THE "MOO"VE TO RENEWABLE ENERGY IN KENTUCKY BEGINS WITH THE DAIRY INDUSTRY

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INTRODUCTION

Kentucky is known for its champion thoroughbred racehorses, tobacco farms, and mountainous terrain.[1] However, the dairy industry has also carved out its place in the Commonwealth and is prominent and thriving throughout the state.[2] The dairy farmers who have made Kentucky their home have situated their farms not in the Appalachians, but in the rolling hills of south-central Kentucky.[3] In 2017, Kentucky was home to approximately 630 dairy farms and 58,000 dairy cattle, with each farm averaging a herd of about ninety-two dairy cattle.[4] Accordingly, by 2017, Kentucky was twenty-seventh in the nation for milk production and number of dairy cattle.[5] The dairy farmers of Kentucky produced a total of one billion pounds of milk last year and received about $172.5 million in cash receipts from the sale of their milk.[6] The dairy industry in Kentucky is thus quite prominent and produces significant amounts of wealth for both the national dairy industry and the Commonwealth.

The current narrative asserts the dairy industry is a large contributor to climate change due to its "man-induced" gas

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[1] *See* Rena Archwamety, *State of the Industry*, CHEESE MKT. NEWS, https://www.cheesemarketnews.com/articlearch/state/28aug09_02.html [https://perma.cc/348H-4TU3].

[2] *See id.*

[3] *See id.*; *see also 2017 Kentucky Dairy Facts*, SOUTHEAST DAIRY, http://southeast-dairy.org/wp-content/uploads/2017/05/Kentucky-State-Sheet.pdf [https://perma.cc/ALB7-72C8].

[4] *See* SOUTHEAST DAIRY, *supra* note 3.

[5] *Id.*

[6] *Id.*

emissions.[7] These emissions include anything from gases produced by cattle burping or flatulating, to lagoon functions and microbial activity on a pen's surface,[8] or carbon dioxide gases produced from milk production.[9] Regardless of your beliefs about the dairy industry's impact on climate change, it is irrelevant for the purpose of this Note because governmental regulations and political activism on the topic are here to stay.[10]

The worldwide dairy industry contributes approximately four percent to the total global greenhouse gas emissions, according to a recent study conducted by the Food and Agriculture Organization (FAO).[11] It logically follows that due to its active dairy industry, Kentucky emits a certain percentage of these greenhouse gases. Kentucky's dairy farmers also utilize a large amount of energy for their milking operations because of "the frequency of milking and the energy intensive nature of harvesting milk, keeping it cool, and cleaning the equipment."[12] Therefore, the copious amount of energy used by dairy farms, in conjunction with readily available resources located on or produced by the farms, Kentucky has an advantageous opportunity to incorporate renewable energy systems.[13]

This Note defends the thesis that a more efficient way to incorporate renewable energy in Kentucky is to use already established industry resources, specifically the dairy industry's resources. Furthermore, it will emphasize that the need to implement renewable energy in the dairy industry does not solely depend on the dairy farmers' or producers' desire to move toward cleaner energy. Rather, the implementation of renewable energy in Kentucky essentially depends upon the availability of financial assistance from governmental subsidies to alleviate part of the

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[7] *See* Stephen B. Blezinger, *Solid, Liquid, Gas…They All Matter*, PROGRESSIVE DAIRYMAN (Dec. 11, 2017), https://www.progressivedairy.com/topics/management/solid-liquid-gas-they-all-matter [https://perma.cc/EH9C-TBGH].

[8] *See id.*

[9] *See Greenhouse Gas Emissions and Energy Intensity in the Dairy Sector*, COOPERATIVE EXTENSION, https://fyi.uwex.edu/greencheese/greenhouse-gas-emissions-and-energy-intensity-in-the-dairy-sector [https://perma.cc/T239-TCJ9].

[10] Blezinger, *supra* note 7.

[11] COOPERATIVE EXTENSION, *supra* note 9.

[12] Brad Heins, *Greening of Ag: Renewable Energy Systems for Dairy Production*, WEST CENT. RES. AND OUTREACH CTR. (Nov. 2017), https://wcroc.cfans.umn.edu/research-programs/dairy/greening-ag-dairy-update [https://perma.cc/WB4T-ZWKB].

[13] *See id.*

start-up costs for local dairy farmers and producers, while also creating wealth for these innovative individuals.

The dairy industry has a variety of ways in which it can reduce its emissions of greenhouse gases, while also using renewable energy sources. First, dairy farmers and producers can begin using solar energy to power their milking operations, thereby reducing the dairy industry's carbon footprint on the environment. Moreover, available net metering policies will allow any excess solar energy to be sold. This would provide farmers with a source of income to not only help offset the start-up costs, but also reduce expenses spent on the farm's energy needs. Second, dairy farmers could install an anaerobic digester to capture the methane gases released from cow manure. Like energy collected by solar panels, the digester can supply the farm with the energy needed to run the farming operations, and any excess may be sold. Both systems of renewable energy will reduce the dairy industry's release of carbon dioxide and methane gases into the environment.

Part I of this Note will discuss the practicality of using solar energy in the dairy industry. Additionally, it will analyze how other states have implemented solar energy to power local dairy operations. Part II will discuss the installation of anaerobic digesters on dairy farms already in operation, and the use of the energy generated from said digesters. It will also analyze how other states have implemented digesters on their farms. Part III will analyze the cost of the investment for both solar energy and anaerobic digesters on smaller, family-owned dairy farms in comparison to larger, corporate ones. Part III will also analyze the incentives and financial assistance currently available for farmers to make the move toward renewable energy. It will discuss ways government programs or subsidies can incentivize farmers and producers within the dairy industry to use renewable energy. This motivation must be carefully balanced between the need of reducing greenhouse gases and emphasizing renewable energy with the need of the farmers' ability to prosper. Lastly, Part III will explain how implementing renewable energy in the dairy industry will allow dairy farmers to grow and flourish for years to come.

I. SOLAR ENERGY IN THE DAIRY INDUSTRY

A. The Use of Solar Energy in U.S. Agriculture

Dairy farmers worldwide need a more reliable, cost-effective energy source because of the inefficiency of on-grid energy and on-site generators. The agriculture industry in the United States has long been known as the industry that reaches the most remote corners of the globe. All farming operations have agricultural needs that require the use of electricity; yet, most of these operations face the disadvantage of being in a remote area where running utility lines to these locations prove to be impossible or too expensive to justify the need.[14] Instead of using the electrical grid, some farmers rely on generators powered by kerosene, diesel, or propane to power their farming operations.[15] The cost of purchasing and transporting fuel for these generators, along with the high maintenance required by them, have proven to be an inefficient form of energy.[16] Consequently, farmers are in need of a more reliable, cost-effective energy source,[17] and solar energy is a viable answer to the dairy industry's energy needs.

Solar power is a renewable energy source that gives farmers the opportunity to decrease pollution and the release of greenhouse gases, while also alleviating energy costs and reducing the need for an electric grid infrastructure.[18] Solar energy systems also typically have low maintenance costs.[19] Because of these low costs, solar energy has proven to be an effective way for farmers to produce on-farm renewable energy to satisfy their agricultural needs.[20] Unlike the typical grid infrastructure, solar energy

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[14] *See* Irene M. Xiarchos & Brian Vick, *Solar Energy Use in U.S. Agriculture Overview and Policy Issues*, U.S. DEP'T OF AGRIC. 1 (2011), https://www.usda.gov/oce/reports/energy/Web_SolarEnergy_combined.pdf [https://perma.cc/7MU5-B8UY]. Please note that the page numbers and numbers cited in this source reflect those used as of January 5, 2018 and in the archived perma.cc.

[15] *See id.*

[16] *Id.*

[17] *See id.*

[18] *Id.*

[19] *Id.*

[20] *See id.*

provides farmers with the energy they need, when and where they need it.[21]

i. Types of solar energy systems

There are two types of solar energy systems that can meet a farmer's energy needs: solar electric (PV systems) and solar thermal (solar heating).[22] Solar electric converts solar energy into electric power while solar thermal uses solar energy to heat water or air.[23]

Solar electric, or PV systems, are typically one of two systems: an on-grid or an off-grid system.[24] On-grid PV systems are connected to a local electrical grid.[25] Thus, when a farming operation's energy needs are satisfied and there is surplus energy, the surplus energy is fed back into the electrical grid.[26] Then, based on the net metering policies of the state, the excess energy can produce additional income for the farmer, which will be discussed in further detail in Part III.[27] However, when insufficient solar energy is produced by a PV system's panels, electricity is drawn from the connected, local electrical grid.[28] A PV on-grid electrical system does not need battery storage because it is connected directly to the grid.[29] Therefore, this system costs less than an off-grid system that requires battery storage.[30]

An off-grid system is an electrical system that is not connected to the grid.[31] In an off-grid system, a farm's energy needs rely solely on the solar energy generated from that farm's PV system.[32] Accordingly, a farmer's dairy operation is only powered when there is enough energy converted from the sun. This type of system often utilizes battery storage because it provides the

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[21] *Id.*
[22] *See id.* at 9.
[23] *Id.*
[24] *Id.* at 13.
[25] *Id.*
[26] *Id.*
[27] *See id.* at 13-14.
[28] *Id.* at 13.
[29] *Id.*
[30] *Id.*
[31] *Id.*
[32] *See id.* at 13-14.

farmer with the ability to store any excess converted energy.[33] Furthermore, this storage allows farmers to use the stored excess energy on a cloudy day when the sun's energy-producing rays are not as prominent.[34] In the past, solar energy in agriculture has been closely associated with off-grid PV systems.[35]

The best PV system for a farming operation depends on that farm's location and available net metering policies within the state.[36] For example, a farm that is located in a remote area and receives plenty of sunshine would utilize an off-grid PV system to power its operations.[37] However, a farmer in a non-remote area near a local electrical grid, with moderate amounts of sunshine and favorable state net metering policies, would opt for an on-grid PV system to power its operations.[38]

Generally, the entire state of Kentucky has good access to the sun's rays (4.5 to 5.5 $kWh/m^2/day$) on a daily basis, though the best solar radiation is concentrated in the southwestern United States (5.5 to 7.5 $kWh/m^2/day$).[39] Both PV systems, on-grid and off-grid, are therefore practical for dairy farms in Kentucky, and the use of one or the other depends on the various factors previously mentioned.[40] The use of PV systems in Kentucky's dairy industry is cost efficient for farmers in places where "utility-generated power is unavailable, impractical, or too costly."[41]

Solar heat systems are another type of solar energy that farmers can use to power their farming operations without leaving a carbon footprint on the environment.[42] Solar heating heats air or water and is either active or passive.[43] Active solar heating uses circulating pumps and moves air or liquid from the solar collector to the barn or hot water system.[44] Passive solar heating, however, does not use pumps or controls. Instead, it relies solely on the fresh

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[33] *Id.* at 13.
[34] *See id.*
[35] *Id.* at 13-14.
[36] *See id.* at 14.
[37] *See id.*
[38] *See id.*
[39] *Id.* at 6-7.
[40] *See id.* at 7, 14.
[41] *Id.* at 14.
[42] *See id.* at 1.
[43] *See id.* at 16.
[44] *Id.*

air or liquid to circulate naturally.[45] Therefore, solar heating can replace the need for commercial water heaters and space heaters in the dairy industry.[46] Because Kentucky generally has good access to the sun's rays on a daily basis, solar heat systems are a practical source of energy that can be used by the dairy industry as well.[47]

B. The Use of Solar Energy in the Dairy Industry

A reduction in carbon dioxide emissions and a dairy farm's operation costs can be achieved in one step—by implementing the use of solar energy for on-farm energy use.[48] The United States agriculture industry contributes around one percent of the country's total carbon dioxide emissions.[49] These emissions come from the use of diesel fuel, electricity, petroleum liquefied petroleum (LP), natural gas, and gasoline on farming operations.[50] An average of six percent of a farm's expenses are related directly to its energy needs.[51] Consequently, the implementation of renewable energy, with solar energy, has the potential to greatly reduce emissions of carbon dioxide into the environment and reduce the costs associated with operating a dairy farm.[52]

Dairy operations require a substantial amount of heated water to clean milking parlors, sterilize equipment, and process and sterilize milk for production.[53] Dairy operations also use a significant amount of energy to heat their buildings to prevent lines from freezing, and to keep their livestock comfortable during harsh winters.[54] The heating of water and cooling of milk accounts for up to forty percent of the energy used on any dairy farm or operation.[55] However, by using a solar thermal system to heat

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[45] *Id.*
[46] *See id.* at 16-17.
[47] *See id.* at 6-7, 17.
[48] *See id.* at 2.
[49] *Id.*
[50] *Id.*
[51] *Id.* at 3.
[52] *See id.* at 2-3.
[53] *See id.* at 17.
[54] *See id.* at 16.
[55] *See id.* at 23.

water and a solar air cooling system to cool milk,[56] a dairy farm's energy needs can be satisfied with solar energy.[57] The use of a solar thermal system also reduces the amount of energy expenses, which can be hundreds of dollars.[58]

Dairy farms use significant amounts of electricity or, in the absence of electricity due to the farm's remote location, fossil fuels to power their farming and milking operations. In addition to the water and heating demands mentioned above, a dairy farm's lighting, feed equipment, refrigeration, gate operations, and electric fences are all farm applications that can be powered by solar PV systems.[59] The use of one of these solar energy systems would reduce a farm's on-grid energy needs while also shrinking year-round electricity bills.[60]

i. The use of solar energy by the states

As of writing this Note, California leads the dairy industry in greenhouse gas mitigation.[61] In fact, twenty-four percent of the farming operations in California generate on-farm solar energy.[62] States that use solar energy systems for on-farm energy are widely concentrated in the western United States due to the higher amounts of solar radiation available on a daily basis.[63] The number of farms that use solar energy nationwide range from four farms in Delaware to 1,906 farms in California.[64]

The use of a solar energy system for on-farm energy can reduce a farm's energy costs by the hundreds.[65] According to a United States Department of Agriculture (USDA) report, the largest commercial solar thermal system in the northeastern United States is located on the roof of a family-owned dairy in

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[56] *Id.* at 16. It should be noted that the use of a solar air-cooling system was not discussed because it is a relatively new application and still under development.
[57] *Id.* at 22-23.
[58] *See id.* at 19.
[59] *See id.* at 21-22.
[60] *See id.* at 22.
[61] *See* Blezinger, *supra* note 7.
[62] Xiarchos & Vick, *supra* note 14, at 24.
[63] *Id.* at 6-7, 24.
[64] *Id.* at 24.
[65] *See id.* at 19.

Portland, Maine.[66] With this installation, the dairy was able to reduce its heating costs by $14,000 to $20,000 annually.[67] Along with these savings, the installation of a solar thermal system reduced the dairy's carbon dioxide emissions by eighty-eight metric tons per year—a decrease of approximately twenty percent.[68]

The production of on-farm solar energy has increased significantly within the past ten years,[69] while the cost of installation has steadily decreased since 2010.[70] The highest growth rates for on-farm solar energy production were found in states with the highest financial support for installation.[71] Thus, farmers are more inclined to install solar energy systems on their farms when adequate financial support is available to make these changes without bankrupting their business.

II. ANOTHER FORM OF ON-FARM RENEWABLE ENERGY: ANAEROBIC DIGESTERS

A. The "Digester" Industry in Agriculture

For years, the dairy industry has been criticized as a contributor to climate change because of the amount of greenhouse gases emitted by cattle and dairy production.[72] Because of such criticism, the dairy industry has reduced its greenhouse gas emissions per gallon of milk by sixty-three percent since 1963.[73] This reduction of greenhouse gas emissions has largely been accomplished by its adoption of alternative energy sources, including the establishment and growth of the "digester industry."[74]

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[66] *Id.* at 31; *see* Scott Hill, *Solar Farming Brings Benefits and Concerns to the Land*, CIV. EATS (March 20, 2017), https://civileats.com/2017/03/20/solar-farming-brings-benefits-and-concerns-to-the-land [https://perma.cc/5BKC-P4QP].

[67] Xiarchos & Vick, *supra* note 14, at 31.

[68] *Id.*

[69] *Id.* at 26.

[70] Hill, *supra* note 66; *see also Solar Industry Data*, SOLAR ENERGY INDUSTRIES ASS'N, https://www.seia.org/solar-industry-data [https://perma.cc/978H-S5DN].

[71] Xiarchos & Vick, *supra* note 14, at 26.

[72] *See* Blezinger, *supra* note 7.

[73] *Id.*

[74] *Id.*

The "digester industry" is the use of anaerobic digesters by farmers to create a renewable energy source in the form of biogas.[75] Specifically, anaerobic digestion is the process by which organic matter, e.g., animal waste, is broken down by bacteria without the use of oxygen.[76] The result of this breakdown is biogas.[77] The biogas generated by this process is made mostly of methane, a primary component of natural gas.[78] Anaerobic digester (AD) systems are used by the agriculture industry—specifically livestock operators and food producers—to reduce greenhouse gases, limit odor from manure storage, and capture the methane emissions from manure for energy use.[79] Furthermore, AD systems optimize the production of a renewable energy source, and by selling or using such energy, farmers have the ability to turn animal waste into "cost savings, profits, and environmental stewardship."[80]

B. Energy Use in the Dairy Industry from Manure

The agriculture industry is the primary source of methane discharge when livestock and manure emissions are combined.[81] When manure is stored or managed on dairy farms, it is typically kept in lagoons or holding tanks.[82] As a consequence of this manure management and storage, significant amounts of methane emissions are generated.[83]

Apart from its foul odor, manure is a part of the dairy industry that can be recycled for two purposes: fertilization and a

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[75] *Learn About Biogas Recovery*, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/agstar/learn-about-biogas-recovery#adwork [https://perma.cc/7BWH-B4B5].

[76] *Id.*

[77] *Id.*

[78] *Id.*

[79] *See Recovering Value from Waste*, U.S. ENVTL. PROT. AGENCY 1 (Dec. 2011), https://www.epa.gov/sites/production/files/2014-12/documents/recovering_value_from_waste.pdf [https://perma.cc/6TJ3-QCKB].

[80] *Id.*

[81] *Overview of Greenhouse Gases, Methane Emissions,* U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/ghgemissions/overview-greenhouse-gases [https://perma.cc/R7C6-8KYR].

[82] *See id.*

[83] *See id.*

renewable energy source.[84] Manure, a natural fertilizer, has been used by farmers to fertilize their fields and household gardens for years.[85] The conversion of manure into a renewable energy source,[86] however, is not as commonly known or utilized, despite farmers' historic use of anaerobic digesters to alleviate air pollution tracing back to the 1970s.[87]

Dairy farmers can use the biogas generated from anaerobic digesters as electricity to power their farming operations; as fuel to power their generators, furnaces, and boilers; or to fuel their vehicles.[88] Like solar energy, any excess electricity or biogas may be sold to local entities or energy utilities.[89] This is another example of how the dairy industry can move toward the use of renewable energy, while also staying true to the saying: "recycling is the heart of dairy farming."[90]

The use of an AD system by a dairy farm depends on the following factors: the type and scale of the livestock operation, how the manure is handled, and the frequency by which the manure is collected.[91] Traditionally, dairy farms with at least 500 cattle were considered an appropriate size to make the use of the anaerobic lagoon digester both technologically and economically viable (economic viability will be analyzed in Part III of this Note).[92] However, as technology advances, new AD systems have been designed to specifically fit smaller dairy operations.[93] The use of these systems has become more successful for smaller farms[94] due to the inclusion of co-digestion, which consists of manure digestion

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[84] *See* Laura Hardie, *Food Waste Gets Second Life as Renewable Energy on Dairy Farm*, COUNTRY FOLKS (March 25, 2016), http://countryfolks.com/food-waste-gets-second-life-as-renewable-energy-on-dairy-farm [https://perma.cc/3FRL-S292].

[85] *Id.*

[86] *Id.; see also Learn About Biogas Recovery*, *supra* note 75.

[87] *See* Nora Goldstein, *Historical Perspective: Farm Digesters*, BIOCYCLE (Feb. 2009), https://www.biocycle.net/2009/02/17/historical-perspective-farm-digesters [https://perma.cc/AKM2-3LP4].

[88] *Recovering Value from Waste*, *supra* note 79, at 2.

[89] *Id.* at 2.

[90] Hardie, *supra* note 84.

[91] *Recovering Value from Waste*, *supra* note 79, at 2.

[92] *Is Anaerobic Digestion Right for Your Farm?*, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/agstar/anaerobic-digestion-right-your-farm [https://perma.cc/67AB-ELEE]; *Recovering Value from Waste*, *supra* note 79, at 2.

[93] *Recovering Value from Waste*, *supra* note 79, at 2.

[94] *Id.*

with other feedstocks (e.g. fats, oils, grease, food wastes from restaurants, and crop residues).[95] Due to developments in technology, along with the available uses of biogas as a renewable energy source, the use of AD systems by the dairy industry serves as a practical energy alternative.

i. Types of anaerobic digesters for the dairy industry

If a farming operation determines that an AD system is economically and technologically feasible, it must select the AD system that best fits its farming needs.[96] There are three main types of anaerobic digesters that may be used by farming operations within the dairy industry: plug-flow digesters, covered lagoons, and complete-mix digesters.[97]

A plug-flow digester is an in-ground, heated, covered tank that collects dairy manure and generates biogas.[98] This system handles thicker manure (eleven to fourteen percent solids) and is well-suited for any climate because it is a heated system.[99] Plug-flow digesters work best with dairy manure, and farms that handle manure by scraping and have minimal bedding.[100] Any excess biogas generated by a plug-flow digester can also be used by the farm as a renewable energy source, and any digested solids can be separated and reused for bedding.[101]

A covered lagoon is the most basic type of anaerobic digester.[102] This digester is a man-made basin, that is either lined or earthen, and filled with liquid, dairy manure from the farm's flush management systems.[103] The lagoon is then covered with an impermeable gas-collecting cover.[104] This system handles thinner,

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[95] *Is Anaerobic Digestion Right for Your Farm?, supra* note 92; *see Increasing Anaerobic Digester Performance with Codigestion*, U.S. ENVTL. PROT. AGENCY 1-2 (Sept. 2012), https://www.epa.gov/sites/production/files/2014-12/documents/codigestion.pdf [http://perma.cc/LA8N-THU9].

[96] *See Recovering Value from Waste*, *supra* note 79, at 3.

[97] *Id.; see also Renewable Energy – biogas*, DFA ENERGY, http://www.dfaenergy.com/renewable-energy/biogas [https://perma.cc/WC4B-CAUK].

[98] *Renewable Energy – biogas*, *supra* note 97.

[99] *Id.*

[100] *See Recovering Value from Waste*, *supra* note 79, at 3.

[101] *Renewable Energy – biogas*, *supra* note 97.

[102] *Id.*

[103] *Id.*

[104] *Recovering Value from Waste*, *supra* note 79, at 3.

liquid manure (less than two percent solids) and generates greater biogas production in warmer climates.[105] In colder temperatures, these lagoons may not produce enough biogas to fuel a dairy farm's generator; however, it can still be flared (burned) to reduce not only the odor, but emissions of greenhouse gases as well.[106]

A complete-mix digester consists of an in-ground or above-ground insulated tank.[107] These tanks are covered with an impermeable gas-collecting cover and are best suited for manure that has three to ten percent solids.[108] In a complete-mix digester, the manure contents are blended by a motor-driven mixer and then heated in the tank.[109] Like a plug-flow digester, any excess biogas may be used by the farm as a renewable energy source, and any digested solids can be separated and reused for bedding.[110]

ii. The use of anaerobic digesters by the states

The size of dairy operations using anaerobic digesters vary greatly. Dairy farms that use AD systems range anywhere from forty-five dairy cattle on a farm in Vermont, to a farm in Oregon with 24,900 dairy cattle.[111] While California leads the dairy industry in on-farm solar energy, it does not lead the industry in its use of operational anaerobic digesters.[112] In fact, as of writing this Note, it is Wisconsin that leads the industry in this area, with thirty-six dairy farms using anaerobic digesters, followed closely by New York with thirty-two, and Pennsylvania with twenty-three.[113] California, on the other hand, has twenty operational anaerobic digesters in use.[114]

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[105] *See id.*; *Renewable Energy – biogas*, *supra* note 97.

[106] *Renewable Energy – biogas*, *supra* note 97.

[107] *Recovering Value from Waste*, *supra* note 79, at 3.

[108] *Id.*

[109] *See id.*; *Renewable Energy – biogas*, *supra* note 97.

[110] *Renewable Energy – biogas*, *supra* note 97.

[111] *See Livestock Anaerobic Digester Database*, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/agstar/livestock-anaerobic-digester-database [http://perma.cc/7QJB-K6A3]. Please note that the numbers cited in this source reflect those used as of January 5, 2018 and in the archived perma.cc.

[112] *Id.*

[113] *Id.*

[114] *Id.*

AD systems can provide plenty of value for dairy farms, while also reducing the farm's carbon footprint in the environment. Fair Oaks Farms, a dairy farm in Indiana, uses anaerobic digesters to convert its livestock manure into biogas, which is further refined into compressed natural gas (CNG) and used to fuel the farm's forty-two milk trucks.[115] By using anaerobic digesters, Fair Oaks Farms has reduced the amount of diesel fuel needed for its milk trucks by more than two million gallons per year, and has sold any surplus biogas to CNG fueling stations.[116] In addition, the biogas produced from the anaerobic digesters on the farm is also used to generate electricity for the farm's buildings and machinery.[117] Fair Oaks Farms converts manure produced by more than 36,000 cattle with two types of anaerobic digesters—a mixed plug flow and a vertical plug flow.[118] By using both AD systems, Fair Oaks Farms has reduced its methane emissions by the equivalent of 42,828 metric tons of carbon dioxide equivalent per year.[119]

AD systems can be implemented by both small and large dairy farms. For example, according to the Environmental Protection Agency (EPA), a dairy farm in Greensboro, Vermont uses a mixed plug-flow digester for its farm of forty-five dairy cattle.[120] This farm's anaerobic digester co-digests dairy processing wastes with the farm's manure and generates boiler and furnace fuel for the farm.[121] With the use of the AD system, this farm has reduced its methane emissions by 147 metric tons of carbon dioxide equivalent per year.[122] Thus, AD systems can be used by both small

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115 *Project Profile: Fair Oaks Farms*, U.S. ENVTL. PROT. AGENCY 1, https://www.epa.gov/sites/production/files/2017-09/documents/agstar-profile-fair-oaks-dairy-september2017.pdf [http://perma.cc/5TU9-ZPDQ]; *see also* Beth Kowitt, *Big Agriculture Gets its Sh*t Together*, FORTUNE (Jan. 20, 2016, 6:30 AM) fortune.com/fair-oaks-dairy-manure-fuel-farming [https://perma.cc/6MHK-2NDZ].

116 *Project Profile: Fair Oaks Farms*, *supra* note 115.

117 *Id.* at 2.

118 *Id.* at 3.

119 *Livestock Anaerobic Digester Database*, *supra* note 111.

120 *AgSTAR: Biogas Recovery in the Agriculture Sector*, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/agstar [https://perma.cc/UY73-ZKKC]. Please note that the numbers cited in this source reflect those used as of January 5, 2018 and in the archived perma.cc.; *see also Livestock Anaerobic Digester Database*, *supra* note 111.

121 *AgSTAR: Biogas Recovery in the Agriculture Sector*, *supra* note 120; *Livestock Anaerobic Digester Database*, *supra* note 111.

122 *Livestock Anaerobic Digester Database*, *supra* 111.

and large dairy farms to produce renewable energy, reduce fossil fuels, and reduce emissions of methane into the environment.[123]

As of writing this Note, none of Kentucky's dairy farms use manure anaerobic digesters.[124] In fact, the only anaerobic digester in Kentucky is on a poultry farm, where the anaerobic digester is used to meet the farm's electricity needs.[125] Yet, due to the size of their operations, dairy farms in Kentucky have the potential to enter into the market of manure anaerobic digesters.[126] In 2009, there were seven dairy farms in Kentucky with herds of 400 to 1,400 cattle;[127] and as of 2017, dairy farms in Kentucky have an average herd of about ninety-two cattle.[128] Subsequently, if a small farm in Vermont can use an anaerobic digester with a herd of forty-five cattle, then most of the dairy farms in Kentucky are capable of doing the same.

III. THE PRICE OF CLEAN ENERGY ON THE DAIRY INDUSTRY

A. Cost of Investing

The ability to invest in renewable energy is the first hurdle that dairy farmers must overcome in order to make the move toward cleaner, on-farm energy. Solar energy requires a large upfront investment, which can be a daunting barrier for those looking to invest in renewable energy sources.[129] Currently, solar energy systems cost about $7,500 per kw (kilowatt) to install, not including any tax deductions or other government incentives.[130] Consequently, a farmer must determine what their farm's daily electricity use is (kwh/day), in order to find out the cost of installing

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[123] *See id.*

[124] *Id.; see also* Subodh Das, *Anaerobic Digesters for Kentucky Dairies* 7 (Nov. 4, 2009), http://energy.ky.gov/BTF%20documents/Anaerobic%20Digesters%20for%20%20Kentucky%20Dairies%20November%204DW.pdf [https://perma.cc/HF4N-FJC3]; *AgSTAR: Biogas Recovery in the Agriculture Sector*, *supra* note 120.

[125] *AgSTAR: Biogas Recovery in the Agriculture Sector*, *supra* note 120; *Livestock Anaerobic Digester Database*, *supra* note 111.

[126] Das, *supra* note 124, at 4.

[127] *Id.*

[128] SOUTHEAST DAIRY, supra note 3.

[129] Xiarchos & Vick, *supra* note 14, at 40.

[130] *Renewable Energy – solar*, DFA ENERGY, http://www.dfaenergy.com/renewable-energy/solar [https://perma.cc/9BRV-QE7F].

a solar energy system. However, even after most variables have been accounted for, it is still extremely difficult to pinpoint exactly how much energy a farm uses, since electricity consumption can vary greatly.[131] A recent study, for example, found that two farms with forty to seventy cattle could use anywhere from 3 to 7.7 kwh of electricity per 100 kilograms of milk produced—demonstrating how electricity consumption on farms can vary significantly.[132]

For most farmers, the initial startup costs can be a major upfront investment. According to a USDA report, the family-owned dairy located in Maine[133] had to pay more than $215,000 in upfront costs to install their commercial thermal system.[134] However, this large dairy, which processes about 130,000 to 150,000 gallons of milk per day,[135] is much larger than the typical dairy processor or farmer in southcentral Kentucky. That is to say, a farmer in Kentucky looking to reduce its carbon footprint and electricity costs would have to pay an initial startup cost of $187,500 to install a 25kw system, not including any government assistance or incentives.[136] Unfortunately, this large upfront cost is likely too unnerving for your average, everyday farmer to look past and notice the financial assistance available from governmental programs and subsidies.

Similar to the implementation of solar energy for on-farm use, AD systems in the dairy industry come with a large initial and often overwhelming burden of debt for farmers and their businesses. The capital cost of an AD system is typically around $400 or more per cow.[137] Because of this, farmers must be in a situation where they can acquire financing necessary to install the

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[131] *Energy Use Within Dairy Farming*, DELAVAL 6, http://www.delavalcorporate.com/globalassets/sustainability/energy-report/delaval_energyreport.pdf [https://perma.cc/H7VG-LEK5].

[132] *Id.*

[133] *See supra* Part I, text accompanying notes 66-68.

[134] Xiarchos & Vick, *supra* note 14, at 31.

[135] J. Hemmerdinger, *The Bottom Line: Maine in a Bottle*, PORTLAND PRESS HERALD (Jan. 9, 2011), https://www.pressherald.com/2011/01/09/maine-in-a-bottle_2011-01-09 [https://perma.cc/J4EA-MP9J].

[136] *See Renewable Energy – solar*, *supra* note 130.

[137] *Profits From Manure Power?*, THE MINN. PROJECT 1, https://www.agmrc.org/media/cms/AD_economics_232C193A1CA1B.pdf [https://perma.cc/H9FE-HWW3].

system.[138] For example, Fair Oaks Farms[139] spent twelve million dollars on the installation of two AD systems.[140] Luckily, the farm used industrial revenue bonds with a loan payback period of fifteen to twenty years to finance ninety-nine percent of the initial capital cost.[141] Fair Oaks Farms' ability to do this illustrates how larger, corporate farms can implement these changes without needing to rely heavily on financial assistance from the government—unlike smaller, family-owned farms. However, on the other end of the spectrum, the small dairy farm located in Greensboro, Vermont[142] spent $750,000 to install an AD system to produce its own hot water.[143] Luckily, the farm had two-thirds of the project paid for by grants.[144] As one can see, the investment cost of implementing an AD system on a dairy farm is a large and intimidating burden that farmers must bear, and it is one that can significantly disincentivize farmers from exploring renewable energy options.

B. Financial Assistance and Incentives are the Key to Renewable Energy's Success

Farmers are genuinely interested in finding ways to reduce their emissions and cut costs, but without sufficient financial assistance from governmental programs and subsidies, farmers will remain reluctant to go green and remain wary of the words "renewable energy."[145] Without assistance, it simply does not make financial sense to implement these changes into an already existing, small business—even if that business relies heavily on the environment.[146]

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138 *Id.*

139 *See supra* Part II, text accompanying notes 115-119.

140 *Project Profile: Fair Oaks Farms*, *supra* note 115, at 4.

141 *Funding On-Farm Anaerobic Digestion*, U.S. ENVTL. PROT. AGENCY 3 (Sept. 2012), https://www.epa.gov/sites/production/files/2014-12/documents/funding_digestion.pdf [https://perma.cc/PK7K-K465].

142 *See supra* Part II, text accompanying notes 120-123.

143 Bethany M. Dunbar, *Jasper Hill Creates Green Machine to Make Energy from Farm and Creamery Waste,* COUNTRY FOLKS 1, http://countryfolks.com/wp-content/uploads/2012/11/Featured-Stories.pdf [https://perma.cc/X32Y-Z7MV].

144 *Id.*

145 Karen Uhlenhuth, *In the Midwest, Farmers Leading the Way on Solar Power*, MIDWEST ENERGY NEWS (Jan. 27, 2014), http://midwestenergynews.com/2014/01/27/in-the-midwest-farmers-leading-the-way-on-solar-power [https://perma.cc/6LS7-Z46Q].

146 *See id.*

It should come as no surprise that farmers with access to "an unusual and lucrative combination of federal, state, and utility incentives" are less reluctant to make the move toward renewable energy because their debt period is significantly shorter.[147] Individuals in the dairy industry are always looking for long-term investments that will reap benefits for years to come.[148] This makes solar energy a natural fit for dairy farms not only because of the suitability of the farm's barn roofs for panels, but also because of the farmers' investment mentality.[149]

While the initial cost of investing in renewable energy may appear to be a daunting or intimidating burden to bear, there is ample financial assistance available through governmental programs and subsidies. For example, both the dairy in Maine and the dairy farm in Vermont received significant amounts of financial assistance from government subsidies to offset initial start-up costs.[150] Thus, dairy farms should not be deterred from moving toward renewable energy because they may be able to receive significant amounts of financial assistance.[151]

i. Financial assistance for Kentucky's dairy industry

The move toward renewable energy in the dairy industry closely tracks the availability of financial assistance for the installation of these renewable energy sources.[152] On-farm solar energy production has significantly increased in the last ten years.[153] New Jersey and Georgia saw the highest growth rates for on-farm solar energy production, with both states also providing the highest-reported financial support for on-farm solar energy system installations.[154]

Kentucky provides some financial support to offset the costs of installing renewable energy sources. On average, Kentucky provides farmers with financial assistance that covers twenty to

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[147] *Id.*
[148] *See id.*
[149] *Id.*
[150] *See* Xiarchos & Vick, *supra* note 14, at 31; Dunbar, *supra* note 143.
[151] *See* Xiarchos & Vick, *supra* note 14, at 31.
[152] *See id.* at 26.
[153] *Id.*
[154] *Id.*

thirty percent of the cost to install solar energy systems.[155] On a federal level, programs like the USDA Rural Energy for America Program (REAP) provide up to twenty-five percent in grants and seventy-five percent in loan guarantees for rural renewable energy projects, such as solar energy and AD systems.[156]

Although these amounts are significant, they are slightly deceiving. REAP does provide a certain percentage of financial assistance to assist renewable energy projects, but this amount is limited depending on the amount of funding REAP receives for the year.[157] Furthermore, this amount is partially given in grants, but is mostly provided through loans.[158] Also, this amount is offered on a national scale, not state by state. Therefore, farmers who wish to implement renewable energy projects, like an AD system or solar energy system, must apply for REAP and hope they are selected from a national applicant pool.[159]

The loan availability provided by these governmental programs is a move in the right direction, but the loans create a disparity among farmers based on their operational size. For example, Fair Oaks Farms' ability to finance the implementation of two AD systems with industrial revenue bonds that had a loan payback period of fifteen to twenty years[160] is due to the farm's massive operation size. In other words, Fair Oaks Farms has the

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[155] *Id.*

[156] *Rural Energy for American Program Renewable Energy Systems & Energy Efficiency Improvement Loans & Grants*, U.S. DEPT. OF AGRIC. RURAL DEV., https://www.rd.usda.gov/programs-services/rural-energy-america-program-renewable-energy-systems-energy-efficiency [https://perma.cc/LRA3-9FBZ].

[157] *See USDA Provides Funding for More than 1,100 Renewable Energy and Energy Efficiency Projects Nationwide*, U.S. DEPT. OF AGRIC. (Oct. 26, 2015), https://www.usda.gov/media/press-releases/2015/10/26/usda-provides-funding-more-1100-renewable-energy-and-energy [https://perma.cc/79TQ-9XYP] ("Congress reauthorized [REAP] in the 2014 Farm Bill with guaranteed funding of at least $50 million annually for the duration of the five-year bill."); *USDA – Rural Energy for America Program (REAP) Energy Audit and Renewable Energy Development Assistance (EA/REDA) Program*, DESIRE (Aug. 21, 2018), http://programs.dsireusa.org/system/program/detail/5681 [https://perma.cc/NMW7-Q74K] ("Congress has allocated funding for the program in the following amounts: $55 million for FY 2009, $60 million for FY 2010, $70 million for FY 2011, and $70 million for FY 2012 . . . In addition to these mandatory funding levels, up to $25 million in discretionary funding may be issued each year.).

[158] *Rural Energy for American Program Renewable Energy Systems & Energy Efficiency Improvement Loans & Grants, supra* note 156.

[159] *Id.; see also USDA Provides Funding for More than 1,100 Renewable Energy and Energy Efficiency Projects Nationwide*, *supra* note 157.

[160] *Funding On-Farm Anaerobic Digestion*, *supra* note 141, at 3.

ability to "do things you can't do at a smaller operation."[161] Therefore, larger, corporate farms, or "big agriculture," have the ability to make the move toward renewable energy with the present financial incentives. But this also creates a disparity among farmers within the industry, giving "big agriculture" the ability to muscle out the smaller, family-owned farms who are unable to accrue such debt.[162]

The availability of federal subsidies is not the only way to promote renewable energy in the dairy industry. States play a crucial role in motivating individuals and businesses that contribute to climate change within their borders to make the move toward renewable energy. Although Kentucky provides significant financial assistance for solar energy system installations, this amount is still, at most, half of what thirty-five other states provide in financial assistance for farmers investing in on-farm solar energy.[163] Some may argue that Kentucky's location makes it unreasonable to provide significant amounts of aid because it receives less solar radiation than the states in the Southwest.[164] However, New Jersey and Georgia—both of which offer more than sixty percent in financial aid to support solar energy installation[165]—each receive a similar amount of solar radiation to Kentucky.[166] The move toward renewable energy in Kentucky is possible with the dairy industry, but the Commonwealth must also provide sufficient aid to those wishing to make the move.

While it may appear that this Note advocates for farmers in the dairy industry to receive large amounts of free money, that is not the case. Instead, this Note highlights the significant amount of financial assistance already available to some farmers. This Note also recognizes that a farmer's ability to implement these changes within their business not only depends on the availability of financial aid, but also on the farmer's assistance in the process. Furthermore, farmers must stop thinking that applying for governmental grants is a hopeless plan simply

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[161] Kowitt, *supra* note 115.
[162] *See id.*
[163] Xiarchos & Vick, *supra* note 14, at 26.
[164] *Id.* at 6-7.
[165] *Id.* at 26.
[166] *See id.* at 7.

because grant funding is limited, and that the move toward renewable energy is not economically feasible. Instead, farmers must continue to apply for these grants to convince the government that the dairy industry is a great place to incorporate renewable energy. Therefore, the Commonwealth and the federal government must simultaneously continue providing and increasing the availability of financial assistance to all sizes of operations in the dairy industry, not just "big agriculture." If the current narrative is that climate change is approaching and imminent, government must convince individuals in the dairy industry that the move toward renewable energy is not only an environmentally friendly and practical move, but that it also makes financial sense.

ii. The benefits and availability of performance-based incentives in Kentucky

Kentucky offers several performance-based incentives for solar PV systems[167] and mid-sized renewable energy generators, such as AD systems.[168] These performance-based incentives will generate additional wealth for farmers and incentivize others in the industry to make similar long-term investments in renewable energy systems. The Tennessee Valley Authority (TVA) currently provides those using renewable energy systems between 50 kilowatt and 20 megawatts with the option to enter into long-term price contracts.[169] The average price for these contracts in 2015 was between $0.029/kwh and $0.051/kwh, depending on the demand periods.[170] Furthermore, TVA currently compliments the already existing Green Power Providers Program, which provides a premium to small-scale renewable energy systems generating 50 kilowatts or less in exchange for electricity.[171] Also, the Solar Solutions Initiative (SSI), a pilot program, offers similar

[167] *TVA – Solar Solutions Initiative,* DSIRE (June 4, 2015), http://programs.dsireusa.org/system/program/detail/5614 [https://perma.cc/UP4R-FD53].

[168] *TVA – Mid-Sized Renewable Standard Offer Program,* DSIRE (June 18, 2015), http://programs.dsireusa.org/system/program/detail/4389 [https://perma.cc/JR4L-Y8U8].

[169] *Id.*

[170] *Id.*

[171] *See Green Power Providers*, TENN. VALLEY AUTHORITY, https://www.tva.com/Energy/Valley-Renewable-Energy/Green-Power-Providers [https://perma.cc/ZKM4-J4KN].

performance-based incentives to those using solar PV systems.[172] SSI offers a performance-based price of $0.04/kwh for the first ten years after a renewable energy system becomes operational.[173] Moreover, these incentives—SSI and TVA—may be combined.[174] These programs make it possible for those in the dairy industry—from small generators to mid-sized generators—to produce additional wealth for their businesses.

iii. The benefits and availability of net metering as an incentive

Net metering is another incentive states may offer to individuals implementing renewable energy sources, which in turn reduces their electricity consumption and generates additional wealth.[175] Net metering, essentially, occurs when a utility company buys any excess power produced from on-farm energy sources at a wholesale or retail price and allows farmers to offset their electricity consumption.[176] As of writing this Note, all but three states have some net metering policy.[177]

Kentucky enacted legislation in 2008 that expanded the current net metering law to require utilities to offer net metering to all customers who generate electricity with "[PV], wind, biomass, biogas, or hydroelectric systems up to 30 kilowatts (kW) in capacity."[178] The customer/generator is credited for any excess energy fed back to the utility.[179] The credit is then used on the customer's next bill or is carried forward indefinitely.[180] Therefore, farmers who wish to implement smaller, renewable energy systems into their businesses can also benefit from net metering.

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[172] *See TVA – Solar Solutions Initiative*, *supra* note 167.

[173] *Id.*

[174] *Id.*; *TVA – Mid-Sized Renewable Standard Offer Program*, *supra* note 168.

[175] *See* Kyle Clark, *Capturing Rays: Is Solar Energy Right for Your Dairy?*, PROGRESSIVE DAIRYMAN (Nov. 6, 2017), https://www.progressivedairy.com/topics/barns-equipment/capturing-rays-is-solar-energy-right-for-your-dairy [https://perma.cc/5SRN-CYCP].

[176] *See Id.* (explaining net metering arrangements for solar energy systems); *see Profits From Manure Power?*, *supra* note 137 (explaining net metering arrangements for ADs systems).

[177] Clark, *supra* note 175.

[178] *Net Metering*, DSIRE (Nov. 30, 2015), http://programs.dsireusa.org/system/program/detail/1081 [https://perma.cc/3K7A-2HB6].

[179] *Id.*

[180] *Id.*

However, Senate Bill 100 (SB 100)—an act signed into law on March 26, 2019—will make significant changes to the current net metering law beginning January 1, 2020.[181] First, SB 100 will increase the capacity size from 30 to 45 kilowatts.[182] Also, SB 100 gives Kentucky's Public Service Commission the authority to set the rates for the electricity being fed into the system, instead of the current one-to-one rate.[183] Lastly, under SB 100, those participating in the current net metering policy will be grandfathered in and will continue to receive the current one-to-one rate and see no change for 25 years.[184]

CONCLUSION

In conclusion, the dairy industry is a terrific place to incorporate renewable energy and lead the revolution for its use in pre-existing businesses. The dairy industry has multiple resources—such as manure and the sun's rays—that are readily available for use. The move toward renewable energy in a pre-existing industry like the dairy industry will help reduce its carbon footprint on the environment.

The use of solar energy systems in the dairy industry is practical in Kentucky because of the state's relatively good access to solar radiation on a daily basis. The implementation of solar energy systems on a dairy farm can drastically reduce a farm's

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[181] *19RS SB 100*, KENTUCKY GENERAL ASSEMBLY, https://apps.legislature.ky.gov/record/19RS/sb100.html [https://perma.cc/K86C-7KVG] (last visited Mar. 30, 2019). I have listed a few of the major changes in this section. However, for more information on SB 100 and how it will affect solar energy in Kentucky and the changes to the current net metering law, please see the Kentucky General Assembly's website.

[182] *Id.*

[183] *Id.*; Ryan Van Velzer, *Net Metering Bill Returns To Kentucky Legislature*, WKU (Feb. 12, 2019), https://www.wkyufm.org/post/net-metering-bill-returns-kentucky-legislature#stream/0 [https://perma.cc/5FXD-J85Z]; Tom Loftus, *Kentucky Bill Would Limit What Solar Customers Earn From Excess Energy*, COURIER-JOURNAL (Feb 12, 2019, 3:09 PM), https://www.courier-journal.com/story/news/politics/ky-legislature/2019/02/12/kentucky-bill-would-limit-what-future-solar-customers-get-credited-from-utilities/2847034002/ [https://perma.cc/YTL8-9EU4]; Matt Partymiller, *Our Lawmakers Can't Let Utility Companies Kill Solar Energy in Kentucky*, COURIER JOURNAL (Feb. 14, 2019, 11:43 AM), https://www.courier-journal.com/story/opinion/2019/02/14/solar-representative-says-bill-would-kill-renewable-energy-in-kentucky/2864440002/ [https://perma.cc/7RM8-DVVG].

[184] *19RS SB 100*, supra note 182; Velzer, *supra* note 184; Loftus, *supra* note 184; Partymiller, *supra* note 184.

electrical needs. A solar energy system could also reduce a dairy farm's production of greenhouse gases and use of fossil fuels. Similar to solar energy systems, the implementation of anaerobic digesters on dairy farms have the possibility of reducing methane gas emissions and turning a cow's waste into electricity or fuel.

Not only is it technologically viable to implement renewable energy sources in the dairy industry, but it can also be economically feasible for most in the industry. The federal government provides significant financial aid to those who choose to make long-term investments in renewable energy, but the present assistance creates a disparity among "big agriculture" and smaller, family-owned farms and businesses. Kentucky also provides some financial assistance, but as a whole this amount is significantly less than other states who provide financial assistance to farmers investing in renewable energy.[185] Therefore, these subsidies, both state and federal, need to provide enough financial assistance to help counterbalance the present disparity, which could help dairy farmers change their mentality about renewable energy as being economically or technologically unfeasible.

The move toward renewable energy is not only beneficial for the environment and the public, but it can also help farmers generate additional wealth. Kentucky provides multiple performance-based incentives to incentivize those in the industry to implement renewable energy systems in their businesses, and the current legislation allows for net metering. Both of these incentives help the local dairy farmer. However, these incentives create another challenge for the legislature because of the disparity it creates among different sized farms and businesses throughout Kentucky. Therefore, Kentucky's legislature and the federal government have a difficult role to play. They must balance the needs of smaller, family-owned farms with those of larger, corporate farms, as well as the needs of the public and the environment. This is clearly a critically important and challenging task. All in all, if the current narrative is that climate change is imminent, and the dairy industry is a contributor to it, the government, the Commonwealth, and the dairy industry must all work together to implement renewable energy systems because of the industry's readily available resources, economic benefits, and technological practicalities.

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[185] Xiarchos & Vick, *supra* note 14, at 26.