Rethinking the Appalachian Economy: How Modern Technology Can Transform Agriculture in Mountainous Regions

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INTRODUCTION

Often overlooked as an essential industrial region, Appalachia has been a pivotal provider of energy to the rest of the country for over a century.[1] The coalfields of northern to central Appalachia, comprised of Pennsylvania, Ohio, West Virginia, and Kentucky, are particularly critical to this supply.[2] Since 1970 alone, these storied coalfields contributed over two billion tons of coal to the rest of the nation, establishing themselves as key players in the nation's energy reserves.[3] Looking at just a single state's output, Kentucky itself produced 63 million tons of coal between 1911 and 1927, leading to significant advancements in infrastructure and policy reform across the state during the mid-1900s.[4]

Additionally, at its peak in 1923, the coal mining industry employed 860 thousand Americans, with a majority of those miners working in the coalfields of the eastern United States.[5]

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[1] Jedediah Britton-Purdy, *The Violent Remaking of Appalachia*, THE ATL. (Mar. 21, 2016), https://www.theatlantic.com/technology/archive/2016/03/the-violent-remaking-of-appalachia/474603/ [https://perma.cc/F95L-WCMX].

[2] U.S. DEP'T OF ENERGY, THE APPALACHIAN ENERGY AND PETROCHEMICAL RENAISSANCE iii (June 2020), https://www.energy.gov/sites/prod/files/2020/06/f76/Appalachian%20Energy%20and%20Petrochemical%20Report_063020_v3.pdf [https://perma.cc/GMM4-XPGW].

[3] Britton-Purdy, *supra* note 1.

[4] *See* KY. ENERGY AND ENV'T CABINET DEP'T FOR ENERGY DEV. AND INDEP., KENTUCKY COAL FACTS 11 (17th ed. 2017), https://eec.ky.gov/Energy/Coal%20Facts%20%20Annual%20Editions/Kentucky%20Coal%20Facts%20-%2017th%20Edition%20(2017).pdf [https://perma.cc/5TKL-K97D].

[5] Trevor Houser, et al., *Can Coal Make A Comeback?*, CTR. ON GLOB. ENERGY POL'Y 7 (Apr. 2017), https://energypolicy.columbia.edu/sites/default/files/Center_on_Global_Energy_Policy_Can_Coal_Make_Comeback_April_2017.pdf [https://perma.cc/2YUC-QW3M]; *see also* Charles D. Kolstad, *What Is Killing the US Coal Industry?*, STAN. INST. FOR ECON. POL'Y RSCH.

The economic success for mining companies was also impressive during the mining boom, with the four largest coal corporations possessing a combined market value of $34 billion in 2011.[6] However, this lucrative, long-term harnessing of energy by major companies has not yielded simultaneous prosperity for the majority of local residents in mining regions, and the disparate economic situations of those employed, formerly-employed, or in some way associated with coal mining, are worsening.[7] But, through modern technology, there are promising opportunities ready to be tapped into across Appalachia.

Illuminating the desolate economic reality facing many Appalachian communities, the same counties with the greatest coal production rates currently have "some of the region's highest unemployment rates," varying between 10 and 14 percent.[8] Additionally, the total number of Americans employed in the coal mining industry has dropped from historic highs to a mere 70 thousand.[9] Specifically in Kentucky and West Virginia, the number of coal miners has dropped to 16 thousand and 20 thousand, respectively.[10] In fact, since 2011, half of all coal industry job loss nationally has taken place in Kentucky and West Virginia.[11] But it is not just jobs that are on the decline—coal production itself is in a state of regression.[12] In a five-year span, from 2011 to 2016, coal production across the United States declined by 27 percent, accompanied and spurred by a 30 percent decrease in domestic demand for the resource.[13]

In direct association with the poor state of the coal industry, poverty rates in rural Appalachian communities are higher than those of rural communities in other parts of the country.[14] As of 2018, there was an at least six-percentage point gap in poverty rates in every age group between rural Appalachia

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(Mar. 2017), https://siepr.stanford.edu/research/publications/what-killing-us-coal-industry [https://perma.cc/8SHA-49SC].

[6] Britton-Purdy, *supra* note 1.

[7] *Id.*

[8] *Id.*

[9] Houser, *supra* note 5, at 44.

[10] Britton-Purdy, *supra* note 1.

[11] Houser, *supra* note 5, at 13.

[12] *Id.* at 12.

[13] *Id.*

[14] Population Reference Bureau, *New Report Explores Appalachia's Current Strengths and Vulnerabilities*, U.S. PROGRAMS (June 10, 2020), https://www.prb.org/appalachias-current-strengths-and-vulnerabilities/ [https://perma.cc/T23T-LV3V].

and rural parts of the rest of America.[15] Furthermore, poverty rates for young adults in Appalachia from 2014 to 2018 were as high as one-third.[16] These harsh realities are further bolstered by the fact that only 26 percent of those in the Appalachian working-age population possess a four-year college degree, which is 7 percent lower than the national average.[17] As a result, it is no surprise that nearly two-thirds of counties in Appalachia suffered a net loss of population from 2014 to 2018.[18]

The dismal fate of coal mining is clear, and Appalachian communities relying on it as a primary—or the only—source of economic sustainability face similarly grim prospects.[19] According to projections, even the best-case scenario for the coal industry is a plausible return to the already dramatically reduced 2013 levels, with production at a little under 1 billion tons per year.[20] On the other end of the theorized spectrum, the projected worst-case scenario is a continuation of the decline in production to 600 million tons per year.[21] This possible reality could lead to as few as 64,000 or less Americans being employed in the coal mining industry in 2025-2030.[22] However, even if the 2013 levels are reached again, such a recovery will not be sufficient to create long-term economic sustainability for Appalachian mining communities and the greater regions they are found in.[23] The bottom line is coal mining does present itself as a viable backbone for the future of the Appalachian economy.[24]

The Appalachian region is not without hope but is instead ripe with potential for innovation and growth in new and unexpected ways. With a total population of over 25 million people spanning a 205,000 square-mile area across all or portions of thirteen states, the opportunities available for integration into the Appalachian region are expansive.[25] The region already contains a readily accessible workforce, and areas of

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[15] *Id.*
[16] *Id.*
[17] *Id.*
[18] *Id.*
[19] Houser, *supra* note 5, at 44.
[20] *Id.*
[21] *Id.*
[22] *Id.*
[23] *Id.*
[24] U.S. DEPT. OF ENERGY, *supra* note 2, at 7.
[25] Population Reference Bureau, *Appalachia: Demographic and Socioeconomic Trends*, U.S. PROGRAMS, https://www.prb.org/program/appalachia-demographic-and-socioeconomic-trends/ [https://perma.cc/687K-Z9S5] (last viewed June 21, 2021).

improvement that could yield immediate positive advancements have already been identified. All that is needed is for governments and private businesses to take steps in bold new directions to achieve long-term progress.[26] One such endeavor has recently garnered attention is particularly promising for further integration into Appalachia and is centered around the sustainable agriculture industry.[27]

Focusing its current operations on groundbreaking projects in eastern Kentucky, AppHarvest is "[a]n indoor farming start-up," taking steps toward redesigning the eastern Kentucky economy.[28] The company's goal is to combine modern technology and agriculture to usher in a new form of farming that is environmentally friendly and, more significantly, is not limited by traditional agricultural resource requirements.[29] To do so, AppHarvest is constructing a sixty-acre, high-tech greenhouse in Morehead, Kentucky.[30] The facility will be one of the largest in the world once completed.[31] Through this facility, the start-up will be able to grow fruits and vegetables with 90 percent less water than is required to produce the exact same crop using traditional methods.[32] Additionally, CEO Jonathan Webb declared the greenhouse's eastern Kentucky location, closer to major metropolitan areas than the agricultural hubs of the southwestern United States, will lead to lower costs and emissions in the transporting of produce.[33]

The benefits of AppHarvest-style greenhouse farming continue beyond lower water consumption and reductions in transportation costs and emissions. Using its greenhouse technology, AppHarvest plans to produce crop yields thirty times

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[26] U.S. DEPT. OF ENERGY, *supra* note 2, at 43.

[27] *AppHarvest, a Pioneering Developer and Operator of Sustainable, Large-Scale Controlled Environment Indoor Farms, to Become a Public AgTech Company*, URB. AG NEWS (Oct. 7, 2020), https://urbanagnews.com/business/appharvest-going-public/ [https://perma.cc/K7VV-AXTG].

[28] Kevin Stankiewicz, *Indoor farming start-up with Martha Stewart on its board joins the SPAC craze to go public*, CNBC (Sept. 29, 2020), https://www.cnbc.com/2020/09/29/indoor-farming-start-up-appharvest-joins-the-spac-craze-to-go-public.html [https://perma.cc/W5RU-XZ4S].

[29] Debra Gibson, *America's New Produce Section*, THE LANE REP. (Oct. 8, 2020), https://www.lanereport.com/131696/2020/10/americas-new-produce-section/ [https://perma.cc/UAT6-KTB3].

[30] Stankiewicz, *supra* note 28.

[31] *Id.*

[32] *Id.*

[33] *Id.*

greater than those of "open-field agriculture," and do so without harmful runoff, pesticides, or even soil.[34] Such projected results are supported by studies performed in Spain, where greenhouse yields were 41 percent higher than those of open-field farming.[35] On the human side of benefits, through the development of its operations, the Morehead facility alone is projected to create 285 full-time jobs, which is in addition to another 100 jobs created solely for construction of the greenhouse.[36] AppHarvest also plans to further extend its footprint through the construction of more greenhouse facilities throughout central Appalachia, helping "meet America's growing food needs" and revitalize the Appalachian economy.[37]

AppHarvest is just one company, though, with a small footprint that has not yet come to complete fruition.[38] While CEO Jonathan Webb's vision for his company is promising for direct impact on the economies of Morehead, other cities housing AppHarvest facilities, and the surrounding area, largescale, Appalachia-wide improvements require more macro-level involvement from critical players.[39] Minor steps have been taken, but much more is needed.[40]

Exemplifying such positive developments, on June 24, 2020, Kentucky Governor Andy Beshear established his support for AppHarvest and entered into an "agritech" agreement with sixteen partner organizations, including the government of The Netherlands.[41] Under Governor Beshear's initiative, an "AgriTech Advisory Council" was also established for the Commonwealth, with a stated goal of guiding Kentucky's advancement into this new form of agriculture.[42] However, Governor Beshear's actions are relatively small, as more is needed to accomplish the

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[34] Gibson, *supra* note 29.

[35] Mercedes Romero-Gámez et al., *Environmental impact of green bean cultivation: Comparison of screen greenhouses vs. open field*, 7 J. OF FOOD, AGRIC. & ENV'T 754, 759 (2009), https://www.researchgate.net/profile/Em_Suarez-Rey/publication/237661623_Environmental_impact_of_greenbean_cultivation_Comparison_of_screen_greenhouses_vs_open_field/links/569501de08ae425c68980fac/Environmental-impact-of-greenbean-cultivation-Comparison-of-screen-greenhouses-vs-open-field.pdf [https://perma.cc/MVV4-MCGA].

[36] Gibson, *supra* note 29.

[37] *Id.*

[38] *Id.*

[39] *Id.*

[40] *Id.*

[41] *Id.*

[42] Gibson, *supra* note 29.

monumental task of truly reforming the Appalachian economy—and doing so through an agricultural revolution.

This Note aims to address the challenges facing Appalachia by advocating for the expansion and implementation of greenhouse agriculture throughout the region, providing guidance on feasible, effective ways to do so. Utilizing explanations of current efforts and available technologies surrounding greenhouse farming, as well as legal and political mechanisms accessible to incentivize development, this Note will provide a blueprint for governments and private partners to follow. Through the application of the topics discussed in this Note, key players will be able to transform Appalachia from a dying coal center of the past to a revitalized agricultural hub of the future.[43]

Part I will provide a comprehensive overview of the technology involved in this proposed initiative and the feasibility and methodology of its integration into the Appalachian landscape. In particular, this section will examine greenhouse farming in general, as well as the specific subsets of hydroponics, aquaponics, and aeroponics. Furthermore, the resources needed to develop such facilities—monetary, land, and workforce—will be examined in depth, as well as how these factors will be involved in the introduction of this technology throughout Appalachia. Lastly, this section will explore the benefits of greenhouse agriculture not just in general, but specifically in the context of the Appalachian region.

Part II will examine the prospective relationship between the coal industry and the new agricultural innovations encouraged by this Note. Specifically, an analysis of the economic and environmental impacts of the transition away from coal mining as the core of the economy, toward a focus on greenhouse agriculture is provided herein. Additionally, emphasis will be placed on how the environmental strain from coal mining, both past and present, could be alleviated by the integration of the measures promoted by this Note.

Part III will dissect policy decisions that could be made by governments—states and municipalities—and private parties to enable the development of greenhouse agriculture. Incentives promulgated by states and municipalities in other contexts will

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[43] Britton-Purdy, *supra* note 1.

be examined and this Note will advocate for their application throughout Appalachia to encourage greenhouse development. In particular, tax incentives and public-private partnerships will be discussed in detail as viable potential mechanisms that could be put in place.

Through the adoption of the measures advocated for in this Note, states and municipalities can reverse the continued decline of the Appalachian economy and revitalize it with a sustainable industry of the future. The adoption and integration of the technology and underlying mechanisms will not be rapidly attainable, but the steps advocated for in this Note will enable the process of transforming Appalachia to begin. The scientific, economic, environmental, legal, and political elements discussed will all present key challenges for the successful development and adoption of greenhouse technology, and this Note will explain how to overcome these difficulties.

I. THE TECHNOLOGY OF GREENHOUSE FARMING, THE METHODOLOGY OF ITS INTEGRATION, AND THE BENEFITS OF ITS USE

A. An Overview of Greenhouse Farming

For centuries, the ability to grow crops was limited to the use of exposed soil and the seasonal growing periods that accompanied it.[44] However, around the year 30 AD, a small agricultural innovation was created that would serve as the blueprint for a revolutionary new way to grow plants.[45] In response to a recommendation for Roman Emperor Tiberius to eat one cucumber a day—and the inherent need to have access to cucumbers year-round—, ancient Roman engineers created small structures with translucent roofs with the ability to house plants.[46] These structures allowed light to enter through the roof while simultaneously preventing heat from escaping; as a result, the Romans were able to maintain a supply of cucumbers year-

[44] Mark Crumpacker, *A Look Back at the Amazing History of Greenhouses*, MEDIUM (June 27, 2019), https://medium.com/@MarkCrumpacker/a-look-back-at-the-amazing-history-of-greenhouses-adf301162a7b [https://perma.cc/V5GB-KT87].

[45] *Id.*

[46] *Id.*

round.[47] In effect, the Romans created the first primitive greenhouse.

Following the initial development by the Romans, greenhouse technology has experienced tremendous advancements, particularly since the 16th Century, when Europe embraced the concept and rapidly evolved it.[48] Today, greenhouses are constructed of a wide variety of materials—from wood to metal to glass and more—and range in size from small structures fitting inside rooms to mammoth facilities covering hundreds of acres.[49] Most notably, however, is the breadth in methodology of what takes place inside of greenhouses to facilitate the growth of crops. Among the many forms, three key techniques merit detailed analysis: hydroponics, aquaponics, and aeroponics.[50] Importantly, these variations in greenhouse technology serve as the most viable options for integration into a strong, robust Appalachian agriculture revolution.

i. Hydroponics

Hydroponics is a growing technique where plants are grown in nutrient-rich water, as opposed to soil.[51] This innovation allows food to be grown in highly controlled environments and represents a viable step to overcoming global food shortages.[52] Housing plants in these various ways allows their roots to be exposed to water, allows crops to absorb carbon, hydrogen, and oxygen from the air while taking in other essential nutrients from the supplemented water.[53] One growing variation is through plastic trays that are periodically flooded, with plants started in one-to-two inch diameter growth blocks that are manually spaced

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[47] *Id.*

[48] *Id.*

[49] *Id.*

[50] Brand Genetics, *Hydroponics, aquaponics and vertical farming systems… What we've been reading this week at Brand Genetics* (Nov. 2, 2018), https://brandgenetics.com/hydroponics-aquaponics-and-vertical-farming-systems-what-weve-been-reading-this-week-at-brand-genetics/ [https://perma.cc/NH2T-JXEX].

[51] Valentina Lagomarsino, *Hydroponics: The power of water to grow food*, HARV. U. GRADUATE SCH. OF ARTS & SCI. (Sept. 26, 2019), http://sitn.hms.harvard.edu/flash/2019/hydroponics-the-power-of-water-to-grow-food/ [https://perma.cc/WHM5-VYTR].

[52] *Id.*

[53] *Id.*

as they grow.[54] Another variation is through the use of plastic-lined ground beds with nutrient solutions pumped in at one end and drained at the other.[55] A more complex integration of the technology is the nutrient film technique, where plastic channels made of film supply nutrients through plastic tubing drained into a below-ground reservoir, all running through plant roots exposed in the channels.[56]

These hydroponic methods require less space and fewer collateral resources to aid yields.[57] In fact, hydroponics is so efficient and low impact it was utilized in space in 2015, when NASA astronauts grew and consumed vegetables during their mission.[58] These high-productivity methods are not just useful for application in space but will help secure access to food on Earth.[59] Enabling growers to have efficient, year-round access to plants independent of external environmental conditions will create a food supply immune to the growing impact of climate change.[60] Furthermore, the Associated Press estimated hydroponic technology was worth $32 billion in 2019, with a projected growth rate of five percent per year through 2025.[61]

ii. Aquaponics

Like hydroponics, aquaponics is a form of agriculture relying upon the use of water, rather than soil, as the supplier of nutrients to plants.[62] However, the key distinguishing factor between the two technologies is the introduction of another living organism into the equation: fish.[63] Through aquaponics, plant roots are exposed to water supplies—where fish reside—along

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[54] U. OF MASS. AMHERST, *Hydroponic Systems*, CTR. FOR AGRIC., FOOD, & THE ENV'T, https://ag.umass.edu/greenhouse-floriculture/fact-sheets/hydroponic-systems [https://perma.cc/L3X5-2FZG] (last viewed June 21, 2021).

[55] *Id.*

[56] *Id.*

[57] Lagomarsino, *supra* note 51.

[58] *Id.*

[59] *Id.*

[60] *Id.*

[61] *Id.*

[62] Todd Sink, Ph.D. & Joseph Masabni, *What is Aquaponics?*, TEX. A&M AGRILIFE EXTENSION SERV. 1 (June 20, 2016), https://aggie-horticulture.tamu.edu/vegetable/files/2013/09/what_is_aquaponics.pdf [https://perma.cc/BY6T-K4YY].

[63] *Id.*

with the waste produced by the fish.[64] This waste is the critical ingredient in the science, as a byproduct rich in ammonia.[65] Once excreted, the ammonia is converted into nitrate through the nitrifying of bacteria, enabling plants to absorb the nitrate and the energy it provides.[66]

Furthermore, aquaponics offers an additional innovation over hydroponics. The system is self-sustaining.[67] In hydroponics, the use of inorganic fertilizers requires consistent flushing of the system to prevent the buildup of harmful substances that may harm the plants.[68] With aquaponics, such an issue is not a concern as the plants themselves act as a symbiotic filtration system with the bacteria produced by the fish.[69] As the plants absorb nitrogen and other minerals produced by the fish, they are actively filtering out the same substances posing the risk in hydroponics.[70] As a result, aquaponics is a circular method of efficient growth and sustainable operations.[71]

iii. Aeroponics

A third method of greenhouse agriculture meriting discussion removes operations from the ground and incorporates an aerial form of innovation: aeroponics.[72] Through this technology, plants are organized vertically rather than horizontally with the goal of maximizing crop output in limited spaces.[73] Whereas with traditional methods supplying horizontal farming nutrients from below the plant, aeroponics, often called vertical farming, supplies nutrients from above.[74] Nutrients are filtered down into plants through pumps or simple gravity-based

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[64] *Id.*
[65] *Id.*
[66] *Id.*
[67] Sink & Masabni, *supra* note 62.
[68] *Id.*
[69] *Id.*
[70] *Id.*
[71] *Id.*
[72] David Roberts, *This company wants to build a giant indoor farm next to every major city in the* world, VOX (Apr. 11, 2018), https://www.vox.com/energy-and-environment/2017/11/8/16611710/vertical-farms [https://perma.cc/5X5A-LNMK].
[73] Mark Crumpacker, *How to Choose Crops for a Vertical Farm*, MEDIUM (Mar. 19, 2020), https://medium.com/@MarkCrumpacker/how-to-choose-crops-for-a-vertical-farm-5f15ceeac69f. [https://perma.cc/582A-48SG].
[74] Roberts, *supra* note 72.

systems directly contacting plant roots.[75] The plants often receive no sunlight, but instead are surrounded by low-cost LED lamps.[76]

In 2018, the vertical farming industry was valued at $2.24 billion, with predictions indicating an increase to $13 billion by 2026.[77] Much of this expected growth is spurred by the ability to grow more crops in confined areas at faster speeds, leading to an overall, increase in productivity of growing operations.[78] As aeroponic technology removes many of the special limitations traditionally imposed upon growers, the method presents itself as a highly viable method of aiding the rapid advancement of modern agriculture in Appalachia.[79]

A. The Feasibility and Methodology of Integration of Greenhouse Facilities

i. Resources needed

Largescale, Appalachia-wide development of greenhouse facilities would necessitate access to and the utilization of a broad scope of resources.[80] Acting as a guide not only for how to successfully develop facilities, AppHarvest and its course of action provides insight and guiding principles for what is needed to enable the construction of such expansive operations.[81] From monetary to land to workforce resources required, an observation of AppHarvest, and other companies of similar nature, can outline what future public and private endeavors must accomplish to establish these agricultural factories of the future.[82]

Regarding the monetary side of resources needed, the funds involved are substantial. On just a single facility, AppHarvest spent $97 million in the construction and

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[75] *Id.*

[76] *Id.*

[77] Mark Crumpacker, *Spotlight on the Growing Indoor Farming Scene in the UK*, MEDIUM (Feb. 20, 2020), https://medium.com/@MarkCrumpacker/spotlight-on-the-growing-indoor-farming-scene-in-the-uk-7d1e2408bc07 [https://perma.cc/HD2J-M9FP].

[78] Crumpacker, *supra* note 73.

[79] Roberts, *supra* note 72.

[80] Keith Schneider, *A Greenhouse Large Enough to Feed the Eastern Seaboard*, N.Y. TIMES (Sept. 3, 2019), https://www.nytimes.com/2019/09/03/businesb/appharvest-greenhouse-kentucky-agriculture.html [http://perma.cc/F2KL-GZ9H].

[81] *Id.*

[82] *Id.*

development process.[83] Granted, this facility—the original Morehead, Kentucky location—is a sixty-acre behemoth of a greenhouse, but its scale and costs mirror the largescale integration of greenhouses this Note advocates for across Appalachia.[84] On a smaller scale, BrightFarms has constructed three greenhouses at $18.3 million each, all 280 thousand square feet in size—less than 10 percent the size of AppHarvest's Morehead facility.[85] Whether greenhouses built are a few acres in size or a few dozen, current precedent points to multi-million dollar commitments required for each.[86]

Access to land for development is another fundamental requirement for the construction of large greenhouses. However, it is not just the character of the land itself that matters, but the lands' location.[87] Large commercial greenhouses are capable of reducing the amount of travel time between harvesting and distribution through strategic locations near hubs of commerce.[88] This increased efficiency can eliminate the estimated 45 percent reduction in nutritional value that can occur during cross-country shipment of produce.[89] Therefore, while greenhouses require land large enough to house each respective facility, an even more pressing matter is ensuring the greenhouse is located in a practical, accessible area. Considerations must include distance to distribution centers, quality of road infrastructure in the surrounding communities, and ability of commercial trucks to commute in the vicinity.

Additionally, large endeavors like the greenhouses promoted in this Note require responsively sized workforces, with properly trained employees.[90] For instance, Plenty, a vertical farming company with locations across the United States, expects to employ hundreds of employees at each of its full-size facilities.[91] AppHarvest plans to maintain 285 employees at its

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[83] Schneider, *supra* note 80.

[84] Stankiewicz, *supra* note 28.

[85] Peter Tasgal, *The Economics of Local Vertical & Greenhouse Farming are Getting Competitive*, AG FUNDER NEWS (Apr. 3, 2019), https://agfundernews.com/the-economics-of-local-vertical-and-greenhouse-farming-are-getting-competitive.html [http://perma.cc/MPF2-FQFH].

[86] *Id.*

[87] Roberts, *supra* note 72.

[88] *Id.*

[89] *Id.*

[90] Roberts, *supra* note 72.

[91] *Id.*

flagship facility in Morehead.[92] Likewise, AeroFarms, another disruptive company in the greenhouse agriculture space, employs several hundred individuals throughout its operations.[93] However, these companies are reliant upon a smaller number of highly skilled employees.[94] Employees are needed with expertise in harvesting, planting, logistics, crop development, business operations, and other incidental components of technologically sophisticated greenhouse agriculture.[95]

ii. Availability of resources

Appalachia is an ideal, geographically ripe area for the implementation of sweeping developments in commercial greenhouse agriculture. With readily accessible land in areas seeking economic revitalization and a workforce capable of being put to work in this field of the future, Appalachia possesses the resources needed to make widespread development of greenhouse agriculture a success.[96] Furthermore, in areas where improvements are needed such as transportation and energy infrastructure advancements, the Appalachian landscape is poised to embrace the changes. [97]

Through the dramatic, devastating process of mountaintop removal coal mining, five hundred mountaintops throughout West Virginia, Kentucky, Virginia, and Tennessee were already leveled or severely impacted as of 2018.[98] This method of mining removes mountain peaks, leveling them into flat or partially flattened landscapes, allowing for easier access and subsequent transportation of coal.[99] However, while the effects of this practice are detrimental to the environment, its longstanding mark on the landscape—a largely flat area representing a

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[92] Gibson, *supra* note 29.

[93] Ian Frazier, *The Vertical Farm*, THE NEW YORKER (Jan. 2, 2017), https://www.newyorker.com/magazine/2017/01/09/the-vertical-farm [https://perma.cc/JY6S-BD6G].

[94] Roberts, *supra* note 72.

[95] *Id.*

[96] U.S. DEP'T OF ENERGY, *supra* note 2, at 44.

[97] *Id.* at 43.

[98] *The Coal Mine Next Door*, HUM. RTS. WATCH (Dec. 10, 2018), https://www.hrw.org/report/2018/12/10/coal-mine-next-door/how-us-governments-deregulation-mountaintop-removal-threatens# [https://perma.cc/D7CW-37RF].

[99] *Basic Information about Surface Coal Mining in Appalachia*, UNITED STATES ENV'T PROT. AGENCY [https://perma.cc/6AAZ-YN52] (last viewed Jan. 12, 2021).

formerly unusable environment—could be repurposed to the benefit of Appalachia.[100]

As exemplified by the operations of existing commercial greenhouse companies, large areas of land, acres in size, are required to house facilities.[101] Consequently, the process of mountain top removal has resulted in large areas of land suitable for development into commercial greenhouses.[102] In 2012, the U.S. Environmental Protection Agency ("EPA") estimated that mountaintop removal mining impacted 1.4 million acres of forests across Appalachia.[103] If one thousand greenhouses were to be developed across Appalachia upon former mountaintop removal sites at the size of AppHarvest's Morehead site (sixty acres), that would be 60 thousand acres in facility square footage alone.[104] Furthermore, additional acreage would be utilized for parking and roadways, further transforming a former area of destruction into a center for the prosperity of the surrounding areas.

B. Collateral Benefits of Greenhouse Farming

i. New peripheral developments

The development of greenhouse agriculture facilities across Appalachia will not just yield direct results through the indoor farms themselves—indirect advancements in the surrounding areas will also occur.[105] By building upon the existing workforce in impacted Appalachian communities and attracting new workers for relocation, the greenhouse development scheme advocated for by this Note echoes successful growth strategies adopted in many rural towns.[106] Numerous

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[100] HUM. RTS. WATCH, *supra* note 98.

[101] Stankiewicz, *supra* note 28.

[102] HUM. RTS. WATCH, *supra* note 98.

[103] *Ecological Impacts of Mountaintop Removal*, APPALACHIAN VOICES, https://appvoices.org/end-mountaintop-removal/ecology/ [https://perma.cc/Q9MM-5629] (last viewed Jan. 12, 2021).

[104] Stankiewicz, *supra* note 28.

[105] *See Framework for Creating a Smart Growth Economic Development Strategy: A Tool for Small Cities and Towns*, U.S. ENV'T PROT. AGENCY 8 (Jan. 2016), https://www.epa.gov/sites/production/files/2016-01/documents/small_town_econ_dev_tool_010516.pdf [https://perma.cc/FN9V-DFR5].

[106] *See* U.S. ENV'T PROT. AGENCY, HOW SMALL TOWNS AND CITIES CAN USE LOCAL ASSETS TO REBUILD THEIR ECONOMIES: LESSONS FROM SUCCESSFUL PLACES, EPA 231-R-15-002 (May 2015),

small towns across the country—specifically, Appalachia—have experienced bursts of economic growth by capitalizing on catalysts, like commercial developments, and supporting collaborative growth that followed.[107]

In small towns, a single development can serve as a dramatic catalyst for economic growth.[108] For example, the construction of a gas diffusion plant near Paducah, Kentucky in 1952 led to an estimated 30 thousand people moving to the city.[109] Following the initial catalyst of the plant's development, the community experienced further growth leading to suburbanization in the following decades.[110] In the 1980s, the opening of a shopping mall marked a high point in the area's economic growth.[111]

Many other towns across the country share similar stories with Paducah.[112] In Dubuque, Iowa, a ninety-acre riverfront development project spurred restaurants, a casino, an aquarium, and other indirectly connected attractions opening.[113] Similarly, each Appalachian town introducing a commercial greenhouse will also see growth in its secondary and tertiary sectors.

ii. Infrastructure improvements

The process of constructing and operating large-scale, commercial greenhouses will spur additional collateral benefits: the improvement of area infrastructure.[114] These developments will aid Appalachian greenhouse facilities in their efficacy and enhance the quality of life for individuals living in impacted communities.[115] As infrastructure improvements unfold, the region experiencing the advancements would encounter increases

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https://www.epa.gov/sites/production/files/201505/documents/competitive_advantage_051215_508_final.pdf [https://perma.cc/L7Q8-LWK4].

[107] *See* Will Lambe, *Small Towns, Big Ideas: Case Studies in Small Town Community Economic Development*, UNIV. OF N.C. SCH. OF GOV'T 5 (Dec. 2008), https://community-wealth.org/sites/clone.community-wealth.org/files/downloads/report-lambe.pdf [https://perma.cc/3BX4-5GDF].

[108] *See id.*

[109] U.S. ENV'T PROT. AGENCY, *supra* note 106, at 27.

[110] *Id.*

[111] *Id.*

[112] *Id.* (examples of which are Roanoke, Virginia and Douglas, Georgia).

[113] *Id.* at 16–17.

[114] *See* U.S. DEP'T OF ENERGY, *supra* note 2, at 43.

[115] *See* U.S. ENV'T PROT. AGENCY, *supra* note 105, at 3.

in their capacities to support further growth.[116] The long-term result would be a process of self-supporting continued advancement through infrastructure improvement supporting business growth and fostering additional infrastructure improvement. For example, Campton, Kentucky completed the construction of a $7 million water-treatment facility in 2010; the city not only improved water quality for its residents, but also increased its capacity for commercial development along an Appalachian Development Highway System ("ADHS") corridor.[117]

Developments following greenhouse construction do not have to be limited to items like roads and utilities but can also extend into avenues such as tourism infrastructure.[118] Many towns in Appalachia are similarly situated to Big Stone Gap, Virginia. The landscape is defined by rolling hills and numerous natural attractions are located nearby, yet the surrounding area still suffers from poor economic conditions.[119] However, a key distinction is Big Stone Gap is actively working to improve its economic situation by embracing the opportunities afforded by its area natural attractions.[120] Through educational and developmental campaigns led by government entities, businesses, and private individuals, Big Stone Gap continues to develop ecotourism infrastructure directly impacting economic statuses of the area.[121] In the same way, the rise in population and interest in Appalachian towns home to greenhouse facilities can be harnessed to improve not just tangible infrastructure, but tourism infrastructure embracing the Appalachian landscape.

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[116] *Investing in Appalachia's Future*, APPALACHIAN REG'L COMM'N 17 (Nov. 2015), https://www.tn.gov/content/dam/tn/ecd/documents/arc/InvestinginAppalachia20162020StrategicPlan.pdf [https://perma.cc/4WTU-7CQJ].

[117] *Id.*

[118] Lambe, *supra* note 107, at 25.

[119] *Id.*

[120] *Id.* at 26.

[121] *Id.* at 27.

II. ECONOMIC AND ENVIRONMENTAL IMPACT OF GREENHOUSE FARMING

A. Economic Impact

By implementing greenhouse farming in Appalachia, the region can reap an array of economic benefits including: job creation, regional transportation improvements, and locally sourced grocery stores.[122] While many of these benefits are difficult to precisely quantify due to the novelty of the industry, and thus the lack of empirical data, comparable results can be gleamed from the integration of similar, "innovation-intensive" developments into communities.[123] Recent studies show net employment growth in rural communities labeled as innovative-intensive grew as much as 8.4 percent from 2010 to 2014.[124] In fact, rural communities characterized by the presence of innovative industries, comprising 25.2 percent of areas studied, added 100 more jobs, on average, between 2010 to 2014 than communities in other rural areas characterized by non-innovative industries (making up 37.2 percent).[125] Such an increase in employment numbers for areas the size of these rural communities would yield significant positive change on the economic nature of the towns.

The employment growth that an innovative industry like commercial greenhouses invites would starkly contrasts the decline in employment defining the Appalachian region for years.[126] As opposed to the current situation where the region relies on the regressing coal industry to serve as the backbone of its economy, the integration of commercial greenhouse technology would implement an industry solving a growing need and, thus,

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[122] *Effects of rural industrialization on rural development in Iowa*, IOWA STATE UNIV. 17–18 (1974), https://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=6112&context=rtd [https://perma.cc/GFL7-6JR7] [hereinafter "IOWA STATE UNIV."].

[123] Tom Wojan & Timothy Parker, *Innovation in the Rural Nonfarm Economy: Its Effect on Job and Earnings Growth, 2010-2014*, U.S. DEP'T OF AGRIC. (Sept. 2017), https://www.ers.usda.gov/webdocs/publications/85191/err-238_summary.pdf?v=3000.6. [https://perma.cc/4QF4-CUJS].

[124] *Id.*

[125] *Id.*

[126] Houser, *supra* note 5, at 13.

possesses a maintained demand for work.[127] Where coal production dropped 27 percent from 2011 to 2016, the demand—and need—for an increased food supply, and supporting jobs, continues to grow.[128] This redirection of Appalachia's economic trajectory would dramatically alter the region, where employment rates currently vary between ten and fourteen percent.[129]

The employment of Appalachian workers in greenhouses in towns where they are located would impact the host cities and surrounding areas through an economic phenomenon known as "leakage."[130] This term defines the scenario where commuting or otherwise non-resident workers are paid to work at a major employer in one town but then take such income and spend it in their own hometown.[131] The effect of this leakage of funds from one community to another is the dissemination of wealth over a broader area.[132] Often viewed as a negative event in the context of an individual-town analysis due to the detrimental impact it has on single-location economic benefits, leakage would actually be an immensely positive occurrence for the landscapes of places like eastern Kentucky and West Virginia.[133]

Dispersing the economic benefits of a commercial greenhouse over areas adjacent to host towns will allow significantly larger portions of Appalachia to experience the positive effects advocated for in this Note. For instance, if Corbin, Kentucky were to become home to a greenhouse, hundreds of employees would be needed, both for construction and on a permanent basis. However, Corbin itself would likely not supply all the workers.[134] Reflective of many Appalachian communities, Corbin is a small town on its own, but it is surrounded by eight other towns with populations of over one thousand people within

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[127] *Id.* at 12.

[128] *Id.*; Dan Charles, *Food Is Growing More Plentiful, So Why Do People Keep Warning Of Shortages?*, NPR (Aug. 4, 2020), https://www.npr.org/2020/08/04/897804434/food-is-growing-more-plentiful-so-why-do-people-keep-warning-of-shortages [https://perma.cc/ZX5A-RTRK].

[129] Britton-Purdy, *supra* note 1.

[130] IOWA STATE UNIV., *supra* note 122, at 21–22.

[131] *Id.* at 22.

[132] *Id.*

[133] *Id.* at 21.

[134] Gibson, *supra* note 29.

a sixteen-mile radius.[135] Given the great likelihood that a greenhouse in Corbin would derive part of its employment base from these surrounding towns, leakage of income would occur in those cities.[136] As a result, not just Corbin would benefit, but the peripheral areas as well.[137] Likewise, the rest of Appalachia would experience similar successes across host towns and their neighboring cities.

On a more individualized basis, greenhouse agriculture jobs would provide entry-level employees with employee benefits unavailable to many across Appalachia.[138] Largescale, commercial greenhouses would provide workers with healthcare, living wages, and other benefits unique to each company, raising the quality of life for those involved and their families.[139] Furthermore, many of the jobs greenhouses would necessitate require no more than a high school diploma, opening access to employment to a broad portion of people in the region.[140] Collectively, the broad and individualized economic benefits presented by commercial greenhouses would transform the socioeconomic landscape of Appalachia.

B. Environmental Impact

In conjunction with the broad economic impact greenhouse agriculture would bring to Appalachia, adoption of this technology would also simultaneously both protect and actively heal the environment.[141] Commercial greenhouses utilize 90 percent less water than traditional agricultural methods, and their placement in Appalachia would dramatically lower emissions involved in the transportation of produce.[142] Additionally, due to the lack or minimal usage of soil, little to no

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[135] *Towns near Corbin (Kentucky) United States,* DISTANTIAS https://www.distantias.com/towns-radius-corbin-kentucky-united_states.htm [https://perma.cc/67ES-4HVL] (last viewed Feb. 17, 2021).

[136] IOWA STATE UNIV., *supra* note 122, at 22.

[137] *Id.*

[138] Christopher Marquis, *AppHarvest's Mega-Indoor Farm Offers Economic Alternative To Coal Mining For Appalachia*, FORBES (Dec. 15, 2020), https://www.forbes.com/sites/christophermarquis/2020/12/15/appharvests-mega-indoor-farm-offers-economic-alternative-to-coal-mining-for-appalachia/?sh=6dabd54d48e8 [https://perma.cc/26M6-RH2W].

[139] *Id.*

[140] *Id.*; *see also* U.S. PROGRAMS, *supra* note 14.

[141] Lagomarsino, *supra* note 51.

[142] Stankiewicz, *supra* note 28.

pesticides are required for the operation of greenhouse facilities, eliminating the detrimental impacts their runoff causes.[143] Thus, by taking advantage of the available land left behind by mountaintop removal mining, greenhouses in Appalachia could convert some of the 1.4 million impacted acres into land uses aiding in the environmental recovery of those areas.[144] These combined characteristics of greenhouse agriculture, working to preserve and heal the environment, starkly contrast the negative historical effects of coal mining on the same plots of land.[145]

Like other companies paving the way for commercial greenhouse utilization, AppHarvest's operations illuminate the positive environmental capabilities of this technology.[146] At their flagship facility in Morehead, Kentucky, AppHarvest is able to not only use significantly less water than traditional farming, but the water it does use is supplied completely by recycled rainwater.[147] As a result, the facility has no need for water from the City of Morehead's utilities, and there is no wastewater contributed into the sewer system.[148] The implementation of this conservation technique into the greenhouses proposed by this Note, and the gradual transition of all farming into greenhouse technology, would dramatically reduce the quantity of water conserved. Currently, the agricultural industry accounts for an astonishing 90 percent of water used annually in the United States; if water-minimal greenhouses became the new standard in agriculture, along with their ninety percent decrease in water usage, the environmental impact would be immense.[149]

The geographic location of Appalachia provides another critical environmental benefit of constructing commercial

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[143] Lagomarsino, *supra* note 51.

[144] *Ecological Impacts*, *supra* note 103.

[145] *See* Martha Keating, *Cradle to Grave: The Environmental Impacts from Coal*, CLEAN AIR TASK FORCE 2 (June 2001), https://www.catf.us/wpcontent/uploads/2019/10/Cradle_to_Grave-300.pdf [https://perma.cc/B5F9-7DRV].

[146] David Kuack, *What Will AppHarvest Bring To Appalachia, The U.S.?*, URB. AG NEWS (Sept. 10, 2020), https://urbanagnews.com/blog/exclusives/what-will-appharvest-bring-to-appalachia-the-u-s/ [https://perma.cc/4ZJB-YJPL].

[147] *Id.*

[148] *Id.*

[149] ECON. RSCH. SERV., *Irrigation & Water Use*, U.S. DEPT. OF AGRIC. (last updated Sept. 23, 2019), https://www.ers.usda.gov/topics/farm-practices-management/irrigation-water-use/ [https://perma.cc/Z7KC-49KR]; *see also* Stankiewicz, *supra* note 28.

greenhouses in the region.[150] 70 percent of the United States population can be reached within a one-day drive from eastern Kentucky, compared to the 2,000-mile trip that a large portion of produce currently takes from Mexico to major markets.[151] This increase in accessibility is not only more economical—it is significantly more environmentally sustainable.[152] On average, freight trucks emit 161.8 grams of CO_2 per ton-mile.[153] This means if a grocery store in Pittsburgh currently gets tomatoes from a farm in Mexico two thousand miles away via freight truck weighing twenty tons, nearly 6.5 million grams of CO_2 are emitted with each shipment.[154] However, a similar supply of tomatoes from a commercial greenhouse in Pikeville, Kentucky to Pittsburgh, also on a twenty ton truck, would be a trip of just 334 miles—resulting in only 1.08 million grams of CO_2 omitted.[155] Every mile matters when it comes to environmental impact. With Appalachia as a strategic source of fresh produce, reaching major markets would be immensely more environmentally sustainable.[156]

III. ANALYSIS OF POLICY OPTIONS AND RECOMMENDATIONS

A. Viable Policy Options Adopted by Governments for Comparable Initiatives

Integrating commercial greenhouse technology into the Appalachian economy on a large scale will require extensive work from both public and private sectors. The geographic locations at the core of the project, the character of the facilities, and the partnerships needed are collectively unprecedented, yet desperately needed.[157] However, while direct examples of projects like this in Appalachia are not available for exact guidance,

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[150] Kuack, *supra* note 146.

[151] *Id.*; Stankiewicz, *supra* note 28.

[152] Stankiewicz, *supra* note 28.

[153] Jason Mathers, *Clean Air Innovation*, ENV'T DEF. FUND (Mar. 24, 2015), https://business.edf.org/insights/green-freight-math-how-to-calculate-emissions-for-a-truck-move/ [https://perma.cc/2K48-WBZ4] (a ton-mile is a calculation of miles traveled multiplied by tons carried).

[154] *Id.*; Stankiewicz, *supra* note 28.

[155] Mathers, *supra* note 153; *Distance from Pikeville, KY to Pittsburgh, PA,* DISTANCE BETWEEN CITIES, https://www.distance-cities.com/distance-pikeville-ky-to-pittsburgh-pa [https://perma.cc/5VGN-L2N6] (last viewed Feb. 19, 2021).

[156] Stankiewicz, *supra* note 28.

[157] *See* Britton-Purdy, *supra* note 1.

promising techniques can be derived from practices used in comparable localities and related enterprises.[158] To explore the possible avenues that could be taken to develop greenhouses, two instruments merit discussion: public-private partnerships and tax incentives.

Providing a more intertwined approach for governments and private entities to collaborate, a public-private partnership ("PPP") involves the delegation of certain governmental duties onto private partners through a long-term contract.[159] Such partnerships are designed to combine "private sector competencies, efficiencies, and capital" with governmental support to improve assets of public benefit.[160] PPPs are often put to use in the development of infrastructure such as roads, airports, hospitals, schools, and other realms helping communities grow and prosper.[161] However, application to greenhouse farming has already been demonstrated as feasible. In 2015, vertical farm company AeroFarms entered into a $39 million public-private partnership with the City of Newark and the State of New Jersey.[162] Through the PPP, government support provided financial incentivization (primarily through tax breaks) for AeroFarms to construct a 69 thousand square foot facility.[163] Of particular interest is the PPP framework put to use in New Jersey, historically used for recruiting factories to be built—not commercial greenhouses.[164] Thus, precedent has been established for these traditionally industrial growth-centric instruments to be applied to modern agricultural advancements.[165]

Tax incentives, a companion to PPPs, are another critical tool state and local governments can implement to attract development.[166] These reductions in tax encourage developers to

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[158] Stephen R. Miller, *Financing Local Food Factories*, 43 FORDHAM URB. L. J. 377, 390–91 (2016).

[159] Isabel Marques de Sá, *How Do You Build Effective Public-Private Partnerships?*, YALE INSIGHTS (May 16, 2017), https://insights.som.yale.edu/insights/how-do-you-build-effective-public-private-partnerships#gref [https://perma.cc/D35P-GM8S].

[160] *Id.*

[161] *Id.*

[162] Miller, *supra* note 158, at 390.

[163] *Id.*

[164] *Id.*

[165] *Id.*

[166] Dan Adkins, *TMMK receives $43.5M in tax incentives*, NEWS-GRAPHIC (Apr. 13, 2017), https://www.news-graphic.com/news/tmmk-receives-43-5m-in-tax-incentives/article_dd9cc63a-1fbd-11e7-83f6-

choose one state or locality over others for their projects.[167] A prime example can be observed through the Toyota manufacturing plant in Georgetown, Kentucky.[168] First announced in 1985, Georgetown's Toyota plant has shaped the modern economic landscape of Scott County, employing eight thousand people and embodying a collective $6 billion investment in the state.[169] This cornerstone of the Kentucky economy was not the product of government-free involvement, but was facilitated by $147 million in tax incentives to help construct the initial $800 million facility.[170] In Kentucky specifically, these incentives most commonly take the form of tax abatements, allowing companies to retain revenue they would otherwise be required to pay in state income taxes.[171] Toyota has taken advantage of an additional, more localized incentive as well, with Scott County and the city of Georgetown approving a $2.5 million payroll tax relief from 2015 to 2019.[172]

Illustrating the positive effects of the incentives, Toyota's workforce represented 1.3 percent of the state's total employment in 2015.[173] With a payroll over $1.9 billion, it accounted for 1.6 percent of Kentucky's total employee compensation that same year.[174] Furthermore, Toyota invested more than $120 million into local communities as of 2015.[175] Considering the collective impact Kentucky's 1985 investment into the development of the plant, tax incentives are shown to yield positive impacts exponentially greater than their initial value over extended

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57df3334ccb3.html#:~:text=In%20addition%20to%20%2410%20million,tax%20breaks%20over%2010%20years.&text=For%20instance%2C%20TMMK%20currently%20produces%20Camrys%2C%20Avalons%20and%20Lexus%20ES350s. [https://perma.cc/BSZ7-WCPL].

[167] Phil Rabinowitz, *Using Tax Incentives to Support Community Health and Development*, CMTY. TOOL BOX, https://ctb.ku.edu/en/table-of-contents/implement/changing-policies/tax-incentives/main [https://perma.cc/D4KZ-95QR] (last viewed Feb. 20, 2021).

[168] Adkins, *supra* note 166.

[169] *30 Years After Groundbreaking, Toyota Kentucky Proves Age is Only a Number,* TOYOTA NEWSROOM (Jun. 8, 2016), https://pressroom.toyota.com/toyota-kentucky-30th-anniversary/ [https://perma.cc/798F-ZQ8Y].

[170] Lindsay Chappell, *Economist Finds Kentucky's Toyota Incentives Pay Off*, AUTOMOTIVE NEWS (Nov. 9, 1998), https://www.autonews.com/article/19981109/ANA/811090824/economist-finds-kentucky-s-toyota-incentives-pay-off [https://perma.cc/7PHC-BTDM].

[171] *Id.*

[172] Adkins, *supra* note 166.

[173] *Id.*

[174] TOYOTA, *supra* note 169.

[175] *Id.*

periods of time.[176] Be it a PPP solely involving the sharing of duties and obligations, a standalone tax incentive, or a combination of the two, government intervention in the development of state and local economies is a viable way to rapidly bolster an industry.[177]

A. Policy Recommendations for Application in Appalachia

Rural regions of central Appalachia—particularly eastern Kentucky and West Virginia—present themselves as optimal locations for the widespread construction of commercial greenhouses and development of an agricultural revolution. Decades of mountaintop removal in these regions have left behind millions of acres of impacted land, mostly consisting of flat, vacant plots.[178] These remnants of environmental destruction currently serve as little more than reminders of the past, but through the proper economic stimulants, they could be transformed into sustainable, agricultural hubs of the future.[179] Commercial greenhouses and modern indoor agricultural technology could fill the physical and environmental void left behind by abandoned mountaintop removal sites and revitalize the Appalachian economy.[180] In order to achieve this ambitious, but attainable goal, state and local governments should engage in incentivization practices shown to yield success in other ventures.[181]

On the state level, governments should enter into public-private partnerships with greenhouse agriculture companies.[182] Combining the power of state governments to establish fertile operating environments and maximize business capabilities of private companies will best catalyze the growth of commercial greenhouse use.[183] While AppHarvest is paving the way for the industry and should continue to be supported in its expansion, other players in the space are needed to provide for rapid,

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[176] *Id.*

[177] Marques de Sá, *supra* note 159; Miller, *supra* note 158, at 390; Chappell, *supra* note 170.

[178] HUM. RTS. WATCH, *supra* note 98.

[179] *Id.*

[180] *See* Britton-Purdy, *supra* note 1.

[181] TOYOTA, *supra* note 169; Miller, *supra* note 158, at 390; Adkins, *supra* note 166.

[182] Miller, *supra* note 158, at 390–91.

[183] Marques de Sá, *supra* note 159.

widespread growth and competition—characteristics needed to propel Appalachia and commercial greenhouses to the forefront of the agriculture industry.[184] Numerous greenhouse agriculture companies competing amongst one another would result in continued investments, lower prices, greater innovation, and other advancements encouraging a dynamic industry.[185] Such a fluid, competitive market is exactly what is needed to fill the economic space left behind by coal.[186]

Specifically, the PPPs should be modeled after the tax incentives offered to companies like Toyota and AeroFarms, along with cooperative efforts to improve infrastructure around greenhouse facilities.[187] Through its tax incentive granted to Toyota, Kentucky has seen a $147 million investment yield billions in employee compensation and investments for Kentuckians, along with the creation of thousands of jobs.[188] A comparable level of success could be replicated today through the implementation of a similar strategy toward commercial greenhouses. Adjusted for inflation, the 1985 investment of $147 million is equivalent to roughly $357 million in 2021; compared to the 2021-2022 Kentucky General Fund Appropriations budget of $23.9 billion, a similar investment in 2021 would represent around 1.49 percent of the budget.[189] Thus, through a tax abatement incentive—not a direct expenditure—valued at only 1.49 percent of its annual budget, Kentucky could help fund a new economic catalyst with the potential to change the course of eastern Kentucky's economy in the same way Toyota did for the central portion of the state.[190] However, the relationship between Kentucky and Toyota and the incentives used there are just one example of the same strategy that could be adopted across Appalachian states.

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[184] Stankiewicz, *supra* note 28; David Wessel, *Is Lack of Competition Strangling the U.S. Economy?*, HARV. BUS. REV. (2018), https://hbr.org/2018/03/is-lack-of-competition-strangling-the-u-s-economy [https://perma.cc/AS8Y-3VD8].

[185] *See* Wessel, *supra* note 184.

[186] Britton-Purdy, *supra* note 1.

[187] Chappell, *supra* note 170; Miller, *supra* note 158, at 390.

[188] Chappell, *supra* note 170; TOYOTA, *supra* note 169.

[189] *2021-2022 Governor's Budget,* OFF. OF STATE BUDGET DIR., GOVERNOR'S OFF. FOR POL'Y AND MGMT. 15 (2021); Ian Webster, *CPI Inflation Calculator,* OFF. DATA FOUND., https://www.in2013dollars.com/us/inflation/1985?amount=147000000 [https://perma.cc/7PPL-XJHJ] (last viewed Feb. 21, 2021).

[190] *See* Chappell, *supra* note 170.

Additionally, PPPs should comprise of cooperative improvements to infrastructure in the communities surrounding greenhouses. As greenhouses are developed, access to water, durable roads, and energy will become critical; through partnerships with state governments, utility access and road infrastructure leading to these facilities could be achieved.[191] In many instances, access to greenhouse sites on mountaintop removal locations may already have sufficient roads due to former transportation of heavy loads of coal. However, other locations may not have such access, or water or energy supplies may be deficient. Engaging in cost and obligation sharing by state governments and private entities through PPPs could resolve these issues in economical and other impactful ways.[192] Governments could provide monetary and logistical support, while private actors could provide their expertise on specific needs for practical success in infrastructural improvements.[193]

While the tax incentives and infrastructure improvements engaged in through PPPs should be directed toward greenhouse agriculture companies, governments should also consider involving coal companies. As discussed, the coal industry is steadily declining, yielding large negative impacts on the lives of Appalachian residents, but this decline is also simultaneously harming the companies themselves.[194] As mines close, profits shrink, and bankruptcy filings rise, coal companies find themselves in a perilous position. However, these companies still represent some of the most capital-enriched entities in Appalachia.[195] As a result, mining companies might be prime candidates for retrofitting their operations and becoming champions of greenhouse agriculture. Proactively engaging in PPPs with coal companies would allow state governments to achieve the financial and environmental advancements attainable through indoor agriculture, while working alongside private partners with the capital and existing physical

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[191] APPALACHIAN REG'L COMM'N, *supra* note 116.

[192] Marques de Sá, *supra* note 159.

[193] *Id.*

[194] Britton-Purdy, *supra* note 1; Stefan Rehbach and Robert Samek, *Downsizing the US coal industry: Can a slow-motion train wreck be avoided?*, MCKINSEY & CO. 10 (Nov. 2015), https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/metals%20and%20mining/pdfs/downsizing-the-us-coal-industry.ashx. [https://perma.cc/9W3U-WRFN].

[195] Rehbach & Samek, *supra* note 194, at 8, 10; Britton-Purdy, *supra* note 1.

infrastructure needed to rapidly develop facilities.[196] However, state governments must consider that the motives of coal companies may not align with the mission of greenhouse agriculture, as this new industry is designed to serve as a replacement for the coal industry across Appalachia.

On the local level, similar to the practices states should engage, municipalities across Appalachia should adopt further tax incentives to drive the construction of greenhouses in their communities. Successful precedent for this practice can be found in Toyota's relationship with Georgetown, Kentucky; there, Scott County and the City of Georgetown jointly approved $2.5 million in payroll tax relief from 2015 to 2019.[197] This incentive, along with the support provided by the Kentucky state government, helped spur a new $1.33 billion investment by Toyota into its Georgetown facility.[198] Therefore, while state-level practices can lead to interest in states as a whole, local cities can further enhance the deal offered to companies and benefit their local communities simultaneously by contributing additional incentives packages.[199]

To encourage the growth of the industry and the number of candidates available for partnerships, Kentucky, West Virginia, Ohio, and Pennsylvania, should also embark on education and awareness campaigns to apprise the public, and the future greenhouse operators within it, of the opportunities presented by indoor agriculture technology.[200] The existence of the technology and plausibility of the industry to transform the economic and environmental landscape of Appalachia is unknown to many. Be it a local farmer or entrepreneur, an existing indoor farming company (like Plenty), coal company, or any other entity, knowledge of the existence and immense potential of commercial greenhouses is essential to the execution of this Note's recommendations.[201] Before there are PPPs and tax incentives, there must be companies to engage in those endeavors.

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[196] Stankiewicz, *supra* note 28; Rehbach & Samek, *supra* note 194, at 8.

[197] Adkins, *supra* note 166.

[198] *Id.*

[199] *Id.*

[200] U.S. DEP'T OF ENERGY, *supra* note 2.

[201] Gibson, *supra* note 29; *How Entrepreneurs Identify New Business Opportunities,* WHARTON SCH. U. PA. (Nov. 9, 2009), https://knowledge.wharton.upenn.edu/article/how-entrepreneurs-identify-new-business-opportunities/. [https://perma.cc/ZEH7-GK4S].

CONCLUSION

Central Appalachia has been a critical producer of the nation's coal supply for decades, and as such, coal mining has represented a key driver of the economy of the region.[202] However, this once booming industry is on the decline, taking along with it the economic fate of the communities it once supported. Much of rural Appalachia is in dire need of an economic revolution, specifically in the form of a new industry to serve as the backbone of its economy.[203] Concurrently, food shortages and environmental concerns are rapidly becoming a greater threat to society as a whole, meriting changes in food supply production.[204] Therefore, it would be highly beneficial to have a development solving both challenges and one exists through commercial greenhouse agriculture.[205]

Through the repurposing of former mountaintop removal mining sites, governments and private entities cooperating through public-private partnerships could take advantage of existing infrastructure and available workforces to turn Appalachia into an agricultural hub of the future. Using AppHarvest's operations as a guide and modeling tax incentivization packages after Kentucky's relationship with Toyota, states, municipalities, and private companies could spark the growth of an economic, environmental, and agricultural revolution amongst their communities. As coal mining continues to decline and environmental conditions further deteriorate, the workforce of Appalachia could be put to work in indoor agriculture facilities possibly serving as sustainable farms. Appalachia could become a new agricultural leader through a rethinking of its economy.

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[202] Britton-Purdy, *supra* note 1; U.S. DEP'T OF ENERGY, *supra* note 2.
[203] Britton-Purdy, *supra* note 1; Houser, *supra* note 5.
[204] Charles, *supra* note 128.
[205] Gibson, *supra* note 29.