass Contracts

For our analysis of model biomass contracts, we collected publicly available contracts and contacted private companies involved in biomass production and procurement. We analyzed the real-life contracts that we were able to obtain and divided them into three groups according to their characteristics. These model contracts represent what is currently found in the bioenergy industry. We present an analysis of the main characteristics of these contracts and our conclusions about what would be the issues parties should consider in choosing the optimal organizational structure for a biomass supply chain. The following sections break down and summarize the relevant terms in the contracts. More details concerning each contact can be found in the Appendices to this Article.

1. Initial Considerations

The developing bioenergy industry requires a reliable supply of biomass, and the reliability of supply can be influenced by biomass purchase contracts and by logistical planning.[264] When the theory of transaction cost economics is applied to the bioenergy industry, it suggests that because of the presence of asset specificity, the industry should likely be more vertically integrated. This is because, as noted above, transaction

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[263] *See supra* Table 1.
[264] Williams, *supra* note 47.

cost economics articulates that when contracting costs exceed external procurement costs (i.e., costs of contracting), parties are more likely to vertically integrate.[265] As we will see, biomass contracts tend to employ provisions to address the varying degrees of asset specificity present in the transactions they govern. In other words, the asset specificity related characteristics of the biomass crop and end uses involved in the transaction inform the contractual provisions employed. The analysis of model contracts will highlight the current organizational structures in the bioenergy industry, and expose specific issues and concerns of the contracting parties. When we also compare the most common agricultural disputes with the common provisions of model biomass contracts, we can better anticipate the risks parties may encounter, and prescribe the best measures to avoid contractual disputes.

As mentioned above, vertical integration reduces the incentives for parties to hold-up and to act opportunistically because the supply chain and the objectives of the different stages of the production processes will be aligned. Vertical integration also solves the problem of specific investments, and helps to address asset specificity concerns. In the bioenergy industry, the relevant assets and investments generally include the processing facility, the biomass cultivation and harvesting equipment, storage and transportation equipment, as well as the time and managing effort of the producer. According to Altman et al., the types of asset specificity that are likely to be significant in the bioenergy industry include: (1) physical asset specificity and spatial asset specificity of the processing facility; (2) physical asset specificity of biomass production; (3) specific transportation and storage assets; and (4) human asset specificity associated with biomass managing efforts.[266] The analysis of the language in the model contracts described below confirms that parties acknowledge the existence of asset specificity and logistic challenges in the contract. As discussed above, contract incompleteness and enforcement costs create obstacles for parties to behave efficiently. We argue that problems during the performance of the contract, together with potential agricultural disputes that may risk the development of the industry, advocate, at least initially, for higher presence of more vertically integrated organizational structures.

2. The Biomass Exchange Platform

The Biomass Exchange Contract in Appendix A is very basic but is a good point at which to start because this contract sets forth the most

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[265] *See The Economics of Organization*, *supra* note 87, at 558.
[266] *Contracting for Biomass*, *supra* note 29, at 5.

basic provisions in a biomass contract. The Biomass Exchange Contract is a general template to be used by a supplier and buyer of biomass to regulate the sale of biomass using the electronic services of the Minneapolis Biomass Exchange ("MBE") platform. A biomass exchange is a mechanism that aims to strengthen the biomass value chain by, among other services, assuring an available market for the resource providers or the producers and consistent feedstock availability, promoting the exchange of information between parties, and assuring the resource quality.[267]

The Biomass Exchange Contract is a suggested basic agreement offered by the MBE. The MBE is a biomass exchange that functions as a listing and bidding platform to biomass buyers and sellers, where they can connect to each other, and others in the industry, furthering biomass trade, and industry knowledge and growth.[268] A buyer in need of biomass feedstock would approach the biomass exchange, where it would be appraised of the availability of the requested feedstock provided by sellers, as well as the quantity and quality of the feedstock. The MBE also offers online settlement, quality control services, and market information in order to reduce the risk in this market and increase trade opportunities. Similar to the Biomass Exchange Contract, the MBE offers spot contracts on an "as-needed basis." The type of feedstock contracted for is not specified in this template, but it can be arranged for by the MBE. One of the roles of a biomass exchange platforms is to facilitate the trading of different types of biomass, such as corn stover, dedicated energy grasses, wood chips, etc.[269]

The term of the contract is not specified because it is a spot-type contract template. The contract contemplates that the supplier is one who regularly engages in the business of "planting, growing, maintaining, harvesting, handling and/or selling one or more types of biomass."[270] Quantity to be delivered and type of biomass are not specified. In terms of delivery, the contract provides that the buyer is the one scheduling delivery dates and quantities to be delivered by written or electronic notice. The supplier is responsible for the costs associated with delivery of the biomass. The price clause is not extensive or complex and it only provides that the

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[267] Setu Goyal, *Biomass Exchange—Key to Success in Biomass Projects*, BIOENERGY CONSULT (May 7, 2014, 11:55 AM), http://www.bioenergyconsult.com/biomass-exchange/, *archived at* http://perma.cc/P83T-HHPN.

[268] *Mission Statement*, MBIOEX, https://www.mbioex.com/mission, *archived at* https://perma.cc/EHY9-BVN4 (last visited Mar. 15, 2015).

[269] *Listing: For Sale*, MBIOEX, https://www.mbioex.com/listings, *archived at* https://perma.cc/7KAL-CYBZ (last visited Mar. 15, 2015) (listing the different crops for sale in the Biomass Exchange).

[270] *See infra* app. A.

supplier will quote prices on the MBE. In this case, it appears that parties have the option to delegate the calculation of the price of biomass to the MBE, and do not need to address it fully in the contract. The MBE offers USDA price reports to be used as estimates by the parties. Payments are not made in advance, but the buyer has the option to make a deposit to secure delivery by the supplier.

The quality of biomass is defined as the "type described on the [MBE], fit for Buyer's needs."[271] Again, if there is a need for more sophisticated agreement, buyers and sellers may use other agreements and services offered by the MBE. The warranty clause provides that the supplier will correct any warranty breach at its expense, pay direct damages, and defend the buyer from any resulting claims. The Biomass Exchange Contract provides for potential remedies for failure to make conforming deliveries, where the buyer has five business days to inspect and reject any non-conforming biomass. The buyer has the burden of proving that biomass is non-conforming and rejected biomass may be returned at the supplier's expense. The contract also reserves the right to the buyer to refuse any biomass, and to cancel the contract if the supplier fails to deliver all or any part of biomass in accordance with the contract.

The contract does not specify whether the buyer has the right to suspend delivery until the seller resolves quality problems. The lack of remedies in the case of non-conforming biomass reveals contract gaps and it also places the seller in a weaker position because, while the seller may not have another chance to redeliver conforming biomass, the contract gives the buyer the right to cancel the entire contract after one non-conforming delivery. According to the remedies provided to the buyer (right to reject biomass and cancel all or part of the contract), the seller does not appear to have the ability to remediate the non-conforming biomass delivery at its own expense. If so, the seller will have the burden of finding another buyer for its biomass. Where investments are made to conform the biomass to the needs of a specific buyer, and the ability to terminate the agreement raises significant concerns for sellers, their weak position may prevent them from entering the biomass industry. Finally, the contract provides for arbitration in case of controversies arising out of the contract.

In the absence of vertical integration, participants in the bioenergy industry need to assure commitment by all parties involved to generate sufficient biomass, and to encourage investment in the industry.[272] This

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[271] *See infra* app. A.
[272] *See* ZWART & DE BOER, ROTTERDAM CLIMATE INITIATIVE, MARKET ANALYSIS FOR THE START OF A BIOMASS COMMODITIES EXCHANGE (2010), *available at* http://biomassconsultancy

is the role biomass exchange platforms such as the MBE seek to perform. Their objective is to meet the demand of market parties for reliable trading instruments by encouraging information exchange and cooperation in a more consistent biomass marketplace.[273] However, while biomass exchanges are an option for providing assurances in this growing market, they do so at certain costs, such as the cost of maintaining and administering the platform. Moreover, a spot-contract may be an efficient alternative where goods are easily fungible, which is not a reality yet in the present biomass industry. Building the trust and commitment in this market is essential to boost its growth. For instance, farmers have shown unwillingness to harvest biomass that has nutrient value to the field unless there is a guaranteed seller for the biomass.[274] The biomass exchange purports to solve this problem by allowing farmers to offer their product prior to harvesting.[275] In such cases, farmers are therefore offering the product before incurring any harvesting costs, but do not guarantee quantity or quality for end-users. It is questionable whether a market that requires high initial investment will develop around this somewhat fragile commitment structure.

3. The Aggregator's Role

A biomass feedstock aggregator combines a large number of biomass sources so that they may provide a supply of feedstock that is large enough to warrant marketing.[276] An aggregator generally works to balance the materials available, the logistics of the market, as well as provide sufficient quantities to customers as needed, and in some cases perform some processing of the biomass feedstock for end-users.[277] The purpose of aggregators

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.com/Publications/Market%20Analysis%20Biomass%20Commodities%20Exchange%20 August%202010.pdf (noting that farmers were reluctant to harvesting agricultural residues unless a credible market was already in place).

[273] *Id.* at 6–7.

[274] *Id.* at 35.

[275] *See* Madhu Khanna, *Policy Incentives for Energy Crop Production: Role of the Biomass Crop Assistance Program*, POLICY MATTERS (June 3, 2014), http://policymatters.illinois .edu/policy-incentives-for-energy-crop-production-role-of-the-biomass-crop-assistance-program/, *archived at* http://perma.cc/Z6VV-JQR8.

[276] See *Wisconsin's Biomass Edge*, FARM PROGRESS (Jan. 2012), *available at* http://mag issues.farmprogress.com/WSA/WA01Jan12/wsa048.pdf (suggesting an aggregator markets a crop); *see also* UNIV. OF MO., MISSOURI BIOMASS AGGREGATOR BUSINESS PLAN (2011), *available at* http://crops.missouri.edu/corn/BiomassAggregatorBusinessPlan.pdf.

[277] Pradeep J. Tharakan et al., *Evaluating the Impact of Three Incentive Programs on the Economics of Cofiring Willow Biomass with Coal in New York State*, 33 ENERGY POL'Y

in the biomass supply chain is to reduce transaction costs and risks related to the supply and demand of biomass. While "corn is corn," biomass is often a seasonal mixture of different waste products. An aggregator may make an offer to a farmer on corn stover that a farmer might need to balance out with a supply of switchgrass, or some other feedstock that does not quite meet the quality required by some biorefineries. Since biomass is a mixture whereas corn, beans, and wheat are homogeneous, one of the jobs of an aggregator appears to be to seek out the right raw materials to yield a marketable mixture in sufficient quantities.

The following contracts involve producers of biomass feedstock (such as farmers), biomass aggregators (including, but not limited to a cooperative) and end-users (such as a power plant, cellulosic ethanol plant, industrial user, or other biomass conversion facility). As discussed below, the aggregator enters into contracts with producers in order to sell the biomass feedstock to end-users (in this case the aggregator will also perform some processing of the feedstock). Each party has specific issues to be addressed in the contract. For producers of biomass, the main issues are the investments required and the risks of producing the biomass.[278] As discussed in Section III, crop establishment issues and the cost of key inputs to produce the biomass are key concerns to farmers. Furthermore, the duration of the contract and risk allocations should be designed in a way that justifies initial investments.[279] End-users need reliable supply and price certainty. End-users also need the feedstock to meet specific quality standards. Aggregators, serving as an intermediary between the two, purport to receive the quantity and quality contracted with producers to meet end-user specifications, thereby entering into complex agreements and incurring the costs of storage, transportation, and non-conforming delivery. The key issue for aggregators is to maintain a profitable transaction between the cost of feedstock purchased from producers, and the sale of the processed biomass.[280]

Aggregator Contracts I and II offer a template with the key issues that parties should address and customize to their specific needs. Aggregator Contract I is an example of a model contract between a producer of biomass feedstock and an aggregator of the feedstock. The essential

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337, 339 (2005); *see Model Biomass Agreement: Presentation to Biomass Market Development Initiative Meeting*, ENERGYLAW (Oct. 29, 2010), *available at* http://www.stateenergyoffice.wi.gov/docview.asp?docid=20582&locid=160 (discussing the role of aggregators).

[278] *Id.*

[279] *Id.*

[280] *Id.*

clauses discussed here are detailed in Appendix B. Aggregator Contract I does not involve the use of a biomass exchange to mediate or complete the terms of the transaction. The type of feedstock contracted for is not described, but footnote 1 of Aggregator Contract I specifies that it contemplates "unprocessed or minimally processed biomass." This footnote also notes that this contract can be adapted for contracts involving limited processing biomass and it suggests a separate "Biomass Procurement Agreement" to address size, density or content issues that arise in the relationship between an aggregator and the purchaser of the processed biomass.

Aggregator Contract I highlights the essential terms of a biomass production agreement, and similarly to what the literature on biomass contracting prescribes, quality, minimum quantity, deliveries, compensation, and costs are generally provided for. Exhibit A of the contract describes the type of renewable biomass raw materials and the specific source locations required under the contract by the purchaser. Exhibit A also provides the template for the specific type of biomass to be inserted, and what specifications the biomass must conform to, including weight, moisture, and acceptable amount of foreign material. This contract notes that parties may add additional criteria that might be critical to the biomass buyer, such as dimensions, content, chemical, and mineral constituents, etc.

Exhibit B of Aggregator Contract I presents basic provisions on compensation. Footnote 16 indicates that if parties have agreed that the purchaser will be only paid on a fixed price basis with few or no adjustments, Exhibit B is not part of the contract. Adjustments may include compensation for additional services if they are not included in the cost of the biomass. In this case, the purchaser should compensate the seller for services such as transportation, storage, and delivery services. That is because footnote 17 in Exhibit B notes that:

> [T]he basis for compensation for transportation is critical and affects other aspects of performance. For example, if payment is based on units of biomass measured by weight times the distance transported, then moisture content is critical, as it would increase the transport cost, but reduce the combustion value of the biomass.[281]

Another concern in Exhibit B revolves around increases in the cost of critical inputs, such as insurance, property taxes, seed, diesel fuel, and

[281] *Infra* app. B at Exhibit B.

storage. The contract observes that these costs are a significant concern for producers, even discouraging some potential biomass producers from getting into the industry. Additional services also include compensating seller for crop establishment assistance, but footnote 18 notes that it may raise complex issues such as how it interacts with Biomass Crop Assistance Program payments. Exhibit C provides a list of definitions to avoid any ambiguity in regards to the definition of a specific word in the contract.

Exhibit D specifies that the Aggregator and the farmer "agree to cooperate fully with each other in the provision of the services [under the contract]."[282] This clause suggests the importance of logistics and aligning the relationship in a way that goes beyond a market trade; cooperation, for the reasons discussed above, influences the performance in biomass contracts because a cooperative arrangement alleviates the effect of asset specificity. Nevertheless, they agree that the farmer is an independent contractor and has the freedom to determine the means and method of delivering the biomass and performing the related services. The farmer will not be considered an agent, servant or employee of the Aggregator. This clause appears to address employment and agency concerns, but even if parties are supposed to act independently, the contract provides for extensive and detailed specifications to govern their relationship.

In terms of indemnity, footnotes on Exhibit D note that parties to the contract should tailor what types of damages and the extent to which risks should be covered in the contract. For instance, the contract may specify how to deal with the situation where non-conforming biomass damages the biorefinery's equipment. Whether parties in biomass contracts should or should not be indemnified for this kind of risk depends not only on the traditional provisions in agricultural contracts, but whether the contract may be more tailored to the particular characteristics of the nascent biomass industry. The template suggests that the farmer incurs the cost of providing insurance (general liability insurance, workers compensation insurance, and any other to be agreed between the parties). The template also suggests negotiation, followed by arbitration, to resolve disputes arising under the agreement.

Aggregator Contract II in Appendix C is designed to be used between an Aggregator and an end-user of the biomass feedstock. Some of the provisions in Aggregator Contract II are similar to Aggregator Contract I, but, differently, since here we have a contract between an aggregator and the end-user, the concern is also to provide value-added processing

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[282] *Infra* app. B at Exhibit D.

to the biomass, such as densification, pelletizing or chipping to address concerns about density, content, or size.

Because in this case the aggregator will process the biomass, footnote 3 suggests that parties specify not only the type of process, but also the specific equipment that will be using the biomass so that parties may cooperate on achieving emission controls and preserving the function of the equipment. Exhibit A of Aggregator Contract II provides some of the issues that must be addressed by the parties, such as the testing and delivery specifications, moisture, weight, biomass particle size if applicable, managing mineral content (such as silica which can corrode equipment) and foreign material, etc. It also provides for "Specifications for Laboratory Testing" where parties need to include how often tests will occur, who does the testing and how costs shall be allocated. Exhibit B addresses compensation provisions, and just like in Aggregator Contract I, it highlights that the basis for compensation for transportation is critical and affects other aspects of the contract performance. One of the clauses in Exhibit B concerns crop establishment assistance, and it also notes that crop establishment provisions raise complex issues (such as to what extent such assistance should be reduced by crop establishment incentive programs). Another provision suggests payment of the biomass on a "take or pay" basis, where end-user would either take the biomass from the aggregator or pay the aggregator a penalty. Such arrangement certainly includes risks to the end-user, and parties would want to consider whether the buyer is excused under certain circumstances.

Exhibit D contains general conditions, and similarly to Aggregator Contract I, parties establish that the end-user is engaging aggregator as an independent contractor and aggregator determines the means and method of delivering the biomass and performing the related services. Again, despite this provision, Aggregator Contract II extensively provides for quality, transportation, processing, compensation and other specifications. The template suggests that the Aggregator incurs the cost of providing insurance to end-users in the processed biomass (general liability insurance, workers compensation insurance, and any other to be agreed between the parties). The template also suggests negotiation, followed by binding arbitration, to resolve disputes arising under the agreement.

As noted above, biomass aggregators purport to organize the contracting, logistics, storage, and mixing of biomass feedstock streams to meet end-users needs. The presence of aggregators in the market tend to indicate that the industry developed to a stage where the material is fungible enough that it can be "aggregated" and sold by an intermediary to end-users. However, the aggregator's goals might be jeopardized by a current infant biomass industry that does not have established supply or demand sides.[283] In other words, the risk of an insufficient quality and quantity supply of biomass feedstock was merely shifted from end-users to aggregators, and the possibility of breaches of contract still presents a high risk.

4. The Cooperatives' Role in Biomass Contracting

a. The Cooperative Model

Another aspect of the current biomass supply chain is the existence of industry participants acting as intermediaries between farmers and biofuel plants and end-users. The farm cooperative business model for bioenergy has been identified as an option for the organizational structure of the biomass industry.[284] In transactional cost theory, the rationale behind the cooperative model largely overlaps the theory positing vertical integration.[285] Just as in the vertical integration model, the cooperative model is based "on the members' efforts to integrate either forwards or backwards in the processing/distribution chain, albeit jointly because each one is too small to accomplish the task separately."[286] Cooperatives play an important economic role for independent farms in providing more competitive returns and access to difficult or more complex and expensive markets.[287] Cooperatives are established in response to the presence of high transaction costs that arise among independent trading partners, and that make market contracting expensive if parties contract alone. When members join forces in a cooperative structure, they are more able to counteract market failures, such as the hold-up and transaction-specific problems discussed above.[288]

Cooperatives also allow members to pool resources and take advantage of economies of scale.[289] For instance, in the case of storage and

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[283] *See Missouri Biomass Aggregator Business, supra* note 276, at 8 (discussing the weakness of the aggregator's role).

[284] Downing et al., *supra* note 65, at 432–33.

[285] Jerker Nilsson, *Organisational Principles for Co-operative Firms*, 17 SCAND. J. MGMT. 329, 332 (2001).

[286] *Id.*

[287] *Id.* at 332–33.

[288] *See id.* at 332 (noting that when farmers own the trading partner in a cooperative model, "transaction costs can be reduced, and due to the difference in the optimal scale of operations.").

[289] *Id.*

transportation of biomass feedstock, members of a cooperative may take advantage of common infrastructure. Cooperative members can use machinery and buy inputs such as seeds and fertilizer at a better price than a member would get if buying them on their own. Additionally, cooperatives allow farmers to focus on farming, and the managers of the cooperative to focus on managing the logistics, such as finding a market for seeds, finding transportation, etc.[290] Farmers pay a price, generally small, to become a member of a cooperative, but that price buys them more distance from the hassle they would have in contracting and managing the crop on their own.[291]

Some studies argue that the cooperative form presents many inefficiencies.[292] First, it is said that because members in a cooperative do not control management, cooperatives may suffer from the principal-agent problem and incur high control costs.[293] The agency theory is concerned with the relationship between principal and its agents, more specifically with problems associated with the separation of ownership and control when principals and agents differ in their objectives.[294] In an agricultural cooperative setting, property rights are generally vaguely defined, and members have no individual ownership right to the cooperative decisions concerning the individually owned shares made by the society, as well as capital that is also subject to collective decision making.[295] Therefore, the argument is that this allocation of property rights does not provide incentives for members to invest in the further development of the cooperative business.[296] Additionally, managers in a cooperative generally enjoy considerable power and stability, since the management is not often replaced and it is difficult for members to evaluate managers.[297] This structure leads to the situation where there is no external information available to the principal (member) that can be used to evaluate the performance of the agents (managers), thus providing little incentive for principals to monitor

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[290] John King, *Farmers Say Co-ops Work for Feed, Seed and Health Care*, CNN POLITICS (Sept. 4, 2009, 10:52 AM), http://www.cnn.com/2009/POLITICS/09/04/sotu.wisconsin.coop/, *archived at* http://perma.cc/UBH3-JCLH.

[291] *Id.*

[292] Nilsson, *supra* note 243, at 285 (inefficiencies are based on unclear property rights and high agency costs).

[293] *Id.* at 333.

[294] *Id.* at 333–34.

[295] *Id.* at 332.

[296] *Id.* at 338.

[297] *Id.* at 339.

the managers of the cooperative, to compel the director to operate in their interest, and to innovate the way the cooperative conducts its business.[298]

Second, because members cannot put a price on their collective ownership in the cooperative, there is a short-term characteristic of the member's investment and there is a presence of the so called "horizon problem."[299] It has been noted that:

> Since the employees have claims on cash flows that are contingent on employment, their expected employment period will enter investment decisions. An employee, in evaluating an investment decision, will truncate cash flows excluding periods in which the assets are productive but which are beyond his expected employment termination date. Thus, a project, to be accepted, will require the present value of the truncated cash flows to exceed outlays. Some projects with positive net present value will be rejected reducing demand for capital.[300]

Put differently, since members in a cooperative cannot capture future payoffs of such investments, members will influence the decisions of the collective based on the horizon problem, where under-investment is expected.[301] Hence, even if planning horizons may differ among members and between members and management, these differences will lead to greater restraint of long-term investments that yield the development of the business. Since members are concerned with the benefits of their membership while they are still members, potentially good and sustainable investments may not be pursued, and the value of the cooperative is reduced.[302] Economies of scale are also affected by the property structure and the short-term horizon for investments from its members.[303] In addition, if cooperatives do not charge an entrance fee, new entrants will enjoy the prior investments made by former members, therefore being allowed

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[298] Philip K. Porter & Gerald W. Scully, *Economic Efficiency in Cooperatives*, 30 J.L. & ECON. 489, 495 (1987) (noting that the inability to define ownership leads to underinvestment and reduces the incentives of its members to innovate).
[299] R. Srinivasan & S.J. Phansalkar, *Residual Claims in Co-Operatives: Design Issues*, 74 ANNALS OF PUB. & COOP. ECON. 365, 368 (2003).
[300] *Id.*
[301] *Id.*
[302] *Id.*
[303] *See id.* (explaining that because of the horizon problem, some projects with positive net present value to the company will be rejected by the cooperative members).

to become free riders.[304] Therefore, the potential to free ride, together with the short-horizon problem, reduces members' involvement and incentives to invest further in the development of the cooperative.

Despite such disadvantages, the cooperative form is commonly employed by different businesses, and public policy in many countries supports the existence of cooperatives.[305] In fact, in the context of agricultural exchanges and the nascent bioenergy industry organization, the cooperative framework may allow a better balance and more certainty in the market for both farmers and biomass end-users than spot markets or contracts that do not address important terms or are simply too incomplete. Downing et al. assess the development and performance of agricultural cooperatives and establish the conditions under which a farm cooperative business structure would be adequate for the bioenergy market.[306] It was found that biomass purchasers generally face less risks and transaction costs when contracting with a single cooperative, rather than with independent and dispersed farmers.[307] Some of the advantages of cooperatives in this market are that the cooperative may provide more certainty and stable supply and delivery of the crop than if the same transaction was done only by contracts with individual farmers.[308] Therefore, biomass purchasers may prefer to contract with cooperatives rather than with farmers in an effort to increase the likelihood of certain deliveries over longer periods of time.

For the cooperative members, one of the benefits is that farmers could have support in harvesting, transporting, and storage of the biomass. Members also receive the benefit of the cooperative in the form of organization, support, improved services, and terms of trade.[309] In addition, there is strength that arises from community education and involvement. The question becomes whether the biomass industry, more specifically the relationship between farmers and purchasers of biomass, would benefit from the existence of a cooperative form. Thus, whether the business conditions inherent to biomass justify the existence of cooperatives will largely depend on the degree of asset specificity in the industry. Higher levels of asset specificity for the biomass buyer represent higher quality and delivery risks. For the farmers, there are more costs involved in planting, managing, and

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[304] Nilsson, *supra* note 285, at 336–37.
[305] Porter & Scully, *supra* note 298, at 491 (noting that the inability to define ownership leads to underinvestment and reduces the incentives of its members to innovate).
[306] Downing et al., *supra* note 65, at 432–33.
[307] *Id.* at 431.
[308] *Id.*
[309] Nilsson, *supra* note 285, at 336.

delivering the crop. For both parties, opportunism and hold-up problems still persist in a contractual arrangement. An analysis of the contracts between the cooperative and the individual farmer, and the cooperative and the biomass purchaser addresses some of the concerns described above.

b. Contracting with the Cooperative

Cooperative Contract I in Appendix D is a ten-year contract to be entered into between an Environmental Fuels Cooperative and Land Owner/Grower member. The type of feedstock contracted for is vegetative waste and woody materials that comply with specifications under the contract. The cooperative has been formed by a number of agriculture and farming interests consisting of individuals and/or corporations. As part of the business services performed on behalf of its members, the cooperative may enter into a Fuel Supply Agreement of biomass fuel with the electric department of a city. Hence, Cooperative Contract I governs the general relationship between the cooperative and its members, where the cooperative will later enter in a Fuel Supply Agreement with city on behalf of its members for sale of biomass.

Section 2 of Cooperative Contract I defines "biomass fuel" as plant material, including trunks, stems, leaves, and twigs harvested for fuel feedstock to produce electricity, not having a dual commercial use. According to the Purpose and Intent section, "[the member] represents that prudent and reasonable levels of due diligence have been performed as to [the] definition of biomass fuel."[310] This provision, together with the "Definition of Biomass Fuel," states the objectives of the relationship and it is an opportunity for parties to set the tone and establish parameters that will inform the interpretation and application of the provisions in the contract. As already seen in the contracts above, here the ability of farmers to meet the minimum amount requirements, with the quality of feedstock as specified under the contract, is also a major concern of the cooperative.

Cooperative Contract I also provides that the quality of the biomass fuel will be specified in the Fuel Supply Agreement, and continued non-compliance of fuel quality will be a material event that may lead to termination of the Fuel Supply Agreement. The contract states that the definition of biomass fuel is a material provision of the Fuel Supply Agreement, and a condition of default under the contract. The contract goes on to specify that in the event members are unable to fulfill the defined minimum

[310] *Infra* app. D.

annual volume deliveries, members will reimburse the cooperative based on a formula that takes into account funds advanced to them, and the deficit of actual annual volume deliveries offered to the cooperative. Members are responsible for acquiring and keeping in force crop insurance, and failure to comply with the insurance requirement may also lead to the termination of the Fuel Supply Agreement. In terms of financing, the contract specifies that the cooperative, acting on behalf and for the benefit of members, shall incur costs in obtaining the finance for the crop establishment costs.

Finally, under Cooperative Contract I, as a condition for the execution of the contract, members are required to submit a "Plantation Site Plan" for review and approval by the cooperative. Among other things, the Plantation Site Plan includes a description of plantation site, management plan, and planting schedule for trees. The cooperative will then submit a report of crop establishment costs based on the Plantation Site Plan and the approved report will provide the basis for the city to finance 50% of the establishment and maintenance costs of the plantation. As mentioned above, organization, support, and education in the area are some of the services a cooperative provide to its members in order to maximize their benefits inside the cooperative.

While members appear to assume many of the obligations under the contract with the cooperative, such as to reimburse the cooperative in case the minimum annual delivery is not reached, members also gain from jointly running the agricultural enterprise, and sharing profits and benefits. In the bioenergy industry context, individual farmers that make specific investments in machinery, land, personnel, etc. are vulnerable on the market. The costs of entering the business alone, and adapting or providing under specific quality, quantity, and location requirements may be higher for the individual farmer than the expected profits. For a buyer of biomass (e.g., the city in Cooperative Contract I), uncertainties in agricultural production and dependence on the biomass to be supplied present a constant risk to his business. Therefore, both parties incur high transaction costs from trading independently. When members of a cooperative, jointly enter into a contract with the trade partner, transaction costs and hold-up problems on both sides are reduced, while the availability of financing and cooperation mechanisms increase, especially on the farmer's side.

Similarly to Cooperative Contract I, which is to be entered into by the cooperative and its members, Cooperative Contract II in Appendix E governs the relationship between a cooperative that sells the biomass fuel (plant material including trunks, stems, leaves, and twigs) and buyer for production of biofuel. The type of feedstock contracted for is plant material including trunks, stems, leaves, and twigs. Cooperative Contract II shows that even when there is a buyer of feedstock on one side, and a cooperative on the other side, concerns about minimum quantity, delivery, quality, and logistics persist. This is because the biomass still presents high levels of asset specificity. The existence of a farmer-owned cooperative may provide better assistance and support for its members to perform under the contract with buyer, but uncertainty still permeates the relationship between seller and buyer.

Cooperative Contract II was entered between a municipal corporation, the buyer, and a fuel cooperative, the seller, for the duration of twelve years. The feedstock contracted for is plant material, including trunks, stems, leaves, twigs, harvested for fuel-feed stock and not having a duel commercial use. The cooperative is defined as a "competent supplier of biomass fuel, owning and controlling or having exclusive right to offer fuel for sale sufficient to partially meet the requirements of the Buyer."[311] The initial provisions in the contract establish that the corporation requires a "dependable and high quality biomass fuel source with the experience and capability necessary to supply."[312]

Section 1 goes on to state that the cooperative's performance under the contract is essential to the corporation's ability to meet environmental initiatives and renewable energy marketing objectives. Section 1 also specifies that the corporation relies upon the cooperative's ability to furnish the portion of the fuel supply it needs. This statement in Section 1 is a material provision of this contract. The initial provisions serve the purpose of describing the general approach parties have to the relationship. Parties to the contract have an opportunity to set the tone for their contractual relationship, and such tone will inform the interpretation of the entire contract. Here, the corporation expresses concern about the ability of the cooperative to timely supply the high quality biomass source, and this concern is reflected in the beginning of the contract. Consequently, minimum annual quantities are required, and the time requirements contained in the schedule are of the essence in the contract. Failure to deliver by the cooperative in violation of the delivery schedule is a material default under the contract. Parties also provide for rejection, and the corporation may choose to accommodate the cooperative's occasional production variables.

The expected quality of the biomass fuel is described in detail, and sampling and analysis are also specified in the contract. For instance,

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[311] *Infra* app. E.
[312] *Infra* app. E.

conforming biomass will comply with specific percentages of moisture, ash, heat, carbon, sulfur, etc. The contract also provides that the biomass needs to conform to size, quality, consistency and other physical characteristics so that loading and handling at the corporation's plant can be accomplished without difficulty. In order to assist the cooperative in determining compliance with the agreement, the corporation agrees to conduct and provide the cooperative with a test of the biomass received at the corporation's own cost. The number of tests to be performed, however, is to be solely determined by the corporation. Cooperative Contract II also provides that in the event the corporation experiences equipment problems, or difficulty in burning the biomass fuel, or determines after any time that significant amount of biomass does not conform to requirements specified in the contract, the corporation will notify the cooperative, and the corporation will have the right to halt delivery until the biomass conforms to the specifications outlined in the contract.

The price clause is very detailed, containing a formula to calculate the "avoided cost base price" of the biomass fuel and including quality price adjustments according to variations in heating qualities and ash. Cooperative Contract II also provides for crop establishment costs, meaning that the corporation will compensate the cooperative, prior to commencement of the agreement, for the establishment and management of the biomass property as estimated and accepted by the parties. Providing for establishment costs shows that the buyer acknowledges that the farmers, through the cooperative, will need to invest capital in order to produce and will likely need to learn new production processes. This provision is in response to the high costs incurred by farmers to start a new process or a new crop, especially when farmers have to choose between a traditional, more secure crop, and dedicated energy crops. For those reasons, the corporation is willing to help finance the feedstock. Finally, the cooperative is responsible for obtaining and keeping in force insurance coverage for the property during the term of contract, and the corporation has the right to inspect, review, and audit the cooperative's books with respect to methods by which the biomass is planted, grown, monitored, sampled, transported, etc.

Arbitration is again the method of choice to the resolution of disputes under the contract. Appendix A to the contract reiterates that, as to fuel quantity, both parties agree that significant uncertainty exists, which the cooperative may have no control over, as to biomass crops yields and environmental force majeure, including but not limited to fire, frost, drought, and wind damage. Thus, the corporation agrees to hold the cooperative harmless for the inability to deliver minimum yearly or environmental force majeure.

In light of the aforementioned, the presence of cooperatives in the bioenergy industry could bring many benefits. Cooperatives bring economic advantages for their members by utilizing economies of scale through aggregating purchases, resolving storage problems, and distributing farm inputs for members. In the case of cooperatives, specific initial investments might be shared among many. Cooperatives also help farmers, especially new farmers, to organize and start growing dedicated energy crops, thereby potentially guaranteeing greater confidence of supply for the industry. In the case of a nascent bioenergy industry, individual farmers may not be willing to make investments in firm-specific assets, such as land, equipment, skill and personnel, and a cooperative arrangement may be a solution for these uncertainties. However, at the same time, farmers may be reluctant in joining a cooperative for biomass production if payoffs from these investments extend beyond their expected terms of employment. As discussed above, the horizon-problem tends to affect decision-making and investment within the cooperative. If the investment is uncertain, such as investments in new land, machinery, seeds, etc. to grow biomass and cater to new biomass plants, cooperative members will be adverse to invest today given that there is a chance they will not be able to capture the future payoffs of this risky investment tomorrow. Therefore, while cooperatives present many benefits to farmers, cooperatives' property rights structure and consequent deficiencies serve as a barrier to the ability of cooperatives to serve as efficient instruments to assist biomass farmers. In a more vertically integrated model, the cooperative role is internalized, and the costs or inefficiencies related to their role in the supply chain is brought to zero.

V. THE CASE FOR VERTICAL INTEGRATION

In light of the asset specificity problems associated with biomass transactions, the inevitable disputes that arise with traditional agricultural contracts, and the inability of common biomass contracts to perfectly address these concerns, vertical integration of the bioenergy industry's supply chain appears to be the optimal choice to reduce risks and potential problems with the supply of biomass feedstock at this early stage of the industry's development. To a certain extent, contracts may be able to provide solutions to asset specificity and relationship-specific investments, even if there is uncertainty and the risk of potential hold-up.[313] But the existence of high asset specificity in the biomass industry gives incentives for parties to seek more supply security than is available from spot markets or traditional supply contracts. Additionally, contracting costs may be too high if parties try to plan for all types of contingencies and attempting to incorporate provisions for all potential disputes that might occur will add to the cost of the transaction.[314]

While the only way to address certain concerns is to allow for key contractual terms to be changed, parties will not always willingly agree to changes and thus any adaptation a contract undergoes may also add to the cost of the transaction.[315] In the specific case of biomass contracting, the risk of non-delivery or non-conforming biomass, and the costs of enforcing a resolution in case of breach under the contract are too great for parties to rely solely on contracting, at least during the current early stage of the industry.

As discussed in Part I above, transaction cost economics suggests that when costs of contracting exceed the costs of internal production, vertical integration is often optimal. Furthermore, vertical integration reduces the chance of opportunism because it produces more convergent goals and the firm will have more complete information. In fact, buyers of feedstock and biorefineries may want to exercise more control over farmers "for reasons other than 'lining up' the suppl[y]."[316] Other identified reasons for further integration in an industry include marketing, confidentiality, and pricing arrangements.[317] The model contracts presented in Part IV show how parties currently address asset specificity concerns in different clauses, and certain clauses and features deserve further attention: type of feedstock, quantity and quality clauses, and logistics concerns.

A. The Impact of the Feedstock Type

The type of biomass crop involved in a supply chain is possibly one of its most important factors. In fact, the entire cultivation and harvesting process will depend upon the biomass purchaser desired feedstock.[318] As

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313 Kvaloy, *supra* note 104, at 551–52.
314 *See id.* (noting that "the leading hypothesis is still that if specificity reaches a certain level, contractual solutions become too costly, and vertical integration becomes more likely.").
315 *Transaction-Cost Economics: The Governance of Contractual Relations*, *supra* note 23, at 251.
316 Kelley, *supra* note 109, at 402.
317 *Id.*
318 Endres et al., *supra* note 73, at 125.

the United States Department of Energy states, "The success of the U.S. bioenergy industry relies on many factors, including reliable, adequate supply of high-quality biomass."[319]

It is important to note that biomass may not yet be categorized as a "commodity," meaning a basic good that is interchangeable with others of the same type and is essentially uniform across producers.[320] The model contracts demonstrate that the feedstock contracted for is not easily interchangeable, because quality specifications, quantity and delivery specifications are significant concerns for the parties. In order for the biomass to be manageable as a commodity, it needs to meet qualities that are compatible with existing commodity standards, such as high density, bulk-flowability, and aerobic stability.[321] Consequently, especially in the early stages of the bioenergy industry, biomass farmers will most likely not be able to load their biomass on barges for export similarly to corn and soybean barges.[322] Therefore, whether dedicated energy crops will one day become a commodity will depend on farmers' ability to achieve certain levels of quality and supply, and many predict that if biomass feedstocks were to become a commodity, it would make moving forward with investments much easier.[323]

The biomass supply chain may benefit from vertical integration because it provides more uniformization and efficient processing of the feedstock from the start. For instance, it may be the case that the feedstock might need processing in its initial phase that may increase its energy density in order to reduce transport and storage costs.[324] Further preparation or pre-treatment may be required to convert the feedstock into a form more suitable for an additional conversion process in the biorefinery.

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[319] *Biomass Feedstocks*, U.S. DEP'T OF ENERGY, http://www.energy.gov/eere/bioenergy/biomass-feedstocks, *archived at* http://perma.cc/GK5C-5TAP (last visited Mar. 15, 2015).
[320] Al Fin, *Growing Demand for Biomass Could Create a New Commodity Market*, OIL PRICE.COM (May 24, 2011, 3:01 PM), http://oilprice.com/Energy/Energy-General/Growing-Demand-For-Biomass-Could-Create-A-New-Commodity-Market.html, *archived at* http://perma.cc/BK8U-GHXK (discussing the potential of wood fuel as a commodity).
[321] REUL SMITH, IDAHO NAT'L LAB., ESTABLISHING BIOMASS COMMODITY FEEDSTOCK SUPPLY SYSTEMS (2011), *available at* http://www.inl.gov/research/establishing-biomass-commodity-feedstock-supply-systems/d/establishing-biomass-commodity-feedstock-supply-systems.pdf.
[322] Schill, *supra* note 191 (noting that "public forums for price discovery that exist for commodities like corn, soybeans and oil are not like to emerge for biomass.").
[323] Lisa Gibson, *Wood: the Next Global Commodity?*, BIOMASS MAGAZINE (Jun. 22, 2011), http://biomassmagazine.com/articles/5610/wood-the-next-global-commodity, *archived at* http://perma.cc/3VHK-M85D.
[324] THE ROYAL SOCIETY, *supra* note 19, at 20.

Consequently, improving the efficiency of the supply chain will require that the feedstock be developed in a way that increases the efficiency of the conversion process.[325] How the stages of the biomass supply chain are managed and organized today will determine the benefits that the biofuel produced can offer tomorrow.[326]

The model biomass contracts presented above use mainly forestry materials, such as tree trunks and leaves, but some also includes agricultural residues. For instance, Cooperative Contract II defines the biomass fuel as "plant material including trunks, stems, leaves, and twigs harvested for fuel feed-stock to produce electricity, not having a dual commercial use, and qualifying under the current definition."[327] One of the reasons we might see the prevalence of one type of feedstock over dedicated energy crops in the model contracts is because of the logistical differences between corn grain and ethanol plants; while the infrastructure for production, harvest, storage, transportation, and price risk management of corn and other traditional grains are well-known and well-developed, it is virtually nonexistent for dedicated energy crops.[328]

Nonetheless, as pointed out in the beginning of this Article, in the long-run, the large-scale production of biofuels and renewable energy will require additional resources other than wood materials. Accordingly:

> Future biofuels are likely to be produced from a much broader range of feedstocks including the lignocellulose in dedicated energy crops, such as perennial grasses, and from forestry, the co-products from food production, and domestic vegetable waste. Advances in the conversion processes will almost certainly improve the ef ciency and reduce the environmental impact of producing biofuels, from both existing food crops and from lignocellulose sources. A significant advantage of developing and using dedicated crops and trees for biofuels is that the plants can be bred for purpose. This could involve development of higher carbon to nitrogen ratios, higher yields of biomass or oil, cell wall lignocellulose characteristics that make the feedstock more amenable for processing, reduced environmental impacts and traits enabling the plant species to be cultivated on marginal land of

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[325] *Id.* at 29.
[326] *Id.* at 20.
[327] *Infra* app. E.
[328] Epplin et al., *supra* note 39, at 1296.

> low agricultural or biodiversity value, or abandoned land no longer suitable for quality food production.[329]

Thus, the type of feedstock used, or to be more widely used, by the industry is relevant because it indicates whether higher or lower physical asset specificity exists. As explained above, physical asset specificity is high for transacting parties when te product is unique and has a very limited market. Higher levels of asset specificity can be identified where a limited market exists for dedicated biomass crops and where biofuel plants are feedstock specific, employing only limited types of feedstock for producing their products.

B. The Impact of Minimum Quantity and Quality Clauses

In order to build a biorefinery, there must be reasonable assurances that feedstock supply will be available at startup, meaning that the feedstock supply must be aligned with the goals of the biorefinery for it to achieve success. Bioenergy producers have large investments at stake. Consequently, they would most likely prefer at least multi-year commitments from farmers to ensure a sufficient supply of biomass feedstock to operate the facility.[330] There are unresolved legal issues in this area, mostly in the application of the Uniform Commercial Code and common law, but we will focus on the contractual aspect of this relationship, and how the choice of governance structure may affect the biomass supply chain.

The quantity clause will determine the amount of biomass to be supplied under the contract. Defining the quantity to be delivered is important for bioenergy producers because it ensures an adequate supply for the year. Minimum quantity requirements also benefit farmers, because they create some financial stability that a certain amount of the crop will be purchased by the buyer, or the latter will be in default under the contract.

All of the model biomass contracts (except for the Biomass Exchange Contract) have specific terms to guarantee the quality of the biomass delivered. Cooperative Contract II is an example of a contract that suggests high physical asset specificity. It requires a specific nature and source of biomass, testing specifications, moisture, weight content, chemical and mineral constituents. All specific requirements reflect how particular the product is and how it may change from one purchaser of feedstock to another.

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[329] THE ROYAL SOCIETY, *supra* note 19, at 2.
[330] Goeringer et al., *supra* note 31, at 74.

While the type of feedstock used in Cooperative Contract II is generally material from plants, such as the trunk, stems and leaves, quality requirements are still provided for in the contract.

In general, quality clauses appear to be the most important provisions in the model biomass contracts because they are generally more detailed than other clauses. That is because depending on the conversion process used, biomass may need to be of a specific quality in order to be effectively and economically converted into bioenergy. As noted above, asset specificity will lead to bilateral dependency and possible abuses and hold-up by one of the parties. Since the contract cannot provide compensation or action for every possible situation, incomplete contracts will cause uncertainty and may prevent parties from entering the biomass market. If the feedstock does not conform to the quality specifications, the model contracts generally provide non-compliance as an event of default, or continued non-compliance is deemed a material event that may result in the termination of the contract. While this appears to lay down a clear consequence for quality problems, if the biorefinery terminates the contract, the question becomes where will it acquire a specific crop sufficiently similar to the one contracted for. Especially in the case of a large farmer, or large cooperative, it will be unlikely that the biorefinery will be able to promptly obtain the product it needs.

In summary, not only the type, but also the quality of feedstock is certainly one of the major factors driving the choice of the most adequate organization of the supply chain for different sectors of the bioenergy industry. For example, if a biofuel producer's production process requires a certain biomass quality for it to work, the production contract should clearly define the type of feedstock and required quality provisions. However, while well-defined specifications for quality may address buyers' concerns, they do not generally account for all possible contingencies, and the failure of any party to perform puts not only the continuance of the relationship at risk, but also the consistent and regular supply of feedstock.

C. Cooperation and Logistics Provisions in the Contract

Biomass production raises a number of logistical issues. Many farmers still struggle with the particulars of cultivating biomass and establishing the allocation of tasks that are needed at harvest.[331] Collecting and storing the biomass also raises concerns. The feedstock must meet

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[331] *See Logistics of a Biopower Plant*, *supra* note 48 (discussing biomass logistic issues).

quality and moisture content specifications upon delivery and those will be affected by the storage method of the feedstock.[332] Addressing logistics concerns will most likely benefit parties in the contract because large investments and high expectations are at stake. Biomass purchasers may wish to consider the benefits of contracting for access and monitoring of the farmer's land so that they may follow the feedstock development more closely. Inadequate coordination on a new biomass crop where the farmer needs to make investments in know-how and machinery, for instance, can result in an inadequate production despite the farmer's best efforts.

In this case, if the biomass cannot be easily redeployed, its value will depend on the relationship between the biomass producers and biorefinery, placing the former in a disadvantageous position in relation to the biorefinery. The opportunistic behavior would be a consequence of the high physical asset specificity. The biorefinery may take advantage of its position and seek to renegotiate the terms of the contract. At the same time, the biorefinery is also in a position of dependence to a specific crop product, and the biorefinery attempts to address this issue in the contract. For instance, Aggregator Contract I suggests that parties should insert a provision that farmers agree to cooperate in keeping the Aggregator informed about the crop development, as well as give the Aggregator access to the property under certain circumstances that are rather subjective. During the performance of the contract, the parties will eventually conclude whether these provisions are sufficient or not to guarantee quality and a continuous relationship, which generates uncertainty and increases transaction costs and the potential for future conflict.

In terms of parties' preference about delivery provisions, the Biomass Exchange Contract establishes that the supplier of biomass is responsible for delivery, including costs of delivery, and Aggregator Contract I establishes that seller bears the risk of loss and responsibility for the insurance until the biomass is delivered. While the farmer is the one with the know-how and ability to supply the biomass to the buyer, the buyer of the feedstock usually has more control over delivery schedules, required quantities, and inspections to guarantee that the farmer is planting in accordance with the contract. The model contracts generally put the burden on the farmer to produce, collect, and store the biomass before delivery. The next question is, despite the contract provisions, what would the biorefinery do if the biomass is not delivered? Whether the biomass end-user will have other options will depend on the type of feedstock

[332] *See id.* (discussing how the storage method may affect the biomass feedstock).

available, location, quantities, etc. At the same time, if the buyer does not accept the biomass, the farmer will have to resell the feedstock. Farmer's options to resell the biomass will depend on circumstance and market conditions. Uncertainty, therefore, cannot be easily and sufficiently contracted around.

CONCLUSION

We provide a thorough and extensive empirical analysis of the contracting issues that inform the optimal organization of the biomass supply chain for the developing bioenergy industry. At the outset of a dynamic bioenergy industry, vertical integration is likely the best organizational model to account for uncertainty and transaction costs of contracting between farmers, or a cooperative, and bioenergy producers. Based on our analysis of model biomass contracts, and our empirical study of agricultural contract arbitration cases, we argue that the most common disputes in agricultural contracts will likely occur in biomass supply contracts. But because biomass contracts have unique characteristics and their transactions involve high levels of asset specificity, the failure to deliver and meet quality standards puts the nascent bioenergy industry at risk.

First, the active role played by the biomass purchaser in the model contracts results in expensive monitoring and enforcement costs, and whether such oversight will actually resolve uncertainties and guarantee quality and delivery of the biomass is not clear. Increased control over the farmer's crop, however, does not necessarily mean sharing the risk of loss. As we propose, vertical integration is a better organizational option than long-term contracts to resolve these issues once and for all, and provide the bioenergy industry with the incentives it needs to further develop.

Second, if the farmer is establishing a new biomass crop, the parties to a contract would need to add non-standard provisions to address the effect of high asset specificity since the farmer will be reluctant in making the first commitment to grow a specific quality crop for a particular buyer without greater assurance that no hold-up or breach of contract will occur. The threat of hold-up in the nascent bioenergy industry will depend of the characteristics of the particular transaction. When the farmer makes *ex ante* investments presenting high asset specificity to supply the needs for specific feedstock, the farmer is in a vulnerable position since the buyer knows that the next best value for farmer in the market will be lower. The model biomass contracts have specific quality, quantity, delivery and logistics concerns, especially allowing the buyer (i.e., the biorefinery) more control over the farmer's actions.

Third, while failing to deliver and meet quality specifications are generally a material term under the model contracts that would allow the buyer to cancel the entire contract, biomass end-users may have their hands tied because the feedstock is the basic material needed for their production. Whether buyers can afford to take the risk will depend on the uniqueness of the product, and the timing of product's use for the biorefinery. In agricultural contracts, our research shows that failure to deliver crops is the most common complaint against farmers. In typical agricultural contracts, most crops are not specific and may be purchased from a third party with fewer consequences than it would be in the case of biomass. Vertical integration would again eliminate the risk of non-delivery and guarantee constant and reliable supply for the industry. Even if *ex ante* investments were already made, reducing the initial costs for farmers, dependency and delivery risks still permeate the contracts, and until different types of biomass become commodities, vertical integration appears to be the best choice.

While contract arrangements are an important way to secure a reliable source of biomass supply, market failures such as the ones described in this Article may undermine the relationship between the farmer and the purchaser of biomass feedstocks, and put production and the development of the bioenergy industry at risk. Vertical integration, at least in this early stage of the industry, will eliminate this risk. As the bioenergy industry matures and risks and costs are better defined, the organizational structure may move towards more arms-length contracts. This means that as the bioenergy industry develops, asset specificity may decrease, initial costs and implementing costs may also decrease, and there will be a larger number of parties offering products and services to complement the biomass market.

In conclusion, when the biomass purchaser acquires control over the price, quantity, and quality of the product, the uncertainty present in the market is eliminated. In face of such uncertainty in a nascent industry, vertical integration appears to be the best solution to bilateral asset specificity concerns and to prevent contractual disputes.

APPENDICES

APPENDIX A: BIOMASS EXCHANGE CONTRACT

Model Contract I[i] has five pages with twenty basic terms: Deliveries; Prices; Payment; Warranties; Inspections and Improper Delivery; Hazardous Substance; Assignment; Alteration of Agreement; Delay and Termination; Independent Contractor; Non-waiver; Limitation of Liability; Changes; Severability; Indemnification; Dispute Resolution; Applicable Law; Survivability; Entire Agreement; and Counterparts. The Deliveries, and Inspections and Improper Delivery are the most detailed clauses in the contract.

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[i] MINNEAPOLIS BIOMASS EXCHANGE, BIOMASS SUPPLY AGREEMENT (2009), *available at* https://www.mbioex.com/contracts/MBioEX_Biomass_Supply_Agreement.pdf.

APPENDIX B: AGGREGATOR CONTRACT I

Model Contract II has nineteen pages and four exhibits. It is divided in three basic terms: Definitions; General Conditions; and Special Conditions. The Special Conditions clause is divided into: Nature and Source of Biomass, Quantity Offered for Sale, Specifications; Testing, Delivery Location, Time for Delivery, Compensation, Contingencies, Term, Commencement, Right to Reject Non-confirming Biomass Delivery, Representations Growing & Harvesting Practices, and Notices.

RECITALS

A. Purchaser desires to procure a consistent supply of biomass of reliable quantity, and quality for processing as **[Insert Purchaser's specific purpose such as pelletizing for fuel for heat or power generation, feedstock for bio-based products or advanced biofuels**] (the "Biomass").
. . .
C. Purchaser wishes to purchase Biomass from Producer and others for aggregation and processing for use or sale and Producer wishes to sell Biomass to Purchaser.
D. Purchaser and Producer are willing to enter into this Biomass Production Agreement on the terms and conditions set forth below, under which Producer will provide and Purchaser will pay for the Biomass and, if applicable, related services, as described on Exhibit A to this Agreement.
. . .

III: SPECIAL CONDITIONS

1. Nature and Source of Biomass. The Biomass delivered by Producer shall consist of the type(s) of renewable biomass raw materials from the specific source locations described on Exhibit A.
. . .
3. Specifications; Testing. The Biomass shall conform to the specifications established by Purchaser and listed on Exhibit A (the "Specifications"). The Biomass shall be tested for conformity to the Specifications as set forth on Exhibit A. All testing conducted by Purchaser at the Delivery Location shall be at the sole cost of Purchaser. If third party testing is required, it shall be conducted with the frequency and the cost allocated as set forth on Exhibit A. Producer shall have the option to collect duplicate samples of the material tested by Purchaser and have such samples tested, at Producer's expense.
. . .

10. Right to Reject Non-Conforming Biomass Delivery. If any delivery of Biomass or portion thereof (e.g., a container within a multi-container delivery) is "Non-Conforming" to Specifications, as set forth in Exhibit A, Purchaser shall have the right to reject the Non-Conforming Biomass delivery or Non-Conforming portion thereof.

. . .

Exhibit A

. . .

4. **Non-Conforming Biomass Delivery**. A Biomass delivery shall be considered "Non-Conforming" for purposes of this Agreement if any of the following circumstances apply: [**Insert degree of deviation from Specifications that trigger right to reject**].

. . .

Exhibit D

GENERAL CONDITIONS

1. Cooperation. Purchaser and Producer agree to cooperate fully with each other in the provision of the Services, including, without limitation, timely payment, timely access to the Delivery Location, and timely provision of requested information, including advance notice of material changes in circumstances that may frustrate performance of either Party's obligations under this Agreement.

2. Independent Contractor. Purchaser and Producer agree that Purchaser is engaging Producer as an independent contractor and Producer shall determine the means and the methods of delivering the Biomass and performing the related services. Producer shall not be considered the agent, servant or employee of Purchaser at any time or under any circumstances or for any purpose whatsoever.

. . .

7. Audit & Inspection. Purchaser, upon reasonable notice to Aggregator at any time during regular business hours, shall have the right to audit and inspect Aggregator's books and records with respect to the methods by which (a) the source material for the Biomass is obtained; and (b) the Biomass is sampled, analyzed, loaded and transported under this Agreement.

. . .

12. Dispute Resolution. Any dispute arising out of or relating to this Agreement, including but not limited to the making of it or the alleged breach of it, including claims of fraud in the inducement, and any alleged violation of any right created by statute, shall be discussed between the disputing Parties in a good faith effort to arrive at a mutual settlement of any such controversy. If, notwithstanding, such dispute cannot be resolved, the Producer and Purchaser agree that such dispute shall be settled by binding arbitration . . . Arbitration will be conducted pursuant to the provisions of this Agreement, and the commercial arbitration rules of the American Arbitration Association, unless such rules are inconsistent with the provisions of this Agreement. If one or both of the parties is a resident of a foreign jurisdiction, the parties may mutually agree in writing prior to arbitration commencement to have such arbitration conducted pursuant to the provisions of this Agreement and the commercial arbitration rules of the International Chamber of Commerce. Limited civil discovery shall be permitted for the production of documents and taking of depositions. Unresolved discovery disputes may be brought to the attention of the arbitrator who may dispose of such dispute. The arbitrator shall have the authority to award any remedy or relief that a court of this state could order or grant; provided, however, that punitive or exemplary damages shall not be awarded. The arbitrator may award to the prevailing Party, if any, as determined by the arbitrator, all of its costs and fees, including the arbitrator's fees, administrative fees, travel expenses, out-of-pocket expenses and reasonable attorneys' fees. . . .

. . .

14. Insurance. Producer agrees to keep in force at its own expense, during the entire period of the Services, the following insurance: [Insert as applicable]

a. Commercial General Liability Insurance:

b. Workers Compensation Insurance:

c. Other Insurance:

Producer agrees to indemnify and hold Purchaser harmless against any loss, damage or liability to third parties resulting from Producer's breach of its agreement to keep the required insurance in place.

APPENDIX C: AGGREGATOR CONTRACT II

Aggregator Contract II has seventeen pages and four exhibits. It is divided in three basic terms: Definitions; General Conditions; and Special Conditions. The Special Conditions clause is divided into: Process and Objectives, Nature and Source of Biomass, Quantity Offered for Sale, Specifications; Testing, Delivery Location, Time for Delivery, Compensation, Contingencies, Term, Commencement, Right to Reject Non-confirming Biomass Delivery, Representations Growing & Harvesting Practices, and Notices.

RECITALS
A. Purchaser desires to procure a consistent supply of processed biomass of reliable quantity, size, and quality [as fuel for heat or power generation] [as feedstock for bio-based products or advanced biofuels] [Alternatively, insert Purchaser's other specific purpose] (the "Biomass").
B. Aggregator is an aggregator and processor of such Biomass.
C. Purchaser wishes to purchase Biomass from Aggregator and Aggregator wishes to sell Biomass to Purchaser.
D. Purchaser and Aggregator are willing to enter into this Biomass Procurement Agreement on the terms and conditions set forth below, under which Aggregator will provide and Purchaser will pay for the Biomass and, if applicable, related services, as described on Exhibit A to this Agreement.
. . .
III: SPECIAL CONDITIONS
1. Process & Objectives
a. Process. Purchaser is procuring the Biomass for use in the following process [Insert description of Purchaser's industrial use, power generation or other biomass conversion process] ("Purchaser's Process"). Aggregator will use commercially reasonable efforts to supply the Biomass and, if applicable, provide the related services in a manner that supports Purchaser's Process.
b. Objectives. Aggregator and Purchaser have entered into this Agreement to accomplish the following objectives and further their respective interests: [Insert as Applicable]. The Parties acknowledge that the above described interests of Purchaser and Aggregator are material provisions of this Agreement.
2. Nature and Source of Biomass. The Biomass delivered by Aggregator shall be derived from one or more of the renewable biomass raw materials described on Exhibit A.
. . .

Exhibit A
Scope of Work/Specifications
1. Nature & Sources of Biomass: The Biomass will be derived from the following sources: [Specify types of biomass raw material that are permitted in Biomass and source location(s).]
2. Biomass Processing. Aggregator shall provide the following processing to the Biomass before delivery to Purchaser at the Delivery Location: [Insert description of pelletizing, densification etc.]
3. Delivery Location Testing Specification: Each Delivery of Biomass shall be tested for the following specifications at the Delivery Location in accordance with the protocols listed below:

a. Weight (in Pounds): Purchaser shall weigh each delivery of Biomass at the Delivery Location.
b. Moisture. Moisture content shall be measured as a percentage of the weight of the Biomass and shall not exceed __% by weight. Moisture content shall be measured by Purchaser at the Delivery Location by [Insert methodology.].
c. Free of Foreign Matter Contamination: Purchaser shall visually inspect each delivery of Biomass at the Delivery Location to confirm that it is free of non-trivial amounts of foreign material, including, but not limited to trash, soil, stones, plastics, dirt, metal and other inorganic content. Notwithstanding whether a delivery passes visual inspection, in no event shall any delivery exceed ___% of such content.
d. Biomass Particle Size12: ________________________________
e. BTU Content: The Biomass shall have an average BTU content of MMBTU/Ton, measured over [insert time period and weight of measured Biomass sampled.]. BTU content of the Biomass shall be measured by Purchaser as follows: [Insert where and how.]
f. Ash Content: The ash content of the Biomass shall not exceed % by weight.
g. Alkalinity Corrosion: [Insert applicable Specifications].
h. Other Criteria (Please Attach)

4. Specifications for Laboratory Testing. [Need to specify how often testing occurs, who does the testing and, if testing is performed by a third party, how the cost of testing is allocated.]
5. Non-Conforming Biomass Delivery. A Biomass delivery shall be considered "Non-Conforming" for purposes of this Agreement if any of the following circumstances apply: [Insert degree of deviation from Specifications that trigger right to reject].
. . .

Exhibit B
Compensation
Purchaser shall compensate Aggregator for the Biomass and any related services provided under this Agreement as follows:
1. Indexed Compensation for Biomass. Purchaser shall compensate Aggregator for Biomass based the indexes and formulas that are set forth on Exhibit B, Schedule 1, as adjusted by the items below.
2. Compensation for Additional Services. If not included in the cost of the Biomass under Section 1 above, Purchaser shall further compensate Aggregator for the services describe below as follows:.

> a. Transportation & Delivery Services16. List any additional charge for transportation and how it is determined (by distance from receiving point to point of Biomass origin, etc.).
> b. Storage Services. [List any additional charge.]
> Crop Establishment Assistance. ___Yes ___No. (If Purchaser is paying Aggregator amounts for crop establishment, attach Crop Establishment Assistance Schedule setting for amount and terms of assistance)

3. Environmental Attributes. Any carbon credits, greenhouse gas offsets, green tags, renewable energy credits, production tax credits for renewable energy, allowances for air emissions or any other environmental attributes associated with the Biomass and its use by Purchaser shall, and any credits, grants or incentive payments derived therefrom ("Environmental Attributes") shall, as between Purchaser and Aggregator

. . .

7. Take or Pay. Biomass deliveries ___will ___will not be made on a take or pay basis.
Exhibit D
GENERAL CONDITIONS
1. Cooperation. Purchaser and Aggregator agree to cooperate fully with each other in the provision of the Services, including, without limitation, timely payment, timely access to the Delivery Location, and timely provision of requested information, including advance notice of material changes in circumstances that may frustrate performance of either Party's obligations under this Agreement.
2. Independent Contractor. Purchaser and Aggregator agree that Purchaser is engaging Aggregator as an independent contractor and Aggregator shall determine the means and the methods of delivering the Biomass and performing the related services. Aggregator shall not be considered

the agent, servant or employee of Purchaser at any time or under any circumstances or for any purpose whatsoever.

. . .

12. Dispute Resolution. Any dispute arising out of or relating to this Agreement, including but not limited to the making of it or the alleged breach of it, including claims of fraud in the inducement, and any alleged violation of any right created by statute, shall be discussed between the disputing Parties in a good faith effort to arrive at a mutual settlement of any such controversy. If, notwithstanding, such dispute cannot be resolved, the Aggregator and Purchaser agree that such dispute shall be settled by binding arbitration. Judgment upon the award rendered by the arbitrator may be entered in any court having jurisdiction thereof. The arbitrator shall be a retired state or federal judge or an attorney who has practiced business litigation for at least 10 years. If the Parties cannot agree on an arbitrator within 20 days, each party shall designate an arbitrator and such selected persons shall choose a third arbitrator with the required qualifications who shall arbitrate the dispute. Arbitration will be conducted pursuant to the provisions of this Agreement, and the commercial arbitration rules of the American Arbitration Association, unless such rules are inconsistent with the provisions of this Agreement. If one or both of the parties is a resident of a foreign jurisdiction, the parties may mutually agree in writing prior to arbitration commencement to have such arbitration conducted pursuant to the provisions of this Agreement and the commercial arbitration rules of the International Chamber of Commerce. Limited civil discovery shall be permitted for the production of documents and taking of depositions. Unresolved discovery disputes may be brought to the attention of the arbitrator who may dispose of such dispute. The arbitrator shall have the authority to award any remedy or relief that a court of this state could order or grant; provided, however, that punitive or exemplary damages shall not be awarded. The arbitrator may award to the prevailing Party, if any, as determined by the arbitrator, all of its costs and fees, including the arbitrator's fees, administrative fees, travel expenses, out-of-pocket expenses and reasonable attorneys' fees. Unless otherwise agreed by the Parties, the place of any arbitration proceedings shall be______ County.

14. Insurance. Aggregator agrees to keep in force at its own expense, during the entire period of the Services, the following insurance: [Insert as applicable]

a. Commercial General Liability Insurance:
b. Workers Compensation Insurance:
c. Other Insurance:

Producer agrees to indemnify and hold Purchaser harmless against any loss, damage or liability to third parties resulting from Producer's beach of its agreement to keep the required insurance in place.

APPENDIX D: COOPERATIVE CONTRACT I

Cooperative Contract I has approximately eight pages where it includes ten basic terms: Purpose and Intent; Definition of Biomass Fuel; Quality of Biomass Fuel; Insurance; Plantation Site Plan; Crop Establishment Cost; Reimbursement of Crop Establishment Costs; Term of Agreement; Pricing of Biomass Fuel; and Quantity of Biomass Fuel. The Quantity of Biomass Fuel is one of the most complex clauses, and it includes four sub-terms: Basics of Determining Quantity Levels, Fuel Supply Agreement Biomass Fuel Quantity Levels, Biomass Fuel Quantity Levels from Individual Plantations and Plantation Crop Performance.

SECTION 1. PURPOSE AND INTENT

Cooperative has been formed by a number of agriculture and farming interests consisting of individuals and/or corporations ("Members"), to provide its Members with "Business Services" (as defined in the By-Laws and Prospectus of the Cooperative) to, among other services, market and provide Biomass Fuels to electric utilities. As part of the Business Services performed on the of behalf of its Members, Cooperative shall enter into a Energy Crop Biomass Fuel Supply Agreement ("Fuel Supply Agreement") with the ____and is contained in Appendix A of this Agreement.

. . .

SECTION 3. QUALITY OF BIOMASS FUEL

"Fuel Quality and Size Specifications" for the Biomass Fuels shall be in accordance with Section 7 of Fuel Supply Agreement. In the event that Land Owner/Grower is unable to comply with these Quality and Size specifications for Biomass Fuels, compensation to Land Owner/Grower for the Biomass Fuel shall be adjusted in accordance with Sections 9.5, 9.5.1, and 9.5.2 of the Fuel Supply Agreement.

Land Owner/Grower recognizes that the continued non-compliance of Fuel Quality and Size Requirements by the Land Owner/Grower, shall be a Material Event, and may result in Termination of the Fuel Supply Agreement (affecting all Cooperative Members), under conditions as described in Sections 7.3, 7.4, 7.5, and Section 18 of the Fuel Supply Agreement.

. . .

SECTION 6. CROP ESTABLISHMENT COST

At the completion of all necessary activities required to establish the Approved Site Plan, Land Owner/Grower shall submit a Report of crop

establishment costs, including adequate documentation (i.e., invoices, bills, bids for future work) for Cooperative's approval. The Approved Report shall provide the basis for ____ contribution to the establishment and maintenance cost of the plantation and will become part of this Agreement, and referenced as Appendix D.
The Approved Report for the following expenses ("Establishment Costs"), shall include all reasonable costs associated with actual and future expenses (until expected first harvest):

Establishment Planting Costs: This shall include incurred costs of Plantation Site Planning (i.e., Professional Forester), Land Preparation, Fire Control and Pest Management Systems, Irrigation Systems (if any), Seedling Costs, Seed Costs, Labor Costs, Tree Planting Costs, Feedstock Delivery Costs, Fertilizer, Compost or mulch, Weed Control Costs, Lab Testing (i.e., soil samples, testing on expected equivalent future biomass fuel feedstocks from Plantation, etc.), Site Permitting/Licensing, and Applicable Legal Costs.
Present Value Cost Land Use Costs: This shall include a documented current market value of the alternative use of the Plantation Site Land (i.e., livestock grazing), or actual Land Lease expenses to be incurred. This amount shall not exceed $_____ per acre year. The dollar amount allowed to be included in Appendix D shall be derived as follows:

1. The Total Acres Planted By Crop Species Type, *times*
2. Land Use Cost (i.e., market value, land lease cost) Per Acre Month, *times*
3. The Number Of Estimated Months Until First Harvest, *equals*
4. Gross Land Use Costs.

The Value of Gross Land Use Costs shall be reduced by a present value discount factor determined by the Cooperative (using current cost of money borrowing rates), to define the total Present Value Land Use Costs to be incurred for the Plantation Site during the time period of initial crop establishment to the expected first harvest.
Insurance Costs: This shall include the actual and forecasted costs of keeping in force "Energy Crop Insurance" (a described in Appendix B), during the time period of initial crop establishment to the expected first harvest.
Site Maintenance Costs: This shall include the forecasted costs of maintaining the Plantation Site during the time period after initial crop

establishment to the expected first harvest. Allowable Site Maintenance Costs may include, but not be limited to, mowing, fertilizer, irrigation costs, pest control, weed control, and forestry management.
Financing Costs: Shall include the sum of (1) Financing Costs incurred by the Cooperative as defined in Section 7 of this Agreement, and (2) the Land Owner's/Grower's financing costs (using a debt borrowing rate identical to that of Cooperative) in financing Establishment Costs.
. . .

APPENDIX E: COOPERATIVE CONTRACT II

Model Contract VI[ii] has approximately twenty-six pages, including five pages of Exhibits. It is divided in nineteen basic terms: Purpose and Intent; Definitions; Term; Representations; Quantity; Source and Delivery; Quality and Specifications; Weights, Sampling, Analysis; Price; Crop Establishment Cost; Invoices, Billing, Payment; Force Majeure; Audit and Inspection; Notices; Right to Resale; Indemnity; Dispute Resolutions; Termination for Default; and Construction of Agreement. The Exhibits provide for specifications on Biomass Fuel Quantity and Delivery; Plantation Establishment Costs; Letter of Credit; and Insurance. The most complex clause in the contract appears to be the Price clause, which is subdivided in: Avoided Cost Base Price; Economic Value Cost Sharing; Minimum Value of Economic Value Cost Sharing; Total Base Price; Quality Price Adjustments; and Government Regulations Affecting Price.

[ii] BIOMASS PROGRAM, CTR. FOR NATURAL RES., UNIV. OF FLA., ENERGY CROP BIOMASS FUEL SUPPLY AGREEMENT BETWEEN ENVIRONMENTAL FUELS COOPERATIVE AND CITY OF LAKELAND, FL, DEP. OF ELECTRIC AND WATER UTILITIES (1999), *available for download at* http://www.retscreen.net/fichier.php/1590/fuelcontract.doc.