HOW THE CHAPTER 313 TAX INCENTIVE HAS IMPACTED SOLAR ENERGY EXPANSION AND SCHOOL DISTRICTS IN TEXAS

An Undergraduate Research Scholars Thesis

by

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RESEARCH COMPLIANCE CERTIFICATION

Research activities involving the use of human subjects, vertebrate animals, and/or biohazards must be reviewed and approved by the appropriate Texas A&M University regulatory research committee (i.e., IRB, IACUC, IBC) before the activity can commence. This requirement applies to activities conducted at Texas A&M and to activities conducted at non-Texas A&M facilities or institutions. In both cases, students are responsible for working with the relevant Texas A&M research compliance program to ensure and document that all Texas A&M compliance obligations are met before the study begins.

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This project did not require approval from the Texas A&M University Research Compliance & Biosafety office.

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ABSTRACT

How Chapter 313 Has Impacted Solar Energy Expansion and School Districts in Texas

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The development of solar energy in Texas began to increase rapidly in 2019, quickly catching up with California, the nationwide leader. This recent rapid increase is an ongoing trend that presents a unique opportunity to understand what is stimulating the expansion of solar energy in the state. Media reports suggest the role of Chapter 313 in the Texas Tax Code that the state implemented in the early 2000s to encourage businesses to develop new capital investments in school districts. Chapter 313 is a state tax incentive for companies to build large-scale projects on a school district's property in return for a limitation on the value of their taxable property for ten years. The program aims to direct investment in rural and property-poor districts which results in millions of dollars for these school districts. Large-scale manufacturing followed by wind energy farms were the majority of the first projects. However, solar energy projects have rapidly increased in recent years. Using the data from Chapter 313 agreements since 2003 and comparing the trends, our research focuses on how Chapter 313 projects have and will continue to substantially impact the expansion of utility-scale solar energy and developing school districts in Texas as we transition to cost-effective forms of carbon-free, sustainable energy.

DEDICATION

I am dedicating my thesis to my family and friends (that are my chosen family) who have continually supported me in academia and all other aspects of my life. My achievements mean nothing without the joy, love, and guidance you bring to my life.

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NOMENCLATURE

ADA	Average Daily Attendance
EIA	Energy Information Administration
ERCOT	Electric Reliability Council of Texas
GW	Gigawatt
I&S	Interest and Sinking
M&O	Maintenance and Operation
MW	Megawatt
PV	Photovoltaic
REEG	Renewable Energy Electric Generation
SIA	Strategic Investment Area
TEA	Texas Education Agency
TTRA	Texas Taxpayers and Research Association
TW	Terawatt

1. INTRODUCTION

1.1 Background

1.1.1 Solar Energy Spike in Texas

The expansion and development of renewable energy such as solar power are not only economically advantageous but also a necessity as we transition to sustainable, fossil fuel-free energy sources. As research and development of solar energy have resulted in lower solar technology costs that are more efficient in producing clean energy, solar capacity in the US and across the globe is expanding. However, in recent years, Texas has contributed significantly to the total installed capacity in the US and is expected to continue to lead the nation in solar energy expansion. While the US Energy Information Administration (EIA) has reported the increase in solar energy capacity, they offer limited explanations as to what in Texas has contributed to the rise in utility-scale solar energy and do not consider the Chapter 313 tax incentive (EIA, 2021). Before expanding our research on Chapter 313, we provide more relevant background information and literature.

In April 2021, the EIA reported on the increase in utility-scale solar capacity in Texas. The graph in Figure 1.1 is provided by the EIA from the Preliminary Monthly Electric Generator Inventory. It illustrates that solar energy capacity in Texas began to increase rapidly in 2019, quickly catching up with California, the nationwide leader. They report that solar energy in Texas is expected to grow and make up the "largest share of the state's capacity additions between 2020 and 2022" (EIA, 2021). Additionally, "one-third of the utility-scale solar capacity planned to come online in the United States in the next two years (30 gigawatts (GW))" will be generated from Texas (EIA, 2021). This statistic is surprising as utility-scale solar energy was

only 4% of Texas's generating capacity in 2020 (EIA, 2021). The same year, the installation of 2.5 GW of solar capacity marked the beginning of the solar boom in Texas (EIA, 2021).

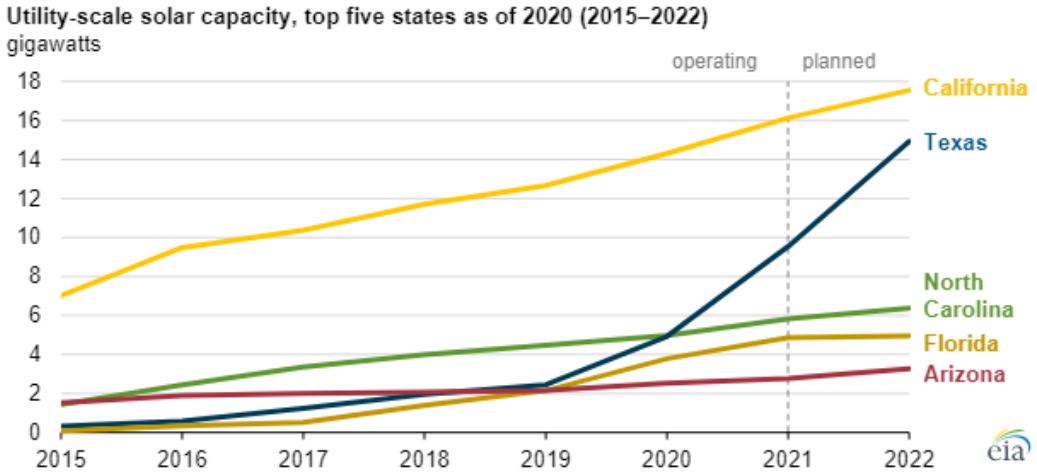

Figure 1.1: U.S. Energy Information Administration (EIA) Solar Capacity Graph, Source: U.S. Energy Information Administration, Detailed State Data, Preliminary Monthly Electric Generator Inventory

In March of 2022, the EIA published a report on the state of solar energy in the US that provides updated information on Texas' solar capacity (EIA, 2022). They report that 60% (51 GW) of the 85 GW of new generating capacity to the US power grid from 2022 to 2023 will be from solar energy and battery storage projects, and 48% (41 GW) of the planned capacity will be from utility-scale solar energy. Of the 51 GW, Texas will account for the largest share, adding 12 GW (23%). The article adds that large additions of utility-scale solar capacity are expected to continue to increase across the US because of the cheaper solar technology costs and the extension of the federal solar Investment Tax Credit (ITC).

The 2021 EIA article previously mentioned also explains that some of the increase is from the lower solar technology costs and the federal solar ITC. However, the costs are falling globally, not just in Texas. Additionally, the ITC credit only applies to projects that began construction in 2021 and later, whereas the increase in Texas began in 2019. The EIA also

mentions plentiful sunlight in West Texas' Permian Basin, where 30% of the state's planned capacity is located, as another possible factor. However, neither EIA article mentions how the Chapter 313 tax incentive has affected the expansion in Texas but media reports on utility-scale solar do. Our research aims to explore other factors that made Texas the champion of solar energy within such a short period of time.

1.1.2 Chapter 313

1.1.2.1 History and Purpose

In 2001, Texas implemented the Texas Development Act in House Bill 1200 (HB1200) to encourage businesses to invest in developing new capital investments in school districts (TTRA, 2021). The bill became law, and Chapter 313 in the Texas Tax Code allows school districts to temporarily limit their property's taxable value (for maintenance and operation tax (M&O) purposes) for ten years (Texas Comptroller of Public Accounts, 2020). Initially set to expire in 2007, the Texas Legislature has renewed the bill several times. The program is set to expire in December of 2022 unless the Texas Legislature elects to renew the program once again.

According to Chapter 313, Section 313.003 in the Texas Tax Code, the purposes of the program are to:

(1) encourage large-scale capital investments in this state;

(2) create new, high-paying jobs in this state;

(3) attract to this state large-scale businesses that are exploring opportunities to locate in other states or other countries;

(4) enable state and local government officials and economic development professionals to compete with other states by authorizing economic development incentives that are

comparable to incentives being offered to prospective employers by other states and to provide state and local officials with an effective means to attract large-scale investment;

(5) strengthen and improve the overall performance of the economy of this state;

(6) expand and enlarge the ad valorem property tax base of this state; and

(7) enhance this state's economic development efforts by providing state and local officials with an effective local economic development tool.

The incentive is beneficial to both the school district and the business because they do not pay the total value of the property for M&O purposes until ten years after the agreement began. The reduction in M&O taxes is a deficit faced by the state, not the school district. To make up for this deficit, the state reduces the amount of state aid provided to the district equivalent to the amount of increase in their property value. Additionally, the district continues to tax the project at its full value for Interest and Sinking (I&S) purposes, which go towards paying "any bond debt the school may have issued for the construction of schools and facilities" (Texas Comptroller of Public Accounts, 2022).

1.1.2.2 Program Requirements

Chapter 313 sets requirements for program applicants, such as the type of project, limitation amount, and investment amount. Chapter 313 restricts eligible projects to businesses in manufacturing, renewable energy, and research and development. The projects have an appraised value limitation amount ranging between $10 million to $100 million and a minimum qualifying investment amount between $1 million to $100 million, depending on the school district's demographics (Texas Comptroller of Public Accounts, 2020). The appraised value limitation amount is the property tax limit allowed for the school district. The minimum qualified investment amounts provide the baselines for the minimum amount a company must invest in a

school district. A high level of investment is required in larger, wealthier districts, whereas the program offers a lower value limitation amount in smaller, poorer, and rural districts. These values ensure that the school district, business, and state benefit from the agreement proportionally.

Chapter 313 also has requirements for the number of jobs the project must provide. According to the Texas Comptroller of Public Accounts, a standard project must create at least 25 jobs or ten jobs if the project is in a rural or economically disadvantaged school district. They must be new, full-time jobs that pay 110% of the average manufacturing wage in the area. The employer must also offer health coverage. However, a school board can waive the job requirement if they show that the number of jobs required by the program exceeds the industry standard for that type of project. The waiver is common in renewable energy projects as they require very little maintenance and operations once the project is built.

After the program's renewal in 2007, House Bill 3390 (HB3390) added additional requirements in 2013 (TTRA, 2021). The additional requirements included that the projects must pay more in taxes than the benefit they will receive, and the limitation must be the determining factor for their decision to invest in Texas. By the limitation being a determining factor, all of the projects are investments the state would not have had otherwise. Additionally, the bill required that the Comptroller provide a biennial report on the progress of Chapter 313 projects. The complete reports, as well as the summary of the findings, are available to the public on the Texas Comptroller's website. The requirements set in place by HB3390 were established to protect the state's economy and ensure the efficiency and effectiveness of the program as they provide significant tax benefits to large-scale capital projects.

1.1.2.3 Application Process

A business with an eligible project may apply to the school district with an application provided by the Comptroller for a temporary limit on the taxable value of the new property they intend to develop. If the district chooses to proceed with the project, they forward the application to the Comptroller and the respective appraisal district. They must certify that it meets the criteria, and that the applicant is in good financial standing. Additionally, the Comptroller is required to make a recommendation on if the school district should accept or reject the application. The recommendation is based on an extensive economic impact evaluation and any other relevant material. The Comptroller must also provide a copy of the application to the Texas Education Agency (TEA), who will determine and report the effect the project will have on the number or size of the school district's instructional facilities and their determination of the project's effectiveness. Based on their findings, the Comptroller will issue a Certificate Packet and Chapter 313 Agreement Review Letter.

The school district can negotiate with the applicant to determine the terms and values of their agreement. Often, a consulting firm will represent the school district to ensure they get a fair deal that will benefit their schools. Businesses often hire a consultant to ensure the terms of the agreement benefit their business as well. The applications require a hefty amount of paperwork, ranging from 50 to over 100 pages. Consultants familiar with the program and the procedures involved help ease the extensive application process. Once the parties finalize the terms of the agreement, the School District Board must hold a public hearing to approve the agreement.

Once the School Board approves the application, the application process is complete, and the limitation agreement begins. Two full tax years prior to the ten-year limitation is the

qualifying time period, which starts on the date the application is approved. The company must make the minimum investment within the qualifying time period. The agreement holders can defer the beginning date of the qualifying time period to maximize tax benefits but not lengthen. The agreement must elect one of the three options of when the limitation begins. The options are to start on January 1st of the year after the application date, the qualifying time period, or the date commercial operations began. After the ten-year limitation period expires, the company is required to maintain a viable presence in the district for five more years.

1.1.2.4 School Districts

In addition to the 10-year limitation on their M&O taxes, Chapter 313 provides three additional types of payments to the school district. The first two types are revenue protection payments and extraordinary educational expenses. Revenue protection is required to be in the terms of the agreement to protect the school district from a reduction in state aid that results from the limitation. A revenue protection payment would be made when the school district's property is taxed at its total value, including the project. Because the district's property value will increase from the amount before the project, the school district will experience a reduction in the amount of state aid they receive. Thus, to the extent necessary, a company would make revenue protection payments to the school district to compensate for the loss of state aid or any other loss of revenue.

Extraordinary education-related expenses are payments made to protect the school district if they face an increase in enrollment due to the attraction of the project. These payments would cover expenses such as hiring additional staff and purchasing portable classrooms to accommodate the influx of students (Texas Comptroller of Public Accounts, 2021). However, no payments have been reported under the extraordinary education-related expense.

The third type of payment made to school districts is a supplemental payment. A business may negotiate and determine an additional payment to the school district capped at either $100 per student per year or $50,000 annually. Schools may receive supplemental payments from the beginning of the ten-year limitation and up to three years after the limitation expires. Formulas to determine the amount of state aid a school receives do not account for supplemental payments, whereas property value is a significant determining factor (TTRA, 2021). Thus, supplemental payments are substantial because they offset the reduction in revenue that results from the limitation and provide additional income through the tenure of the agreement.

Chapter 313 is also designed to benefit low-income areas with a lower threshold for investments in rural communities and districts in a Strategic Investment Area (SIA). Rural communities are categorized by having low real estate values and a lack of commercial development. An SIA is designated by the Comptroller and defined as a county with a higher-than-average unemployment rate and a lower-than-average income. An SIA can be in a rural or urban community, which has positive implications for attracting investment in inner-city schools. The program categorizes districts using these demographic markers to determine which districts qualify for a lower threshold for building an investment project on their property.

According to the Comptroller Fiscal Notes, as of 2020, nearly 90 percent of active Chapter 313 projects are subject to these lower thresholds because they invested in a rural or SIA district (Grubbs, Halbrook, and Wright, 2020). These agreements account for "$182 billion in investments (83.7 percent of the active project total), $9.2 billion in gross tax benefit (85.8 percent), and $1.2 billion in supplemental payments to school districts (75.2 percent)" (Grubbs, Halbrook and Wright, 2020). Thus, the lower thresholds seem to effectively prioritize and maximize investment in the districts that need it the most.

Additionally, negotiations to determine a beneficial supplemental payment amount between large firms and school districts with limited resources to determine a fair deal seems unfair. However, under Chapter 313, the business pays a hefty application fee between $75,000 and $150,000, which covers the cost of hiring a professional consultant to ensure that the school district receives the maximum benefits and supplemental payments from these agreements. The incentives, additional payments, and lower thresholds substantially improve low-income, property-poor communities.

1.1.2.5 Economic Implications

A strong controversy over Chapter 313 is over the effectiveness of the tax incentives. On the one hand, critics contend that the program grants billions of dollars in abatements when the company would have invested in Texas regardless. On the other hand, proponents of the program argue that most states offer tax incentives, and Texas is known for having high property taxes that make it less appealing to businesses to invest without an incentive. While our research focuses more on the social and environmental implications of the program and less on the tax benefits, it is necessary to understand the fundamental economic implications from both sides.

In their 2021 Research Report, The Texas Taxpayers and Research Association (TTRA) called Chapter 313 “the state’s most critical economic development tool” because of the tax subsidies in a state that has a “heavy reliance on local property taxes, particularly to finance public schools” will bring in revenue from attracting projects that would not have otherwise invested in Texas without the Chapter 313 incentives (TTARA, 2021). School districts often account for the biggest share of a property tax bill, making an incentive program that temporarily limits the taxable value of the district’s property more economically appealing to potential investors. They report that prior to Chapter 313 offering school abatements, Texas began to drift

from its rankings as the nation's top location for industrial projects, falling from first to tenth in five years and experiencing a 70% decrease in new projects.

The TTRA explains that while there are a multitude of reasons to invest in Texas, such as available land, no personal income tax, and affordable energy sources, high property taxes have become a barrier for large investment projects because property taxes are the largest tax a business in Texas pays-especially those that are capital intensive. They found that "relative to economic output, Texas' business tax burden was 11 percent above the national average," ranking 14th highest among the states in 2019. Further, while property taxes in Texas include all real estate, land, improvements, and tangible personal property used for producing income, such as inventory, TTRA reports that "12 states exempt all or majority of tangible property from taxation and 36 states exempt inventory in its entirety." They add that the Lincoln Institute of Land Policy and the Minnesota Center for Fiscal Excellence work in conjunction to produce a periodic review of property taxes across the states, which found that in 2019, "Texas has the fourth-highest property tax burden of the 50 states" and ranks higher than any neighboring state for an industrial project.

According to the TTRA, Chapter 313 is not "giving away state money" because the incentive attracts new investment from taxpayers who would not have chosen Texas without it. They write that "the only revenue 'lost' are tax dollars Texas would never have collected." Thus, Chapter 313 imposes no cost to the state. They add that abatements and limitations are commonly used across the United States and Chapter 313, while beneficial, is still not as favorable as programs in other states. For example, the average Chapter 313 agreement only saves a project 37.5% of what it would have paid without the limitation, and the transparency of

the program requires high administrative costs for businesses to complete paperwork requirements that take away from their overall net tax benefit.

To elaborate on why companies favor incentives in other states, TTRA explains that programs in other states typically offer a temporary 100 percent exemption during the limitation period (most commonly 5 or 10 years). In contrast, Chapter 313 is far from 100% exemption. For one, Chapter 313 applies only to school taxes as opposed to programs that offer abatements on all local property taxes. Additionally, even the benefit from school tax reduction is not fully comprehensive. For example, in 2019, TTRA reports that Chapter 313 projects added $5.4 billion of property value onto tax rolls, resulting in approximately $156.5 million of school M&O tax payments and $178.3 million in I&S taxes for school districts.

Additionally, businesses paid approximately $173.5 million in supplemental payments to school districts in 2019 alone. The projects totaled a net tax benefit of $305.1 million in the same year. Still, they paid $508.4 million in taxes and supplemental payments, excluding additional overhead costs, such as application and consultant fees. Moreover, TTRA concludes that "Chapter 313 is far less financially advantageous than property tax incentive programs common in other states" that offer 100% abatements with no overhead costs.

The TTRA also writes that critics argue that the state loses money through Chapter 313 projects through state aid formulas that will subsidize districts with a limitation by sending more aid while their property value increases during the limitation. However, this is not true because state aid formulas still account for the value the project adds to its tax rolls. Thus, school districts initially see a reduction in state aid by offering a 313 limitation, saving the state money. Additionally, after the limitation reaches the 10-year expiration, "the district sees a further and typically much deeper in state aid (or increase in recapture) due to the value the project adds to

tax rolls." The reduction is why the supplemental payments from the business to the school are in place because they are excluded from state-aid formulas and can be used by the district without restriction for any lawful purpose, such as classroom funding or facility improvements. Moreover, the district benefits from the payments while the state gains money by reducing state aid that corresponds to the amount of increase in the district's tax base from the project.

The report concludes that while the program is highly criticized because of the revenue lost from tax breaks, history shows that absent the abatement, Texas will lose "substantial new investment to other states and countries." Furthermore, while the tax benefits from Chapter 313 are relatively small with high administrative costs relative to programs in other states, TTRA deduces that, combined with the other positive factors of starting a business in Texas, the incentives are sufficient to bring projects to our state. For further proof of the program's success, "in 2020, Texas was awarded the Governor's Cup in total qualifying new capital investment" for the eighth year in a row (TTRA, 2021).

The view of the State Comptroller is highly technical. In the Fiscal Notes published in 2020, the State Comptroller reports that since 2015, the program has brought over $80 billion in new investment to the state, creating a total of 50,300 jobs and adding $2.0 billion in personal income. Further, "for about $2.9 billion in gross tax benefits, they've attracted about $62 billion in investments and created more than 1,193 jobs, while generating $526.3 million in supplemental payments to school districts" and in 2019, adding "$1.1 billion to Texas' gross domestic product (GDP)."

The Comptroller's office argues that not only has Chapter 313 provided a significant economic development boost in Texas, but the design of the program has specifically been beneficial in rural communities. The Comptroller explains that the program's lower threshold to

direct investment to rural communities and communities in an SIA has resulted in nearly 90% of active Chapter 313 projects in these communities. The report concludes that the program's rapid growth has prompted controversy because Texas already has natural advantages over the competition in commercial development. However, in the face of the international economic turmoil we see today, "the program still may have an important role to play in encouraging investment," especially in the areas of the state that need it most (Grubbs, Halbrook, Wright, 2020).

In 2009, the Texas Legislature required that the Comptroller publish all Chapter 313 applications, agreements, and economic impact evaluations, on the Comptroller's website to improve the program's transparency (Garza and Nalukwago, 2016). The following information is from the 2021 Texas Economic Development Biennial Report Chapter 313 Summary Data that measures the progress of the agreements made through June 1st, 2020. In addition to the required reporting information, the report, compiled by the Comptroller, also includes data for informational purposes.

The reported total investment and gross tax benefit from the 509 active agreements through 2019 were $134,214,858,000 and $2,515,514,000, respectively. The estimated gross tax benefit from 2019 through 2040 is $8,764,959,000. The total amount of supplemental and revenue protection payments from the current agreements are $1,555,240,000 and $1,459,006,000, respectively. The Comptroller reports that of the "estimated gross tax benefit of $10.8 billion, manufacturing projects are estimated to receive 72.9 percent; renewable energy projects, 26.9 percent." Further, renewable energy projects return 18.2 percent of their tax benefits to the school districts, while manufacturing projects return 13.1 percent of their benefits through supplemental payments (Texas Comptroller of Public Accounts, 2021).

Nate Jensen, a professor of government at The University of Texas at Austin, is one of the few scholars who has written about Chapter 313. Jensen writes that the "fundamental flaw" with the Chapter 313 program is that 85 to 95% of companies that received an incentive between 2002 to 2016 would have chosen to locate in Texas regardless of the program despite the requirement that the limitation is a determining factor in an applicant's decision to invest in Texas (Jensen, 2017). Thus, the state gives away tax dollars they would have collected without offering an incentive.

He explains that the "waste of taxpayer dollars resulted in part from the structure of the program" for a few reasons. First, the program requires approval from a school district, but the state ultimately loses the tax benefits. He explains that the second issue is that school districts request and negotiate supplemental payments from the company before approving the application, which allows for the rare instance of "company-government bargaining." Further, the supplemental payments "often amount to more than 40 percent of the tax benefits" the company received from the limitation, which leads to his third concern of the state offering a tax benefit so large that companies are willing to give back a significant portion of their benefits.

To help explain why these factors raise concerns, Jensen provides an example using large firms such as Toyota and Samsung. He explains that firms like the two mentioned have the ability to locate in other states and countries and thus negotiate "substantially lower supplemental payments to school districts in exchange for the school district's approval to participate in the program." On the other hand, companies with fewer options to locate in and are looking to expand their existing facilities "paid substantially higher supplemental payments to school districts." Thus, Jensen asserts that the program provides no net benefit to the state and only "transferred tax dollars from communities to companies" when they were planning to move

to Texas regardless, contradicting the program's designs for the limitation to be the determining factor in the company's decision to invest.

He concludes that "the state would be better off by being more selective in the use of these taxpayer benefits and reforming the structure of the program" as there are ethical concerns when a school district becomes an "economic developer" that can sign off on incentives financed by the state in exchange for payments from the companies that are outside of state aid formula calculations. He adds that it is unethical and excessively costly to "allow 10 percent of Texas school districts to receive millions in supplemental payments while they grant billions in tax incentives." Jensen further suggests that sensible reforms to Chapter 313 would require changing the benefits and making "a more targeted use of incentives" that focuses on "new investments (and not expansions) and non-energy-related investments" to "dramatically reduce waste." He writes that this can be done by the state eliminating supplemental payments and allowing the Texas Comptroller to have "additional oversight of the program" (Jensen, 2017).

Norton Rose Fulbright, one of the top international law firms both in America and globally, offers a more optimistic assessment of Chapter 313. According to their website, they provide "the world's preeminent corporations and financial institutions with a full business law service" across "all the key industry sectors: financial institutions; energy, infrastructure and resources; consumer markets; transport; technology; and life sciences and healthcare" through their global risk advisory group. The following information is from a presentation on Chapter 313 limitations by Stephen A. Kuntz, a firm partner, at the 2020 Texas Oil and Gas Association Annual Property Tax Conference in San Antonio, Texas.

In terms of economic development and tax incentives, Kuntz says that property tax relief is key to Texas because the property tax rates in the state "are some of the highest in the

country." He writes that across Texas, "the combined annual school district, county, city, and special district property tax exceeds 2.5% of a property's market value," posing a cost that can be "a major factor in a business's decision to locate a capital-intensive project in Texas." He adds that outside of Chapter 313, "most property tax incentives in Texas are discretionary and awarded on a case-by-case basis to entice desirable companies to relocate or expand in the area." He explains that, while incentives are rarely the primary decision to choose a location, "they are important to ensure the economic feasibility of the project" and "incentives are often a tie-breaker" between a company's final decision on a location.

He moves on to explain how Chapter 313 is beneficial. He explains that while a limitation is in place on the M&O taxes, the school district imposes the project's full taxable value through the I&S tax, which is used to pay down the school district's debt. So, the I&S taxes generated from these large projects from Chapter 313 "can help a school district quickly pay down its debt and decrease future I&S taxes for all taxpayers in the school district," or they "can form the basis for additional borrowing by the school district."

Kuntz also explains that revenue protection and supplemental payment amounts are often "set by a formula as the amount of tax and school finance revenue the district would have received in the absence of the Chapter 313 agreement." The provisions for these calculations are "heavily dependent on the Texas school finance system" that is subject to change by the Texas Legislature or because the specifics of the school district's demographics changed. The school district's financial consultant determines these calculations and projections in the preliminary stages of the application process. Thus, it is crucial to predict and budget for changes in the Texas school finance system and project investment logistics over the ten-year span of the agreement to adequately estimate the costs (Kuntz, 2020).

1.1.2.6 Social and Political Implications

As with any policy, some concerns arise about how it will affect the lives of the citizens. While Chapter 313 brings many benefits to the participating school districts, there are still communities living in these districts with other interests than providing tax benefits to large companies or expanding utility-scale renewable energy. The following articles provide insight into the social implications and controversy of the large utility-scale Chapter 313 projects in their communities.

Media reporting for the Texas Tribune, "the only member-supported, digital-first, nonpartisan media organization that informs Texans — and engages with them — about public policy, politics, government, and statewide issues," indicates some challenges with Chapter 313. In Duncan Anew's reporting, the program's renewal seemed like a guarantee before the Legislature allowed the program to expire at the end of 2022. However, debates over suggested revisions have stalled efforts to extend Chapter 313 in the 2021 Texas Legislature. He quotes Doug Greco, lead organizer for Central Texas Interfaith and affiliate of the Texas Industrial Areas Foundation, who explains that the program has winners and losers, yet "the big winners are a small number of companies, and losers are kids in urban school districts."

Anew explains Greco's statement that many advocates see a significant problem with Chapter 313 because of the supplemental payments "from companies to school districts that lie outside of the traditional school finance system, which requires wealthier districts to share some of their bounties with poorer ones." Thus, the state cannot redistribute any funds from supplemental payments to lower-income districts, which allows some "school districts that make deals with companies to get a massive revenue boost, while other Texas schools lose out." He

writes that if this problem cannot be fixed, “critics would prefer to see the 313 program scrapped entirely.”

Anew writes that “according to the most recent report on Chapter 313 from the Texas Comptroller, 222 school districts in the state have a total of 509 agreements with companies through the program,” which is “less than 20% of all Texas school districts” that “encompass about 5% of K-12 students in the state.” He uses the example of Barbers Hill ISD, which has 36 active Chapter 313 agreements, to show how the program disproportionately benefits districts in Texas. The superintendent of Barbers Hill ISD, Greg Poole, started his own consulting firm “to broker deals between school boards across the state and companies” (Anew, 2021).

Reporting in the Texas Observer, “a nonprofit news organization that strives to make Texas a more equitable place by exposing injustice through investigative journalism, narrative storytelling, and cultural coverage,” Justin Miller highlighted the Motiva Enterprises Chapter 313 agreement with Port Arthur Independent School District (Texas Observer, 2021). The Motiva oil refinery, initially owned by Texaco, was located on the Texas-Louisiana border in Port Arthur since 1902 and decided in 2006 that the company would “expand its production to more than 600,000 barrels a day, which would make it the largest refinery in the country and one of the biggest in the world.” At this time, they entered into a Chapter 313 agreement, making the deal the biggest project since the creation of the program. In need of revenue for their students, Port Arthur ISD approved the project and entered into an agreement with one of the world’s biggest oil refineries.

After the project's construction was completed in 2012, “Motiva had spent $10 billion, and the refinery’s market value soon ballooned to $3.5 billion.” However, when the tax breaks from Chapter 313 expired in 2018, Motiva contested the appraised value of the refinery, saying it

was worth $1.5 billion, and sued the Jefferson County Appraisal District for drastically overvaluing the plant in comparison to the surrounding refineries. The appraisal district eventually had to settle, which allowed Motiva to save "tens of millions of dollars in property taxes" while leaving Port Arthur ISD, a predominantly low-income, Black and Hispanic school district, in a crisis as the "Motiva refinery alone accounts for roughly half its tax base."

According to the article, Phyllis Geans, Port Arthur ISD's chief financial officer, said that "although we love Chapter 313 agreements, it is not without difficulties," such as the negotiations from huge oil and gas corporations, like Motiva, to avoid their tax liabilities. The threat of these expensive and complex legal battles against large corporations often forces tax appraisers to settle. The settlement between Jefferson County and Motiva resulted in a taxable value of one-third less than what Motiva projected in 2010 that they would return to the tax rolls. The settlement also "forced Port Arthur ISD to refund Motiva $8.5 million of property taxes it had already allocated to school programs." Additionally, Port Arthur ISD had recently finished "paying off $30 million in tax refunds to Valero, after the San Antonio-based energy giant won several lawsuits that deflated the value of its properties in Jefferson County" that included another refinery in Port Arthur with a Chapter 313 agreement.

Miller explains that despite these instances, "Chapter 313 deals are typically low-risk, high-reward ventures for school districts" that provide a financial boost in districts, such as Port Arthur ISD, through supplemental payments. He quotes Geans again, who says that, with the availability of the funds from Chapter 313 agreements," the district has been able to provide much-needed assistance to parents, students, and staff for reading materials, social services assistance, purchase of band instruments, uniforms, and temporary employment," and "other services such offering full-day kindergarten when the state only funded half-days."

Miller provides a statement from Motiva in response to the suit in Port Arthur that states that an in-depth review of their taxes revealed that the assessed value of the Port Arthur refinery was disproportionately higher than the assessed value of the others in the industry. To help ensure long-term viability and success, we made the decision to pursue a valuation adjustment for our refinery." Miller adds that the project that was meant to promote long-term investment ended up with a total worth of 10% of its initial investment. Additionally, "in 2020, Motiva challenged its appraisal again and got its value further reduced to just $1 billion." The district expects that the company will rechallenge its value this year.

This example proceeds Miller explaining why critics believe the subsidies from the program are wasteful and "starve the state of revenue that could be used to fund public schools." He writes that using data obtained from the 313 agreements on the state comptroller's office, "the Texas Observer analyzed 71 projects in the manufacturing and wind sectors—which account for the vast majority of the program—that have reached the end of their tax breaks." While "some projects met or exceeded their early projections… almost all of the 55 wind projects overestimated what their projects' value would be once tax breaks expired." Additionally, "12 of the 16 manufacturing projects also undershot their earlier projections." While it is normal for the value of industrial properties to decline with age, Miller adds that 313 projects were "losing much more value than expected."

Another example provided by the Observer is in Port Neches-Groves ISD. Miller quotes the Port Neches-Groves ISD Superintendent Mike Gonzales, who attests that the program "provides many positive outcomes if the contracts and promises are honored," but sadly, "organizations choose to contest values and appeal those agreements," which places school districts at an economic disadvantage. In one of the first Chapter 313 agreements in 2002, Sabina

Petrochemicals sued the county appraiser responsible for Port Neches-Groves ISD, settling on a project value of $58 million despite its peak value of $230 million in 2007. Despite the dispute, Port Neches-Groves currently has three other active agreements "that are expected to bring the district $25 million in supplemental payments."

Miller writes that, from 2011 to 2019, the program has increased its number of deals by 200 percent and has been notorious for big projects such as "a Toyota truck factory to San Antonio, the Samsung semiconductor plant in Austin, and most recently, the Tesla factory in Del Valle." However, he asserts that "the program has been the biggest boon to the state's already-dominant energy industry—specifically oil and gas and wind generation." He explains the contention with this is that 60% of Chapter 313 tax limitations have gone to fossil fuel projects and oil and gas giants that have always done business in Texas, such as "Exxon Mobil, Chevron Phillips, Dow Chemical, and Enterprise Products Partner" that now have saved "hundred of millions in property taxes thanks to Chapter 313," which contradicts the programs design to reserve deals for projects that would not otherwise be built in Texas.

He writes that, in 2013, the Legislature passed a measure to ensure that Chapter 313 programs are beneficial for the state by "requiring the Comptroller's Office to report whether a project is "reasonably likely" to generate enough tax revenue over 25 years to offset the cost of a decade of tax breaks." Additionally, critics argue that "the test is almost impossible to fail and isn't followed up on." Nevertheless, he adds that despite all the problems with the program, "the vast majority of lawmakers—Republicans and Democrats alike" and both "the oil and gas industry and renewable energy advocates" support the program.

The East Texas news channel KLTV published an article by Victoria Lara in January of 2022 titled "Texas residents push back against solar plant construction." The article introduces

the city of Crawford, Texas, who raised concerns about the school district meeting with OCI Solar Power over a proposed $115 million solar farm. Lara writes that an official managing the project for the company said the project will not impose any cost to the community if the limitation is approved. Thus, it is up to the school board to decide where to designate land to build the commercial property. Lara adds that a farmer in Crawford was offered more money to sell his land for the project than he could make farming. However, he added that "his neighbors would not be happy living next to a plant."

Lara provides an example of another similar situation in Southmayd, Texas, where the school district voted to enter a Chapter 313 agreement with Galactic Energy, a solar development company. The company proposed a 1,750-acre solar farm that has divided residents that "do not want to lose the landscape and property they have lived on for generations." Some residents bring their concerns to the school board and ask them to reconsider. Additionally, they are considering a petition against the solar farm's construction. On the other hand, supporters of the project argue that "adding solar plants like these help keep the power on during severe weather events like extremely hot summers and the winter blast last year," referring to Winter Storm Uri in 2021.

Lara concludes that two solar plant farms are set to begin generating power this year in East Texas. One of which is located where the Oak Hill lignite mine used to be. Instead, the two farms will be producing 200 MW of solar power, which is equivalent to the amount of electricity needed to power the lights "in as many as 200,000 homes." According to the US Census Bureau, Lara adds that the power from these two solar plants is "enough to power all households in Nacogdoches, Smith, Angelina, Gregg, and Van Zandt counties" (Lara, 2022).

According to their website, “Texas Farm Bureau’s mission is to be the Voice of Texas Agriculture.” Their leadership is composed entirely of Texas farmers and ranchers that finance the organization completely by “voluntary dues” (Texas Farm Bureau, 2020). In August 2021, Julie Tomascik wrote the article, published on the Texas Farm Bureau’s website, “Solar panels crop up across Texas, divide rural communities.” She addresses the concern that solar energy development companies are dividing rural communities by utilizing thousands of acres across Texas for solar energy instead of livestock and crop production.

Tomascik explains that while some landowners have chosen to enter into long-term leases with the solar companies, their “neighbors and other communities across the state oppose the industrial facilities and are attempting to stop them.” She introduces Robert Flemming, a farmer and rancher in Central Texas that helped organize a “grassroots effort to temporarily block the projects from taking area land out of agricultural production.” He stated that he is not opposed to solar energy unless it is “taking prime farmland and ranchland out of production.” Additionally, he says that the companies are organized, professional, and sneaky as they separate communities, families, and friends with money because they know they cannot compete economically “in a depressed agricultural economy.”

The final decision for the approval of Chapter 313 abatement for the solar project came down to Troy ISD, where “Fleming, several landowners, and concerned citizens spoke out against the abatement and met with State Rep. Hugh Shine, Troy ISD school board officials, county commissioners, and community leaders” to provide information and express their concerns. Their efforts to convince officials in Troy ISD to deny the abatement were successful, as the district denied the project proposal in a 6-1 vote. Tomascik writes that the solar company responded by stating to a media outlet that the decision made by Troy ISD “could eliminate

opportunities for local private landowners and that county at large, including over $36 million in tax payments to Bell County and Troy ISD."

Tomascik writes that "Texas Farm Bureau's current policy is supportive of legislation and incentives to develop farm-based renewable energy such as solar, wind and biogas projects." However, "members recognize a need to study the cumulative impacts to agricultural land values and electrical markets that result from incentive programs such as local tax abatements." Some property owners welcome the solar projects because the companies offer "lucrative leases, around $450 to $1,200 per acre per year with incremental increases" for leases that range for 20-40 years. The solar farm leases provide steady income with no cost to the landowner that "the financial roller coaster of growing crops and raising livestock" cannot offer.

She adds that while the solar industry grows across the country due to technology, federal tax credits, and cheaper material costs, critics contend that thousands of acres removed from agricultural production will affect local agriculture businesses in Texas. Fleming explained that it is not just the producer that depends on the land but also the businesses such as the "fertilizer company, chemical salesmen, feed companies, insurance company, tractor implement companies, (and) trucking." Additionally, critics assert that the development of the projects "stresses rural infrastructure" because farm-to-market and county roads are not designed for frequent heavy machines and gravel trucks, and crop fields and pastures will lose their livestock and new growth to rocks "guarded by chain-link fences topped with razor wire" (Tomasick, 2021).

The Austin American-Statesman provides daily news for Austin and the State of Texas. In May 2021, Kara Carlson wrote an article for the news source about $673 million Chapter 313 solar project under consideration for Samsung C&T, a subsidiary of Samsung, in the article,

"Samsung subsidiary considers $670 million in solar farm projects in Central Texas." She writes that Samsung C&T already has a significant presence in Central Texas. The project in Milam County will consist of three solar farms projects across 6,800 acres of land that will "generate as much as 700 megawatts of electricity" for 25 years or longer. She adds that according to the project application provided by the Comptroller, the Milam County sites in three districts are competing with sites in California, Georgia, Michigan, Illinois, Virginia, Tennessee, Minnesota, Arkansas, and Mississippi" and several sites in other countries.

Rosebud-Lott, Cameron, and Buckholts ISD combined and approved four separate Chapter 313 agreements with Samsung C&T that will begin in the 2024-25 school year, but "construction of the projects could start as early as June 2022." Carlson notes that "Buckholts school district has an agreement that limits the taxable value to $17 million" while Cameron ISD has a $20 million limitation and Rosebud-Lott ISD has two agreements that limit the taxable value to $40 million. Further, the filings suggest that while the project can only guarantee "one job to each district" due to the limited maintenance solar plants need, "the project would bring several hundred direct and indirect jobs each year for the first two years."

Carlson writes that "Samsung has made big investments in renewable energy in recent years" In October, Samsung C&T announced that it would no longer invest in new coal projects. She adds that in 2018, "Samsung Electronics said it aimed to use 1100% renewable energy by 2020 for factories and offices in the US, Europe, and China, about half of its total buildings globally." In a filing, Samsung said that the Milam County project "is still in the early stages of development and could be redeployed to other states competing for similar renewable projects if necessary." Carlson explains that the February 2021 freeze in Texas shut down Samsung's Austin fabrication plant for more than a month and reportedly lost $268 million in damaged

productions due to the shutdown from the power outages. She writes that it is unclear if the freeze will sway the company away from the project.

The Brownwood Bulletin, a local newspaper, published an article by Steve Nash in April 2021 titled, “Solar farm debate draws large crowd in Brownwood.” Nash’s article briefs on an informational public meeting with a Brown County Commissioner Court member regarding the proposed 2,5000-acre solar farm in Brookesmith Independent School District. Referenced as an informational workshop, the meeting's agenda included twenty speakers who voiced their opinions in favor and opposition to the potential 313 abatement agreement between Brookesmith ISD and Intersection Power, a California-based company.

Nash first offers the proponent's arguments in favor of the project. First, Intersect power representatives began the meeting by providing facts and logistical information about the project. They stated that the proposed project utilizes private land from 12 landowners on the border of Brown County and Coleman County that is currently surrounded by rural country roads. They add that the project will bring tax revenue into the county every year and will not cause taxes to increase. Over the 35-year lifespan of the plant, the project would pay a total of $25 million in taxes — $16 million to Brookesmith ISD and $9 million to the county.” The power company compared the amount of money in taxes the 2,500 acres of land would generate under ag exemptions without the agreement, which would only be $140,000 over the same 35-year period. Additionally, the project will create “300 to 400 temporary construction jobs over 12 to 18 months” and two permanent jobs after. They add that the company is interested in the abatement to be competitive with other wholesale power companies across Texas, all of whom have tax abatement agreements.

Intersect Power addressed prominent social concerns as well. They comment that the project was developed "under the Trump administration and is not part of the Green New Deal." Second, had the solar plant project been fully operational during the February 2021 winter storm, the plant would have generated energy when natural gas did not. Finally, the company addresses environmental and aesthetic concerns by noting that, unlike wind projects, solar projects are "no higher than 10 feet tall and do not have bright blinking red lights that can be seen at night from a distance." Additionally, solar panels are very dark blue, and "from a distance, if they are seen at all, they will look like water." Intersect Power representatives conclude by noting that "after the project is built, the land will return in great part to its natural state."

The following people that spoke in favor of the agreement were all Brown County residents. The superintendent of Brookesmith ISD, Steve Mickelson, stated the following:

> "From the school district's vantage, this is a gift. It's just a straight-up gift. Funding for schools is very difficult right now. It's difficult for small schools… no one's footing the bill except for the (Intersect). I'm having a hard time understanding how this is not absolutely outstanding news. I cannot imagine any district thinking this is just not absolutely outstanding. This is an absolute amazing thing for Brookesmith ISD. We have come through some really tough times but this would help us tremendously."

Property owner Kenneth Adams said, "landowners never thought that we would come across a project that would take our assets, provide for the Brookesmith school, provide for us and provide for Brown County citizens," calling Chapter 313 a blessing and a "win-win situation." He adds that opponents of the project have turned it "into basically a monster," talking about "how terrible everything was that had anything to do with it." Adams personally

obtained paperwork “from a certified appraiser in a neighboring county showing alternative energy projects don’t hurt land values.”

Nash writes that Ray Slayton, a Brooksmith resident and a 1998 Brookesmith graduate, said “the project will help ensure his grandchildren will also be Brookesmith graduates.” Additionally, John Conaway, a property owner, “read a letter from Lamar County Judge Brandon Bell” regarding the success the projects in their county had. The final pro-agreement speaker was property owner Terry McIver. According to Nash, McIver said opponents of the project are people who “are probably wealthy” and “don’t want the rest of us to share the wealth.” Nash quotes McIver asking, “who has the authority and the right to take away over $100,000 a year annuity that I’ll get selling solar off of my place?”

Nash moves on to convey the concerns of the opponents of the agreement. First off was Jeff Tucker, a property owner who states that he is “not against solar” unless it does not make common or fiscal sense. Following Tucker, business owner Rex Tacket spoke about how land value is lost when solar or wind farms are built, saying that the benefits are small and short-lived “compared to the long-term effects of these solar farms.” Additionally, a vote of no for the agreement would “send a message to these companies that Brown County isn’t for sale.” Real estate broker Josh Stegemoller spoke about how the first questions he is asked when marketing a ranch for sale are regarding the views of turbines and power lines from the property. He states that, in his opinion, solar farms will cause the same concerns for buyers as they avoid counties with “eyesores.” Nash writes that Brookesmith resident Skylar Mabee worries about his land losing value due to the project. He says that “land is one thing you cannot make more of, no matter what it pays a month.”

Kendra Clardy, a natural resource management employee, spoke about how the construction of a solar farm causes permanent damage to the environment. She said that once panels cover the area, “the height of the grasses will be heavily monitored” to grow to a certain height so that they do not attract unwanted wildlife. Clardy also raised the question of what happens to the solar panels once they go bad. She compared the land used for the farm to a parking lot because “nothing is meant to live or grow there” once it is used for solar panels. Additionally, she argued that a solar farm will only bring “money to certain people,” but it will remove “woody vegetation, destruction to the existing watersheds, wildlife habitat, good agriculture land, livestock grazing, and hunting.”

1.1.2.7 Environmental Impact

The final background literature I provided will be regarding the implications of expanding utility-scale renewable energy. I provided a summary of two scientific reports, a report on solar energy from the Dallas Federal Reserve Bank, the Comptroller’s fiscal notes on the impact of REEG projects, and four news reports on utility-scale solar energy development in local Texas communities.

The widely respected scientific news and research journal “Science” published an article in 2019 titled “Terawatt-scale photovoltaics: Transform global energy.” The article describes how the sun's omnipresent nature, scale, and predictability give solar energy the “potential to play a central role in the future global energy system.” They explain that the addition of over 500 GW of solar photovoltaic (PV) energy installed globally in 2018, followed by an estimated additional 500 GW projected to be installed between 2022 and 2023, has brought to the era of TW (terawatt) scale solar energy. The authors write that the rapid, drastic change in the PV industry has shocked many observers studying the “continued dramatic cost decreases and

manufacturing-scale increases." They add that only two years ago, scientists were struggling to overcome the challenges of solar energy to achieve "3 to 20 TW of PV by 2030." Now they "envision a future with ~10 TW of PV by 2030 and 30 to 70 TW by 2050" that would provide the majority of energy across the globe.

The journal discusses and summarizes the history, challenges, and requirements of "PV performance, reliability, manufacturing, and recycling." Beginning with decreasing costs, the authors note that by the end of 2018, the global average PV module "selling price was already below $0.25/W" for 500 GW, whereas the price was not previously expected to reach $0.50/W and $0.25/W until global capacity reached 1 and 8 TW, respectively. They draw the comparison between PV electricity costs that are consistently declining sharply and other forms of electricity generation (nuclear and fossil fuels) that "have remained relatively constant over a long period in Japan, Germany, and the United States." The decrease in PV costs is consistent when measured in terms of unsubsidized levelized cost of energy (LCOE) in the US and Japan, as well as changes in German feed-in tariffs. While regional changes have affected all sources of energy generation, the resistance of declining solar costs illustrates that the PV industry is or will soon be cost-competitive with traditional forms of energy across the globe.

In terms of the challenges of rapid PV growth rates, current operational practices must address how to reduce curtailment (reducing the amount of energy produced due to a lack of available resources to meet increased output). They explain that previous research suggests that "the value of PV will decrease as PV grid penetration increases" because of the current PV electricity generation operational practices. More recent analyses presented evidence in states such as California that changes in the operational practices of existing PV systems enabled higher levels of utility-scale PV, with curtailment stabilized at around 1 to 2% annually.

However, they add that if REEG "continues to increase rapidly without substantial storage and/or load shifting, then curtailment could increase." Thus, there must be a focus on achieving low-cost operational strategies that accommodate the rapid growth of renewable energy. Developing research has promising conclusions that the least cost pathway for low-carbon sustainable energy includes PV growth.

The next topic addressed in this article is the logistics of grid integration. The authors explain how "geographic and technology diversity and managing the supply-demand balance over larger geographic footprints" can ease some variability of solar integration. For example, locations with peak wind output during the night can complement peak solar output in the daytime. High-voltage transmission lines and increasing flexibility in the remaining portion of electricity generation also play a significant role in responding to peak production and demand patterns to shift the load when excess PV is available.

They add that the increased amount of PV on the grid will require a much higher degree of energy storage and demand response. PV requires the grid to have advanced capabilities such as "voltage regulation, active power controls, ramp-rate controls, fault ride through, and frequency control," whereas traditional power plants use synchronous generators with specific response characteristics. Currently, PV systems only produce power by connecting to the grid through inverters that respond to grid frequency but lack the ability to provide the additional specialized services necessary for large amounts of solar energy to be reliably integrated. However, new techniques and installations of PV inverters "provide essential grid reliability services such as voltage and frequency regulation" and battery storage to create a reliable, resilient system that can provide dispatchable power.

To add to the importance of battery storage as PV installations increase, the article provides an example of a 100-MW battery installed by Tesla in South Australia and recovered 14% of the capital cost in the first six months. Battery storage improvements are expected to continue from technological advances, increased manufacturing capacity, and the decreasing price of lithium-ion batteries. To reduce costs further, researchers should explore materials with higher energy densities. Additionally, research indicates that pumped-storage hydropower batteries have the advantage of providing short-term responsiveness with storage capacity to provide energy daily at potentially low costs but pose the challenge of meeting energy demands during the winter in high latitudes.

Following the topic of battery storage, the journal discusses how PV solar energy will "play a critical role in electrifying" the transport, heating, and industrial sectors currently dominated by the fossil fuel industry. They provide the statistic that globally, electric vehicle sales increased by 63% in 2018. As far as energy for heat, 17% of the fossil fuels in the final global energy consumption came from coal, oil, and gas used to generate heat for buildings. However, increasing the use of heat pumps could reduce fossil fuel-generated heat, increase overall efficiency, and increase the global share of renewables. With a higher level of performance, heat pumps can also "reduce end-use energy consumption and enable thermal storage options that may have a lower cost than battery storage."

As far as industrial processes, 27% of the fossil fuel consumed across the globe comes from producing cement, iron and steel, aluminum, pulp and paper, and chemicals. An alternative mentioned in the article that would "substantially reduce greenhouse gas emissions associated with the iron, steel, and fertilizer industries" is using low-cost solar energy to produce hydrogen and ammonia in an approach called power-to-gas (PtG). They add that the installed solar and

wind capacity can “be used to produce hydrogen, methane, or more complex hydrocarbons,” which would have a subsequent effect on a multitude of energy sectors that rely on more than electricity, such as “metals refining, biofuels upgrading, ammonia synthesis for fertilizer production, and synthetic fuel generation.”

To conclude on the history, challenges, and future of PV integration, the authors write that the “learning curve in PV is expected to continue to drive costs down as the market grows to TW scale.” Additionally, roadmaps for implementing materials and device research to increase efficiency “exist in all established technology areas.” However, critical research is still needed on advancing PV reliability on the grid. New and more accurate solar system designs will be able to respond to an array of stressors on the mechanical processes that are specific to the ranges of weather any given environment may present around the world.

While increased production of more efficient and technologically advanced designs will reduce costs, it will also bring new research and development challenges from failed modules that “raise the stakes for materials supply, sustainability, and recycling.” Thus, “reuse of primary semiconductor materials, addressing embedded energy in terms of extraction and purification, could be an important consideration for sustainability at the TW scale.” With research focusing on addressing the challenges of module design, reliability, grid integration, and manufacturing of multi-TW-scale PV generation, solar energy will “play a critical role in transforming the global energy system.”

In 2019, the Institute of Physics (IOP) published a corrigendum (correction) article on the power densities of wind and solar power titled “Corrigendum: Observation-based solar and wind power capacity factors and power densities” by Lee M Miller and David W Keith. The article is correcting a previous error in the estimate of wind plant area that led researchers to

“underestimate wind power density by 40%.” They add that while some of the exact numbers may have been incorrect, the paper's overall conclusions were not affected.

The journal begins with an essential explanation of power density and why it plays a vital role in determining the efficiency and environmental consequences of low-carbon energy sources. They explain that “power density is the rate of energy generation per unit of land surface area occupied by an energy system.” Fossil fuels have a high power density as they require a relatively low amount of land to provide high amounts of electricity. With all other factors equal, lower power densities require larger amounts of land and, subsequently, environmental footprints.

Miller and Keith explain that “wind plants with the largest areas have the lowest power densities.” While wind power capacity is increasing, there is a corresponding decrease in the capacity densities. Further, if wind power plants continue to expand and move away from prime locations, “it seems likely that wind’s power density will decrease as total wind generation increases.” On the other hand, solar capacity and power densities are likely to increase with time. The increase is driven “in part by improved panel efficiencies.” While both wind and solar pose social consequences, primarily with land occupancy, “wind power has a 6-fold lower power density than solar,” but occupy less land.

To summarize their results, the authors write that while wind turbine sites and design have improved to increase capacity and decrease costs, “they have not altered power densities.” Additionally, while there was no clear relationship between the area of the plant site and the power density for solar, there was a strong relationship for wind as power density decreases with increasing power plant size. Further, while wind capacity has continually increased, there has been no significant corresponding trend in power density. They explain that the underlying cause

for these results is “three defining characteristics” of wind power plants: the area of the wind farm, the capacity of individual turbines, and the installed capacity density of the wind farm. To conclude, larger wind power plants have lower power densities. Because expanding wind power plants will require moving to less ideal locations, wind power density will likely decrease with time.

Specifically, the researchers found that the “mean and 90-percentile power densities for wind are 0.90 and 1.48 We m−2, while the corresponding values for solar are 5.7 and 7.5 We m−2” as of 2016. They use present-day US electricity consumption and the previously mentioned power densities to model the difference in the amount of land required for solar and wind power plants. To meet US energy demands, it “would require 12% of the Continental US land area for wind… or just 1% for solar.” They add that it is crucial to understand that it is implausible that one single energy source will ever supply all of the electricity. However, these comparisons serve as a demonstration to understand the implications of land use and power density.

The Federal Reserve Bank of Dallas published an article by Garrett Golding in August 2021 titled, “Surging Renewable Energy in Texas Prompts Electricity Generation Adequacy Questions,” that explains some of the implications of the increase of intermittent renewable energy on the grid. According to data retrieved from the Texas grid operator, Electric Reliability Council of Texas (ERCOT), “renewable electricity amounted to one-quarter of the power consumed in 2020, up from just 8 percent in 2010,” and solar capacity is expected to quadruple from today’s rates. He writes that ERCOT anticipates that utility-scale solar capacity will increase “from 7,800 MW today to more than 28,000 MW by 2024,” which is enough to power nearly 4.5 million Texas homes in the heat of the summer.

Golding adds an important note that, because of the intermittency of solar and wind as weather and seasons change output, other power sources are needed to meet demand. The additional sources of power that can be accessed quickly, such as natural gas, to compensate for the decreased output are referred to as dispatchable power. When forecasting the amount of energy available to provide electricity and prevent blackouts, ERCOT accounts for weather patterns and the required downtime for power plants, such as natural gas maintenance. He explains how in the case of Winter Storm Uri in February 2021, every scenario that would prevent electricity generation occurred simultaneously. These scenarios included an unexpected demand for electricity due to the uncharacteristically below freezing temperatures, "insufficient winterization of power plants and natural gas facilities, more plants were offline for maintenance than expected, and renewable generation was extremely low."

The article continues to explain that "Texas is approaching the limits of the current generating mix if it has not already reached them" because of the uncertainty that power from natural gas and coal can make up for unexpected shortfalls from extreme weather events while electricity demands increase. Golding writes that because of this, "the grid is increasingly reliant on intermittent renewable energy generation," which requires improvements in utility-scale battery storage for wind and solar facilities as the current battery capacity is only 853 MW, designed to meet demands during peak hours when renewables are lacking, but only for one to two hours. He adds that, by 2024, there is scheduled to be 2,400 MW of battery capacity.

Golding explains how the design of the energy market in Texas also presents a challenge. Texas is the only US state that operates on an "energy-only" electricity market, meaning that electricity providers are only paid for electricity they deliver as opposed to the more common "capacity market" design that requires providers to "own certain levels of reserve capacity." He

explains that this design is meant to incentivize power plant development in Texas as higher electricity prices come during periods of higher demand. Because of this design, renewable energy has decreased the economic incentive to build and maintain natural gas and coal power plants because wholesale electricity prices decrease on sunny and windy days, which causes these plants to be offline more often as renewable energy expands.

An issue for policymakers as this trend intensifies with renewable energy capacity growing "is if the market structure will encourage enough investment in dispatchable capacity in the future" to compensate for intermittency. Additionally, they must determine if it will be necessary to establish a capacity market in Texas or "bolster requirements within the energy-only market for additional reserve power capacity" to provide adequate energy resources. Golding concludes by saying that electricity sector carbon emissions have decreased "by 13 percent over the previous decade even as consumption increased 20 percent according to the US Energy Information Administration" due to the rapid increase in renewable energy in Texas, increased use of natural gas, and coal plant closures. Furthermore, "continuing this trend and providing reliable electricity are not incompatible goals with prudent planning and incentives" (Golding, 2021).

According to the Comptroller 2020 Fiscal Notes on Chapter 313, as of 2019, the REEG industry accounts for more than 61% of active projects under Chapter 313, which accounts for "about $2.9 billion in gross tax benefits… $62 billion in investments and created more than 1,193 jobs, while generating $526.3 million in supplemental payments to school districts." Wind farm projects have been the most common REEG agreements as Texas has installed more "wind power capacity than any other state and produced about 28 percent of all US wind-powered

electricity in 2019." The Comptroller notes that "according to The US Department of Energy, wind power is responsible for an estimated 17.6 percent of production on Texas' energy grid."

The article explains that Texas has "ample wind and solar resources" because "renewable energy depends heavily on location and landscape," and Texas has plenty of open land to harvest wind and solar energy. In addition to the natural resources, the Texas Legislature addressed a prominent concern for developers when they "required the Public Utility Commission of Texas to designate competitive renewable energy zones (CREZs) for the purpose of integrating REEG projects with traditional electric generation projects and providing open access to the Electric Reliability Council of Texas (ERCOT)" in 2005. The project, completed in January 2014, included 3,500 miles of transmission lines which significantly reduced the cost for REEG project developers. This was a critical development for Texas as REEG projects are in rural areas, far from other sources of energy that are already connected to the power grid. The Comptroller adds that as REEG projects rapidly develop, many states still lack the transmission infrastructure to adequately distribute electricity from wind or solar sources.

In comparison to the billions of dollars wind has added to the state's GDP, "the solar power generation industry has a much smaller economic footprint in Texas," adding only $76.8 million in 2019. However, "solar electric power is on the rise," bumping Texas to "fifth in the nation for total installed solar capacity in 2020." In terms of Chapter 313 agreements, solar projects more than doubled their share of the REEG projects from accounting for only "15.8 percent of the total in 2018 to 103 or 32.7 percent in 2020." According to the EIA, the Comptroller adds that between 2013 and 2018, "costs for solar power fell by 50 percent… while costs for wind fell by 27 percent." This statistic indicates that REEG projects are becoming more "financially viable in the long term."

The article concludes to say that REEG projects have historically required higher capital costs than traditional electricity generation. However, the costs have recently fallen, primarily due to "advances in technology and cheaper components such as wind turbine blades and solar panels." Additionally, due to the necessity for REEG projects to be located in rural, isolated areas, "program incentives for REEG projects encourage clean energy and tend to boost rural economic development" (Grubbs, Halbrook, Wright).

The Houstonia is a Houston-based source that "provides news, entertainment, and information." In April 2021, Houstonia published Gwendolyn Knapp's article "What's Going on with the Sunnyside Solar Farm?" where she writes about the city's clean energy development on an abandoned landfill. Knapp starts her article by writing that "a closed city dump on the edge of one of Houston's oldest historically Black southside neighborhoods is set to become the nation's biggest urban solar farm" after the city of Sunnyside solicited ideas globally for carbon-neutral projects that could be developed on a landfill that's been closed for 50 years. In response to the request, Knapp adds that the ideas that the city's chief sustainability officer received were all solar energy related. Thus, the mayor and city council approved a lease with Sunnyside Energy to convert 240 acres of the landfill into "the largest brownfield solar installation in the nation" that will power thousands of Houston homes with clean energy from the Sunnyside Solar Farm by 2023.

She adds that the project is part of the city's Climate Action Plan and Complete Communities Initiative, which the mayor states "will help bring much-needed economic development to the community and also makes Sunnyside part of the international energy transition to using 'clean,' renewable energy sources, reducing pollution and limiting climate change in the process." The solar farm will produce 50 MW of energy, enough to power roughly

5,000 homes, and is estimated to cost $70 million to develop. Additionally, the project development has heavily involved the community in the planning, which led to the addition of a "hub for aquaponics and a raised-bed handicap-accessible labyrinth" so that kids and adults will be able to learn about solar and STEM topics at the education facilities. Knapp adds that "there will be opportunities for residents to receive solar installation training at the neighboring Sunnyside Community Center that could land them jobs" and a portion of the community center "will operate as a co-op owned by the community."

In terms of environmental benefits, Knapp writes that "the city believes the farm will prevent potential future environmental hazards posed by the landfill and help retain and store stormwater to aid in flood mitigation" and "offset 120 million pounds of CO2 per year." According to a statement by project developers, at this rate, "in the first five years of operation, it will have offset the carbon it took to create the farm." She adds that many citizens promote the project of turning a toxic dump into clean energy as environmental justice because "historically landfills are more commonly located near Black communities and people of color, and this one has been sitting overgrown for five decades." Thus, it will give back to the community that has suffered from the consequences of the toxicity while bringing clean energy to Houston.

According to project investors and developers, Knapp writes that construction is expected to begin in 2022 and take nine months to build. Not only will the community own a portion of the farm, but the project will give some low-income Sunnyside residents discounted power rates. Following its completion, the project is expected to become a model for other cities that have already reached out, wanting to transform their landfills. The project is especially significant because of the lack of green space within Houston city limits to build solar farms.

The Houston Chronicle is one of the largest news sources in the Houston area. In April of 2021, they published an article by Carissa Lamkahouan titled “Brazoria County a magnet for solar farms” that briefly discusses solar energy development in Brazoria County. Lamkahouan begins by writing about how the “rapidly growing population, open acres of former rice fields and lots of sunshine” have attracted solar farm project developers to Brazoria County.

She quotes County Judge Matt Sebesta about the recent developments. Sebesta stated that “Brazoria County is a large county with lots of open spaces that is easy to develop into solar farms” because of the rice fields that occupied 60,000 acres of land 50 years ago compared to the roughly 15,000 acres they occupy today. Another appealing factor is the county’s growing population, which provides an opportunity for companies to penetrate the residential solar market. According to the article, Brazoria County has one completed solar farm already, and seven more are in development, accounting for $623 million in investment in the county (Lamkahouan, 2021).

The Waxahachie Daily Light is a local news source in Texas. The following information is from their 2021 report titled “Construction on solar farms underway,” which discusses the 163 MW Elm Branch Solar Farm located in Ennis and the 153 MW Briar Creek Solar Farm located in Corsicana. Both plants are being constructed by the McCarthy Building Companies. The energy from the two solar farms “will offset greenhouse gas emissions by a total of 370,000 metric tons of CO2 annually.” The Elm Branch Solar Farm in Ellis County will span 1,350 acres of land with 360,000 solar panels that generate “272,000 megawatt-hours of solar power annually – or enough to power 24,790 US homes in a year while reducing CO2 emissions by 156,000 metric tons.” The Briar Creek facility in Navarro County will produce enough clean

energy to power 27,270 homes and offset “223,440 metric tons of CO2 annually, equivalent to taking 45,815 cars off the road.”

In addition to providing clean energy, the project developers plan to hire approximately 500 craft workers from the local military and veteran community to construct the two projects. The positions range from “entry-level to experienced, including laborer, operator, crew lead, electrician, and journeyman electrician.” Additionally, they will “train laborers seeking utility-scale solar construction experience.” The article concludes with a quote from the executive vice president of McCarthy’s Renewable Energy & Storage team, Scott Canada, who spoke about their focus on employing and training “local skilled craft workers, veterans and those displaced from jobs in other sectors” on their solar project teams to help them develop careers in the “growing renewable energy sector” (Waxahachie Daily Light, 2021).

1.2 Our Research

The science behind renewable energy such as solar power and the need for carbon-free energy resources to remain within required emissions standards is understood. It is also known that utility-scale solar requires land to capture solar radiation. Solar farms have a higher power density than wind farms, defined as watts produced per unit area. However, the rise of solar energy capacity in Texas and its implementation to be advantageous to low-income school districts and communities are a recent and ongoing phenomenon.

Additionally, very little research has been done on the social science implications of Chapter 313 as it has primarily been studied from an economic and tax perspective. These social science implications include how the expansion of utility-scale solar energy impacts the districts and communities, as well as how the Chapter 313 program affects and is affected by social acceptance, politics, and geographical implications. Using the data from the current Chapter 313

agreements and projects since 2003, our research focuses on the importance of how Chapter 313 projects have and will continue to substantially impact the future expansion of solar energy, developing school districts, and the expansion of the renewable energy electric generation (REEG) industry as we transition to cost-effective forms of carbon-free, sustainable energy.

2. METHODS

The research supporting this thesis included accessing and analyzing data from publicly available websites and interviewing stakeholders for technical background information. In the interviews with the stakeholders, I asked questions regarding technical information on Chapter 313 based on their experience, not personal opinions on the program. I also prefaced my interview by noting that I can only use information from their professional experience.

I began by accessing a Microsoft Excel spreadsheet on the Texas Comptroller website listing the 603 active Chapter 313 agreements as of September 15th, 2021. From here, I began constructing a separate spreadsheet in Google Sheets that included information about the agreements that applied to our research. I chose to use Google Sheets so that my advisor had access to the data as I collected it through the shared document feature.

I started adding the basic information such as the school district, county, business applicant, project name, the statutory eligibility category, date of the application, and first full tax year in a spreadsheet. At this point, I noticed that the statutory eligibility credit included agreements that were manufacturing and research and development projects. Considering my focus was on renewable energy projects, I removed the 200 manufacturing agreements and the four research and development projects. I also removed the two nuclear energy projects as a webinar on the Comptroller's website said they are no longer a part of the program. Two projects did not have applications accessible on the Comptroller's website, so I removed them from the spreadsheet as well, leaving me with 395 Chapter 313 renewable energy agreements.

Next, I reviewed each of the applications on the Comptroller's website to determine what terms of the agreement are most relevant to understanding the impact on renewable energy and

the school districts. After going through each of the solar applications, which are approximately 50 to 100 pages long, I determined which characteristics were most relevant to familiarize myself with the contents. Two essential characteristics were if the district was in a rural or non-rural city and if the district was in a strategic investment area. These factors are important as they define the required amount of qualifying jobs, minimum qualified investment, and the minimum amount of the value limitation.

To determine these required amounts, the Commissioner of Education organizes the districts into categories (1-5) based on the property's taxable value. Different minimum qualified investment amounts depend on if the district is in a rural or non-rural district and the amount of the property's taxable value. If a district is rural (population under 50,000), it is subject to subchapter C, and if it is non-rural, it is subject to subchapter B. A district may also be subject to subchapter C if they are located in a county where the population remained the same, decreased, or increased but slower than the average rate of increase in the state between the years 2000 and 2010. If the district has territory in a Strategic Investment Area (SIA), it is also subject to subchapter C.

The Comptroller's website has a Limitation Values Table listing each school district's category. The table also includes if the school district is subject to subchapter C. I took that list and used it to fill in my spreadsheet with the district's category (1-5) and if they are subject to subchapter C or not. I found a list of the districts in a Strategic Investment Area. Using the list, I answered yes or no to if the district was in an SIA or not on my spreadsheet. Table 2.1, Rural District Category Values, illustrates the categories and corresponding monetary amounts for districts in rural areas. Table 2.2, Non-Rural District Category Values, does the same for non-rural districts.

Table 2.1: Rural District Category Values.

Category	Property Taxable Value	Minimum Qualified Investment
1	$200 million or more	$30 million
2	Between $90 million and $200 million	$20 million
3	Between $1 million and $90 million	$10 million
4	Between $100,000 and $1 million	$5 million
5	Less than $100,000	$1 million

Table 2.2: Non-Rural District Category Values.

Category	Property Taxable Value	Minimum Qualified Investment
1	$10 billion or more	$100 million
2	Between $1 billion and $10 billion	$80 million
3	Between $500 million and $1 billion	$60 million
4	Between $100 million and $500 million	$40 million
5	Less than $100 million	$20 million

Given the prominence of the discussion of solar energy in the media, I decided to focus more on the rate of solar energy increasing in Texas and how Chapter 313 agreements have affected the rates and community response. I went through the applications to determine if it was a solar or wind project to go more in-depth in the solar project data set. Afterward, I created separate spreadsheets for the wind and solar projects. For the solar projects, I added cells in the spreadsheet for the number of PV modules and inverters, the total acres of the project, and the megawatts of solar energy the project will generate. I also added a column for the year commercial operations began, the qualified investment agreed, the business's consulting firm, and the appraised value limitation amount. As I began going through each application, I found

that some of the listed projects did not have accessible applications, so I removed them from my spreadsheet, leaving me with 238 wind projects and 143 solar projects.

In addition to the project applications, I used the 2020 Biennial Progress Reports to find the year commercial operations began and the total amount of investment agreed because some applications requested to keep project specifics confidential. Additionally, the Biennial Progress Report provided a more accurate date for the commencement of commercial operations as they are from 2020. The Biennial Progress Reports from 2020 also include the amount of investment paid as of 2019. If this value was larger than the amount of qualified investment agreed, I added it to the spreadsheet. I did not include if the value was the same, lower, or not paid because it is a recent agreement. From here, I went through every solar project application and 2020 Biennial Progress Report to fill in the information on my spreadsheet.

Once I finished going through each application and collected all pertinent information on my spreadsheet for solar energy projects, I created another spreadsheet with all the pending applications. This spreadsheet included the name and ID number of the district, the application date, the first full tax year, and the type of project. I created this spreadsheet to see what percentage of future applications are solar energy projects versus manufacturing or wind energy projects. After completing my data collection in spreadsheets, I decided on categories I would compare to best analyze the impact of Chapter 313 on solar energy expansion. These comparisons included the total number of active solar project agreements to all other project types, the number of solar projects created each year, the number of solar projects versus wind projects, and the distribution of project types within the pending applications.

Additionally, I compared the amount of each demographic category the projects are in or if they are an SIA to see the distribution of socio-economic status. I used the column statistics

function to find the sum of the total qualified investment and the total amount of MW installed. Because the EIA uses GW, I converted the total MW to GW. I generated graphs on Google Sheets to visualize the data and see the changes. Under my advisor's advice, I included the graphs and tables in my results section that I felt would help me understand the changes.

To compare the amount of installed capacity per year to the amounts the EIA provides, I used three different categories of dates- the date of the application, the date of the first year of the qualifying time period, and the year the plant became fully operational. I used the date of the application and the first year of the qualifying time period when I compared the solar and wind projects because I did not go through each individual wind application and the date of the application and first year of the qualifying time period were accessible on a list on the Comptroller's website. The date of the application also allowed me to see when the increase in solar projects under Chapter 313 began. I used the date of the first year of the qualifying time period because it would provide a more accurate date on when the project added capacity to the grid. Finally, I collected the date of year the solar plants became fully operational from each project's 2020 Biennial Progress Reports to get the most accurate date the applications provide as to when the capacity was added to the grid.

Following the completion of my data collection in spreadsheets, I decided on categories I would compare to best analyze the impact of Chapter 313 on solar energy expansion. These comparisons included the total number of active solar project agreements to all other project types, the number of solar projects created each year, the number of solar projects versus wind projects, and the distribution of project type within the pending applications. Additionally, I compared the amount of each demographic category the projects are in or if they are an SIA to see the distribution of socio-economic status. I also used the column statistics function to find the

sum of the total qualified investment and total amount of megawatts installed. Because the EIA uses gigawatts (GW), I converted the total megawatts (MW) to gigawatts.

Throughout collecting data from the applications to put in the spreadsheet, I familiarized myself with the terms and requirements of the agreements using webinars and information on the Comptroller's website and other sources such as TTRA. I also researched and read a multitude of economic reviews and articles over Chapter 313 and reports on solar energy expansion in Texas and across the US. I chose the most relevant, cohesive, and up-to-date reports and articles to include in the background literature of my research paper. I based my decision on which articles and reports to include by choosing the most unbiased sources with reliable data on renewable energy development- primarily utility-scale solar energy and the logistics and implications of Chapter 313. I also included the sources that my advisor provided me because of his knowledge and research on renewable energy development.

While these articles were helpful in understanding the program, solar energy development, and some of the community responses to utility-scale PV installations, many of the reports on Chapter 313, specifically, were focused on reviewing the program from a tax incentive and investment effectiveness perspective. So, I began to reach out to consulting firms with a long history with Chapter 313 and have consulted for multiple agreements on behalf of the school districts to see if they would be open to me interviewing them about the program.

I met with Dan Casey and Gretchen Hoffman from Moak Casey consulting firm to gain more technical information on how the program works, the benefits seen in the school districts, and their experience with how the program has changed. I also met with Shelly Leung from Powell Law Group, who provided more information on their experience with Chapter 313. Ms. Leung also referred me to other contacts that would be able to assist in helping me gain a better

perspective on the impacts seen in school districts. I reached out to all the contacts she provided me and arranged a meeting over the phone with the Superintendent of Mount Calm ISD, James Wright, who was able to provide me with more clarification on how the program is beneficial to school districts.

3. RESULTS

3.1 Agreements

As of the September 15, 2021, Agreement List excel sheet, there are 200 manufacturing projects, 238 wind projects, and 143 solar projects. I did not include the nuclear energy projects as they are no longer part of the program. I also did not include the research and development projects as there were only four current agreements and only one active agreement as of the January 2022 active agreement list. To summarize, manufacturing projects are 34% of the agreements, wind projects are 41%, and solar projects are 25%.

Of the REEG agreements, wind projects are 63%, and solar projects are 38%. Using the year of the application date, Figure 3.1 illustrates the amount of wind projects compared to solar projects from the year of the first solar project application in 2013 and September of 2021. From 2013 to 2017, solar applications remained relatively low, with six agreements or less per year. However, in 2018, there was a 233% increase in solar projects from six to twenty. From 2018 to 2019, there was a 185% increase in applications and a 105% increase from 2018 to 2020.

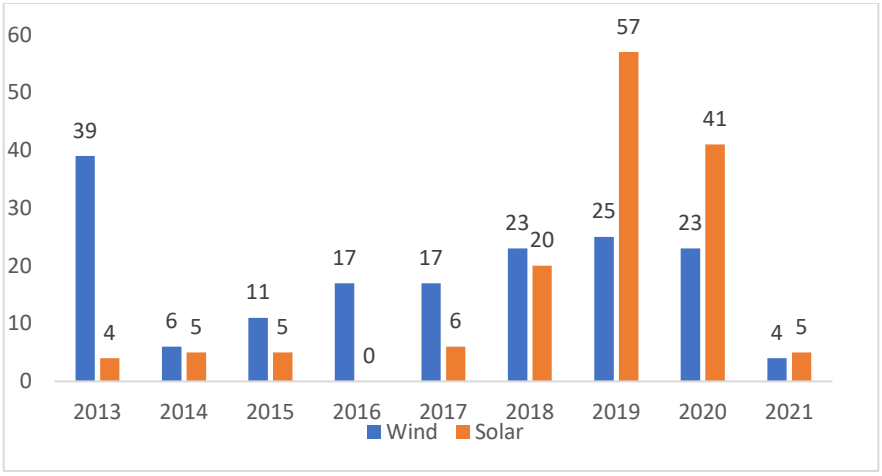

Figure 3.1: Wind and Solar Applications per Year

Using the date of the first complete year of the qualifying time period, Figure 3.2 shows that from 2014 to 2019, solar projects had seven agreements or less per year. In 2020, solar projects increased from six agreements in 2019 to twenty agreements in 2020, a 316% increase. From 2020 to 2021, there is a 120% increase. 2022 is the first year of a decrease with twenty-five agreements compared to fifty-five the year before; however, the data from the agreement list cut off at the end of 2021. Additionally, the application date and the beginning of the qualifying time period vary across applications.

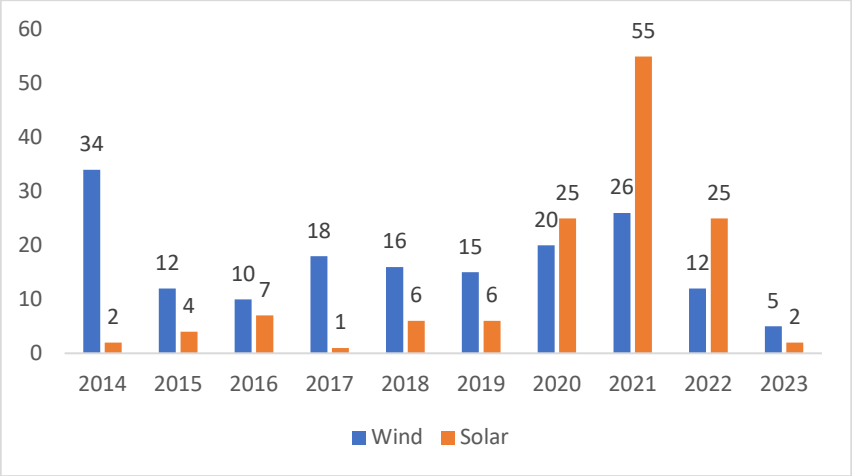

Figure 3.2: Wind and Solar per Year

Table 3.1 shows the total installed solar capacity per year and the corresponding number of agreements based on the fully operational date. I combined 2014 to 2018 because there were only 15 agreements between these five years, all between 2 and 5 applications per year. The total installed capacity was 1.88 GW between these years, with an average of 1.25 GW installed per project. The minimum and maximum installed capacity per project were .40 and 1.82 GW, respectively. In 2019, the total installed capacity for five applications was .81 GW, with an average of 1.6 GW installed per project. The minimum and maximum capacity installed by a project that year were 1 and 2.5 GW, respectively.

Table 3.1: Installed Solar Capacity per Year

Year	Agreements	Installed Capacity (GW)
2014-2018	15	1.88
2019	5	.81
2020	13	2.6
2021	47	11.27
2022	52	10.46
2023	11	1.91
Total	61	29.3

The following three years saw significant increases. In 2020, there was a total installed capacity of 2.6 GW, with an average of 2 GW installed per project. The minimum and maximum installed capacity per project were .5 and 5 GW. In 2021, there was a total installed capacity of 11.27 GW, with an average of 2.4 GW installed per project. The minimum and maximum installed capacity per project were .95 and 6.5 GW. In 2022, there was a total installed capacity of 10.46 GW, with an average of 2 GW installed per project. The minimum and maximum installed capacity per project were .7 and 2 GW. The expected capacity to be installed in 2023, based on the agreements we used for our data, is 1.91 GW.

The percent increase in installed capacity from 2019 to 2020 was 221%. From 2020 to 2021, there was a 333% increase, and from 2020 to 2022, there was a 302% increase. The percent increase in the number of applications from 2019 to 2020 was 160%, from 2020 to 2021 was 262%, and from 2019 to 2022 was 940%. Of the 89 pending applications as of January 2022, there are 61 solar applications (71.8%), nine wind applications (10.6%), eleven manufacturing applications (12.9%), and four renewable gas applications (4.7%). The pending installed capacity in the 61 solar applications is 14.47 GW, with an average of 2.4 GW per

project and minimum and maximum values of .08 and 6 GW, respectively. The total amount of investment from solar projects alone came to a total of $26,606,764,157. Table 3.2 shows the distribution of investment per year.

Table 3.2: Total Amounts of Investment from Solar Projects

Year	Amount of Investment
2014-2018	$2,873,562,250
2019	$603,802,000
2020	$2,633,100,000
2021	$9,837,019,551
2022	$8,708,365,303
2023	$1,556,451,053
Total	$26,606,764,157

The number of solar agreements in rural districts was 90% and 10% in non-rural districts. 31% of agreements were in SIA, and 69% were not. In comparison, 99% of wind agreements were in rural districts, and 1% were in non-rural districts. 40% of the wind agreements were in an SIA, and 60% were not. Figure 3.3 shows the distribution of the property value categories for wind and solar agreements. While solar agreements most frequently occur in districts under categories 3 and 5 for property values, most wind agreements fall into categories 1 and 3, with category 2 following closely behind. 41% of wind agreements are in category 1 districts, 30% in category 3, and 25% in category 2. 38% and 37% of solar agreements are in category 3 and 5 districts, respectively. Thus, wind agreements tend to be in districts with higher to moderate property values, whereas solar agreements tend to be in districts with moderate to lower property values.

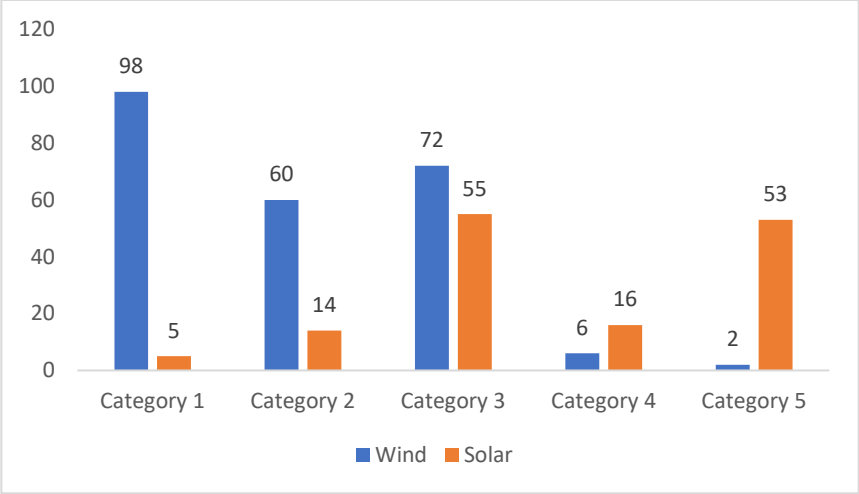

Figure 3.3: Wind and Solar Property Values

In addition to the specific numerical and demographic data that I collected from the applications, I have added information from the project applications to provide insight into the applications' qualitative data. Due to the requirement that the limitation is why they chose to invest in Texas, the applications include a section that should help determine if the limitation is a determining factor. I chose a few applications that were representative of the type of information the companies chose to add.

Renegade Renewables' Dawn Solar project has a capacity of 6.5 GW in Hereford ISD, located in Deaf Smith County. This solar farm is the largest in Chapter 313 solar agreements. The project developers begin by saying that despite the high levels of sunshine and low land costs, "solar has lagged far behind wind development in Texas," which is why their project will be competitive in the ERCOT market. They explain that solar is more competitive to add to the ERCOT grid than wind because the peak output coincides with peak hours of demand during the day, whereas wind power hits peak production at night when the wind is the lowest. In terms of the time of year, the summer months have the highest energy demand when solar output is strongest and the wind is at its weakest.

They explain that while wind and solar are intermittent and require a supplementary base load source of power such as coal, nuclear, or natural gas, solar energy would require less baseload energy because of its ability to perform during peak demand hours and months. They write that they have evaluated several other sites in other states across the Southwest that also provide suitable solar conditions. They list the following reasons why the site in Hereford is optimal:

(1) The selected land parcel is relatively flat, contiguous, and adjacent to a US highway, allowing easy site access and making plant design and placement of equipment less complex;

(2) Dawn Solar is also adjacent to Sharyland Utilities' 345kV transmission line, which is double strung and therefore has ample capacity to carry the power from Dawn Solar at a high voltage, resulting in a excellent access to the North Hub while also enabling a lower cost of construction of the interconnection line from the project to the substation;

(3) The geotechnical conditions of the site do not require significant remediation or disturbance of the property. There are also very few identified wetlands on the parcel of land, and the solar PV plant will not be constructed on the wetlands;

(4) Hereford is located within Deaf Smith County which is part of the ERCOT market. Twenty-two panhandle counties are outside of ERCOT, including two that are directly adjacent to Deaf Smith. The opportunities within ERCOT are much better for a solar powerplant than if the project were located outside ERCOT

The final documentation the developers provide includes the benefits and impact on Deaf Smith County. They state that the project provides multiple benefits to the economy "while simultaneously demanding relatively little from County services." For example, during the 18-

month construction period, 500 temporary employees will live, eat, and shop at local businesses. The seven permanent employees will bring a "positive net economic benefit to Deaf Smith County of approximately $550,000 in payroll dollars annually, or about $20 Million" over the 35-year lifespan of the project. Even with the tax abatements, Dawn Solar will significantly add to the property tax base.

In terms of the environment, the project will produce 1,400 GWh of electricity per year, enough to power 120,000 homes on the ERCOT grid. They note that the solar plant is "quiet, pollution-free, and has little impact on surrounding properties." For example, "the racking systems reach no higher than about 10 feet and vegetation is kept low to prevent shading of the solar modules while also checking erosion." Additionally, at the end of the plant's viable commercial life, "the pilings holding the racking are removed, cables that have been laid underground are pulled up, and the land can be returned to a natural state without much further work" (Hereford Application, 2019).

Other applications, such as Chermac Energy Corporation's Quanah Solar Project in Quanah ISD, provide documentation on how established their company is in the solar industry. They write that after working with petroleum engineering and oil/gas property leasing in 1982, they began to develop wind energy in Oklahoma in 1999. Following their transition to alternative forms of energy, Chermac acquired over 100,000 acres of wind lease "in Oklahoma, over 70,000 acres in Texas, 13,000 acres in Kansas and over 20,000 acres in New Mexico representing approximately 2,600 MW" of energy in the last twenty years. Additionally, they have leased 13,000 acres of land in Texas to develop solar energy. Thus, the value limitation offered in Quanah ISD is a determining factor for the project to be developed in Hardeman County "as opposed to building and investing in another county, state or region,"

They continue on alternative locations. Chermac already has active projects and ongoing project developments in other states, and if necessary, “further investment can be redeployed to other counties and states competing for similar solar projects.” Due to their establishment in the industry, they “continually compare investment opportunities, rate of return, and market viability of each project based upon project financial metrics.” Additionally, “each project individually competes for a finite pool of capital investment.” So, “state and local tax incentives contribute to the lowering of the cost of power” they can sell to their customers, making their “investment more viable and marketable.”

The project developers explain that “due to the extremely competitive power market in Texas,” power purchase agreements are at a much lower contracted power rate than in other states. Thus, “the property tax liabilities of a project without tax incentives in Texas lowers the return to investors and financiers to an unacceptable level at today’s contracted power rates.” Moreover, without the tax incentives offered by the program, an energy project with a power purchase agreement in Texas becomes non-financeable, so the incentive is critical to the development of the proposed project (Quanah Application, 2021).

The final project example is from Oberon Solar Project developed by 174 Power Global in Ector County Independent School District. The first notable statement of the documentation they provided is that currently, the 6,000-acre project has a minimum capacity of 50 MW but has the potential to be larger “as feasibility is improved via economic development incentives.” They add that their company is the “vertically integrated subsidiary of the $100 billion, Fortune Global 500 Hanwha Group,” and they have “become the 2nd largest global manufacturer of solar cells and modules, and a leading developer, financier, and owner of the US and international solar projects.” They also attach a handout that provides project and company details. In addition to

the location and capacity, they add that it is a $50 million investment. The company also added that they had developed more than 35 utility-scale solar projects totaling 500 MW completed and 450 MW in the final stages of development.

The following documentation to assist in determining if the limitation is a determining factor begins by saying that the company is actively developing projects throughout the US and internationally. They explain that property taxes are the highest operating cost for developing a solar farm because there is no associated fuel cost to produce solar energy. In Texas, wholesale electricity prices are already below the national average. Moreover, it is necessary for the state to limit property tax liabilities for solar projects to offer competitive electricity prices to Texans with an adequate return to the project investor and financers. Without the incentive, the level of return is an "unacceptable level at today's contracted power rates under a power purchase agreement."

They provide the example of California, which has statewide subsidies available for REEG projects and higher electricity prices that allow for a higher average contracted power rate. Thus, markets in states like California "offer an attractive incentive for developers to build projects in those markets over Texas." Therefore, they require an appraised value limitation to proceed with investing capital to develop a project in Texas over "other states where the rate of return is higher on a project basis" due to the statewide subsidies and higher electricity prices. Consequently, they will abandon their application and invest in other states without the limitation.

In all of the solar project applications on the Comptroller's website, the project developers list all of the facilities needed for commercial generation of electricity, such as solar PV panels and modules, racking and mounting structures to support the modules that convert the

sunlight to direct current electrical power, inverters to convert the direct current power to alternating electrical power, transformers to increase the voltage, generation transmission lines, meteorological equipment, roadways, paving, fencing, and more. Many projects also include battery storage in their project descriptions (Ector County Application, 2018).

3.2 Interviews with Stakeholders

The process of creating Chapter 313 agreements relies upon expert legal assistance to Independent School Districts and investors. To understand this process, I met with Dan Casey and Gretchen Hoffman from Moak, Casey, & Associates (also known as MoakCasey), a school district finance consulting firm in Austin, Texas. Originally established in 1998 to run revenue estimates and provide expertise on financial matters for districts, MoakCasey has worked on Chapter 313 agreements since its inception in 2001. Their website notes that Lynn Moak and Dan Casey created the consulting firm "after recognizing the need for an independent source of high-quality, data-driven public information useful to school district leaders and policymakers" (MoakCasey, 2022).

Outside his work at MoakCasey, Dan Casey has also held senior staff positions at the Texas Association of School Boards, the Texas Legislative Budget Board, and the Texas Comptroller of Public Accounts. Their website notes that his experiences and "relationships with education leaders at the legislature and Texas Education Agency" have made him well-distinguished within the financial and educational industries. Dan Casey is recognized as the "foremost expert on Chapter 313 agreements due to his extensive work advising over 300 school districts on their limitation agreements (MoakCasey, 2022). Based on our data, MoakCasey is the leading consulting firm in Chapter 313 solar agreements as they consulted on 44 of the 143 active solar agreements.

During our meeting, Mr. Casey began by providing historical insight into the conception of Chapter 313. He explained that in the early 1980s, voters approved a constitutional amendment that allowed local taxing units to offer tax incentives to attract new industries and businesses (Casey, 2022). However, the incentives could only be under a state-created program. Cities, counties, and school districts participated in these abatements under Chapter 312, the code that Chapter 313 comes from. In 1993, new school district litigation resulted in what is known as the recapture system.

The recapture system, also known as the Robin Hood system, involves wealthy districts sending money to the state to even out wealth advantages. The recapture system arose from the attraction for companies and districts to grant 312 abatements to reduce their wealth to not have to send as much money to the state. Consequently, through the 1990s, school districts became less involved in tax incentives for new industries. Mr. Casey explained that their lack of involvement became problematic because school taxes are roughly half the amount one pays in property taxes. He elaborated that large companies, such as Intel, planning on investing in development in Texas, abandoned their plans because of the high property taxes. Intel specifically chose to build its manufacturing facility in Arizona.

The lack of involvement of school districts in these incentives, as well as the high property taxes led to House Bill 1200, the foundation of Chapter 313 in the Tax Code, to be passed in 2001 for the purpose of attracting capital investment. He noted that the target of attracting large capital investment to Texas is why many of the first 313 agreements are manufacturing projects. In the early stages of the program, they tried to attract energy and utility companies to participate. However, utilities were not interested because they were going through the process of deregulating the electricity grid in Texas and did not want subsidized competition

from Chapter 313 agreements. Nevertheless, they were simultaneously facing portfolio requirements that required them to source some portion of their electricity from renewable energy. As a result, renewable energy projects were added to the program.

Mr. Casey recalls that after adding renewable energy to the program, their first agreements were the wind energy projects outside the small city of Sweetwater, Texas, in Nolan County. He explained that this project in Blackwell ISD spanned across three school districts and the total investment was approximately $90 million in a city that had not seen new investment at this scale in decades. The commissioners of Nolan County began to focus on attracting these wind energy projects, which led them to go from having one wind turbine to having 1,400 in five years. The city began to experience a shift in its employment demographics as vacant storefronts, such as an empty Coca-Cola bottling plant, began to be bought out by wind energy servicing and repair companies. The development of the wind energy industry in Sweetwater kindled the spread of wind energy projects in the Panhandle and throughout West Texas.

He further elaborated that more projects have been developing on the coast and throughout South Texas within the last decade due to the consistency in coastal winds throughout the day instead of the peak production time at 2 am in West Texas. Shortly after, solar energy projects began developing in the same area. More recently, MoakCasey has been working on constructing a Tesla plant outside of Austin, Texas, in Del Valle ISD- a billion-dollar project. He stated that the plant has already hired 55 students graduating from Del Valle High School. While the manufacturing projects with these large companies are attractive for districts as they bring in significant attention and investment, Mr. Casey estimates that around two-thirds to a quarter of the current projects they are working on are renewable energy. In terms of the investment amount, manufacturing projects consume around two-thirds to a quarter of the program's total

investments and offer more jobs than renewable energy. However, they see fewer jobs offered in manufacturing facilities as technology advances.

Mr. Casey considers the most significant impact of Chapter 313 that he has seen to be the opportunity for investment the small rural communities now have to expand their tax base and put the money to use. He provided the example of a small community that he visited the week prior, bringing in an additional $235 million to their existing $130 million tax base from a renewable energy agreement. Mr. Casey further explained that the schools use the money for a multitude of purposes, such as issuing bonds to build newer schools. He said that the first two agreements that he worked on were on campuses with buildings built in the 1930s by the Works Progress Administration during the Great Depression. Additionally, one district was built over a sewer line which engulfed the schools with sewage in the air when the weather became warmer. The Chapter 313 agreements afforded the districts the opportunity to improve their facilities and provide a source of income for improvements for at least 50 years.

Regarding criticism of Chapter 313, Mr. Casey stated that prior to the program, the majority of the wealth these rural cities had was tied to the oil and gas industry. Consequently, there has been heavy criticism from the fossil fuel industry. Mr. Casey said he responds to the criticism by asking, “what would replace this level of investment that is going into these communities without this program,” which often results in no answer. Another contention he has experienced is people arguing that the companies would have come to Texas regardless of the program. However, he stated that they have dealt with enough of these agreements to know that is not true. Mr. Casey elaborated that the lack of state regulation is one of the aspects that may make Texas more convenient to invest in.

Additionally, because of the prominence of large pieces of land owned by one person, it is more convenient to lease land from one landowner. Moreover, there are plenty of other places that offer benefits for these companies to locate and invest in, not only in the US but also internationally. He concluded that the biggest controversy with the 313 program is whether tax incentive programs are necessary. He added that from his observation, most other states and countries offer incentives, and companies are ultimately obligated to pursue the maximum benefit for their shareholders.

On the logistics of the program, Mr. Casey explains how the design of the agreements ensures that the school will not suffer financially from the abatements because they include revenue protection payments and supplemental payments. The income from revenue protection payments and supplemental payments are appealing to schools because they are not subject to recapture or accounted for in state aid formulas. Based on the Average Daily Attendance (ADA), assuming that there is a minimum of 500 students, the supplemental payments are capped at $100 per student or $50,000 annually. He said that school districts would often put this additional revenue into a foundation that can issue scholarships for their students.

Regarding the limitation on the property value, he explains that the limitation amount typically corresponds with the minimum amount of investment a company must make. For example, if the limitation amount a company is receiving is $20 million, it must make at least a $20 million investment within the qualifying time period. The maximum limitation amount is $100 million a year for ten years, depending on the size and demographics of the school district. At the end of the ten years, the school will begin taxing the company at the full property value amount, factoring in market conditions and depreciation of machinery equipment. He estimates that most of these smaller districts see a limitation amount of at least $20-30 million and thus an

investment of at least that or more within the first couple of years of the agreement that provides a long-term benefit. He comments that many of these property-poor school districts, especially wind projects near the South Texas border, have never seen investment of this scale.

Further, while there is a limitation on the school's property value for M&O purposes, the whole project value is taxable for I&S taxes for payments on their bonds. He considers this a major attraction for these communities. He explains that equalized state aid funding essentially subsidizes the tax savings a company receives under Chapter 313 because state aid formulas use the limited property value amount, not the full project value, resulting in less state aid. Mr. Casey notes that the program's design is significant to the effectiveness of the school expanding their tax because, while the state provides some funding, that amount has shrunk over the years, leaving the district to rely heavily on local taxpayers and bonds. However, it is essential to note that because of the program's design, the taxpayer will not be paying any higher taxes because of an agreement in their city. Moreover, these agreements bring significant capital investment to communities where there would not be otherwise.

In regard to the availability of 313 agreements in urban districts, Mr. Casey explained that because the agreements require a minimum investment amount before they can receive tax benefits, it is typically not logistical for a few reasons. First, they do not have the space to have a project large enough to meet the minimum investment amount. Second, a solar or wind project that requires more than 1,000 acres may not be as beneficial to a city with limited space. He explained that it would be more beneficial for those cities to build a subdivision to attract more students to their districts. On the other hand, it is typically more beneficial for them to keep their remaining land for agriculture because it can be more heavily taxed.

As far as the expiration of the program in December 2022, Mr. Casey notes that he is not sure what to expect from the Texas Legislature but that the expiration will have no impact on existing agreements. He does add that he has been told that if the program were to continue, it would not be able to continue under the name "Chapter 313." He said there had been discussions about limiting the program to only large projects. However, he does not know if the legislative support will be there for this option because it limits the areas available to around 10-15 school districts where the projects can be built in. Ms. Hoffman added that the legislature should consider what aspects of the program may need to change to benefit our economy, such as job and wage requirements and the addition of newer industries such as cryptocurrency, based on the changes we have seen in Texas, not just since the program was established but also in response to COVID-19.

After our interview, I reached out to Mr. Casey via email to clarify information on supplemental payments. Specifically, the statistic mentioned by Nathan Jensen and the TTRA that Chapter 313 school districts recover approximately 40% of the tax benefits a company receives. In an email response, he wrote that in the 2001 legislative session, when Chapter 313 was being developed under House Bill 1200, "the late Kim Brimer, then a House member who was the bill sponsor, wanted the support of the Texas Association of School Boards for his bill." The incentive they decided on was to allow school districts to negotiate with the company on some benefits in exchange for approving the agreement. After the first Chapter 313 agreement between Brazosport ISD and Dow Chemical was approved, "the district asked that it be protected from revenue losses and sought no additional benefits."

He recalled that the next project their firm worked on was in Port Neches-Groves ISD. The company representative informed Mr. Casey and the school district that "the company

believed strongly in their educational program and they were going to donate 50% of any tax savings they received to the District." Following this agreement, he recalled working on several wind projects and negotiated a 40% supplemental pay with the company representative on his projects. Mr. Casey explained that "once a few districts received 40%, all of the other school districts wanted the same deal as their neighbors, although this still required negotiations with the companies in each case."

He explained that the 40% became controversial as the projects began to increase dramatically in size. The first project he referenced in Brazosport ISD had "about a $90 million valuation spread over three school districts." In contrast, the later projects were individual districts with 200 or fewer students with $400-500 million projects. For these larger projects, "the 40% translated into several million dollars a year," which triggered the legislative response in 2009 to limit supplemental payments to $100 per student using the ADA in future agreements. A few years later, the $50,000 annual minimum was established for smaller districts that do not have a high ADA. Under the current law, these benefits can be collected for 15-16 years.

Mr. Casey adds that in the agreements their firm has worked on for the last decade, 35-45% was standard for supplemental payments because it was "a smaller project and/or involved a large district in terms of ADA and the $100 per ADA consumed too much of the net tax savings to make the project viable." From his experience, he senses that "most companies feel like they need to see at least a 50% savings before they can sell the agreement to their management." While he has not gone back to read Jensen's research "in some years," Mr. Casey recalled that Jensen focused on "much earlier agreements which operated under looser rules and the original negotiated 40% I mentioned that emerged."

He addresses that what he typically hears now from critics of the program is that "if a 40% benefit is received by a school district, the state is overpaying by that amount" through subsidies. He wrote that his "personal observation" working on these agreements is that "without some form of district incentives, a number of these projects would not be considered by school boards, although they clearly add to the capital investment that is the goal of the program." Additionally, he believes that the major companies developing the projects "have consistently supported supplemental benefits for local school districts as part of their consideration of these company incentives" (Casey, 2022).

To further develop my understanding of the 313 processes, I met with Shelly Leung, the Director of Economic Development at Powell Law Group (PLG). According to their website, PLG "has helped to bring over $30 billion of economic development through the successful negotiation of many Chapter 313 value limitation agreements" (Powell Law Group, 2022). According to our data on active solar projects, PLG was the school district consultant on 30 projects, second to MoakCasey.

Ms. Leung explained that a lot of the money received by the school districts from the agreements goes towards supporting the Education Foundation, which can provide scholarships for their students for higher education (Leung, 2022). Additionally, they typically see the money go towards funding teacher salary raises. Outside of the monetary benefits, she explains that they see long-term partnerships between the school districts and these companies to help their Career Technical Education (CTE) program or provide internships for students interested in renewable energy. Further, they have the opportunity to be exposed to what working in that field looks like and understand how solar panels work.

When I asked about the plausibility of the program working for inner-city school districts, Ms. Leung explained that due to the large amount of land needed to install utility-scale solar farms, Chapter 313 could not directly impact these urban districts. However, she does note that while inner-city schools may not be able to participate in Chapter 313 solar agreements directly, a large amount of investment the program brings to Texas overall, the more property taxes get shared throughout the state through recapture.

Ms. Leung concludes that she is glad renewable energy programs can participate in the Chapter 313 agreements and Texas is diversifying its energy portfolio. However, she added that during every legislative session, some legislators try to remove renewable energy projects from the program. Specifically, due to the politics of Winter Storm Uri, there became a distinct division of oil and gas versus renewable energy. Ms. Leung said that they all work together in reality, but politics distract from progress. For example, there has been a push from the fossil fuel industry. Now, large oil and gas companies such as BP and Shell are investing in the research and development of renewable energy and have renewable energy subsidiaries.

To gain a better perspective on the program's impact on school districts, I met with the Superintendent of Mount Calm ISD, James Wright. According to Mr. Wright, the Mount Calm ISD has Chapter 313 agreements in the developing phases with three school districts. He explains that the agreements are incredibly beneficial because one-third of their operating budget, or $2.5 million, comes from the local tax base, whereas the other approximately $6 million comes from the state.

Furthermore, if there were no Chapter 313 agreement in place, by year two or three of the project’s development, they would become a property-wealthy school district subject to giving money back to the state through recapture. So, for every dollar their property value increases,

they must give an equivalent amount back to the state to remain at a certain level allotted to spend for M&O purposes such as salaries, transportation, furniture, and food. The only way for a district to receive income that the state cannot take is from the supplemental payments offered through the Chapter 313 agreements.

He adds that their agreements provide them $100 per student starting year one of the agreement, and by year three or four, they receive a "hold harmless lump sum." For their district, between the three agreements, they will receive over 4 million dollars in the 2024-2025 school year. The money from these additional payments can be put into a savings account that he plans to use for long-term salary increases for their staff on all levels, including teachers, custodians, bus drivers, maintenance workers, and cafeteria workers. Mr. Wright stated that, while the program has provided huge advantages and benefits to their school district, a downside is resistance from their farming and ranching community because the projects take acreage out of production (Wright, 2022).

4. CONCLUSION

4.1 Summary of Results

The rapid development of solar energy capacity in Texas has raised a series of political, social, economic, and environmental implications. Previous analyses on the increased capacity, such as the report done by the EIA, offer few explanations for the increase, such as the federal solar ITC, lower solar technology costs, and ample sunlight in the West Texas Permian Basin. However, these studies have omitted a relevant policy instrument affecting Texas's solar energy expansion. Our research aimed to answer how Chapter 313 utility-scale PV installations have impacted solar capacity expansion and rural and low-income school districts and surrounding communities.

A systemic analysis of publicly available data revealed a large expansion of utility-scale solar power using Chapter 313 agreements between solar companies and ISDs. Since the first solar project application in 2013, solar energy Chapter 313 applications began to increase in 2018, with a significantly larger increase in 2019. Since the solar agreements have increased, wind project agreements have remained the same at roughly half the number of agreements as solar per year. In terms of the year the solar plants became fully operational, the total installed capacity per year gradually increased in 2019 and again in 2020. However, in 2021, there was a much more significant increase in the total installed capacity than the increase in the two years prior. Solar energy projects also consume a large share of the pending applications, and if all of them are approved, Chapter 313 solar farms will add nearly 15 GW to the ERCOT grid.

The limitations to this data are that while the applications and Biennial Reports from 2020 provide the date of the application, the first day of the qualifying time period, and the date

the facility became fully operational, there is no exact date for when the capacity became available on the ERCOT grid. So, there could be some differences in the exact amount of GW added per year. Additionally, the pending applications also do not have a date they will be added to the grid. Nonetheless, the projects have contributed significantly to Texas' solar capacity.

Other limitations to our research are that Chapter 313 and the rise of solar energy are both ongoing phenomena subject to geographic, social, political, economic, and environmental factors. Geographically, utility-scale REEG projects require substantial amounts of land in order to have an efficient power density. Wind projects have a longer history of developing in Texas than solar projects. According to the IOP report, wind projects require more land than solar projects, which could also be a contributing factor to the dramatic increase in 313 solar agreements.

Another geographical limitation to Chapter 313 is that the utility-scale REEG projects are not feasible for inner-city districts. Thus, while they benefit property-poor rural districts that receive supplemental payments outside of state aid formulas, inner-city districts are largely excluded from the opportunity for these investments and additional revenue due to the nature of the amount of land the projects require. However, once the projects are taxed at full value, if the district becomes property wealthy based on their tax base, the additional investment from the project outside of the supplemental payments is subject to a dollar-for-dollar recapture from the state to redistribute to property-poor districts.

The social and political limitations are that because this is an ongoing phenomenon, the political climate around renewable energy and climate change can be divisive, leading to an increased acceptance of REEG or increasing negative connotations. While there has generally been a wide social acceptance of REEG as people recognize the need to transition away from

fossil fuels to develop clean and sustainable energy, the political climate, especially in Texas, also produces strong negative feelings towards phasing out fossil fuels for wind and solar energy. This is not to dismiss the concerns farmers, ranchers, and local communities have about how these large-scale projects will affect their land but rather explain how other factors besides Chapter 313 influence the development and acceptance of REEG.

An economic limitation is our ability to measure how the federal solar ITC affected the development in Texas as it offers a 26% tax credit for any utility-scale solar project that begins construction in 2021 and 2022 and lowers for projects beginning in 2023 and later. However, this does not apply to the rise seen in 2019 and 2020. Additionally, Chapter 313 currently expires at the end of 2022 for new applications, which could also contribute to the urgency to apply for a solar project while the incentive lasts.

A final limitation on determining the impact Chapter 313 projects have on benefiting the environment is that these agreements include large manufacturing projects that may have negative environmental impacts. Thus, there is no way to measure the difference between the adverse effects of the manufacturing projects to the benefits of REEG projects. However, the rates that Chapter 313 agreements have added solar energy capacity to Texas is promising to their overall benefit. Additionally, Chapter 313 has four pending renewable gas projects which are also adding to REEG development in Texas.

Based on the data we collected on the total amounts of investment from the solar energy projects and the stakeholders' statements, Chapter 313 agreements have brought significant investment into these districts that will increase the tax base. While we did not collect the data on how much the agreements brought into the districts from supplemental payments due to time constraints, the interviews clarified that most, if not all the agreements receive supplemental

payments from the companies because a consultant is provided to the district at no cost to negotiate their agreement. The full taxable value on the I&S taxes has also been helpful in these districts paying off debts. While there was only approximately a 10% difference in the number of projects that were in a rural county or an SIA between solar and wind projects, there were significant differences in property value categories as wind agreements tend to be in districts with higher property values than solar agreements.

As far as the requirement for the limitation to be the determining factor for the company to invest in Texas, the documentation provided by the companies all emphasizes the need for an incentive to make an adequate return on their investment. The primary reasons for the limitation being necessary are that property taxes are the highest tax solar companies will pay, and many states have subsidies on all renewable energy projects, whereas Texas does not. Additionally, the low energy prices in Texas require an incentive for the company to charge a competitive price to consumers while making an adequate return to investors. Without the incentive, the level of return for the current contracted power rates in other states is unacceptable. Many companies add their prominence as solar energy developers and thus have many other project locations in other states and countries that offer higher returns on their investment.

4.2 Future Implications and Research

The data collected from the Comptroller's website that we used for our research shows that the program has been implementing utility-scale solar energy at fast rates in recent years. As a result, they are expanding the solar energy industry and market in Texas and contributing to the expansion of carbon-free energy. Additionally, the projects provide large amounts of investment into the state and increase local tax bases while also providing extra revenue for school districts at no expense through supplemental payments. The investment is primarily located in rural,

property-poor districts that would not have seen these levels of investment in their community without the program. With the money they receive from supplemental payments, they can improve their facilities and provide salary increases for their teachers and supporting staff.

Chapter 313 projects are also exposing generations of students and workers to the renewable energy industry as it is increasing in prominence. School districts are adding renewable energy to their CTE program which is a unique opportunity for students to work directly with the plant. Additionally, the projects provide opportunities for students to have internships and valuable knowledge from their exposure to utility-scale renewable energy plants. Their knowledge and exposure will make them competitive employees and potential researchers.

While there are numerous benefits to the program, there are also disadvantages to Chapter 313. The primary disadvantage of Chapter 313 is the lack of availability of the program and the benefits of revenue from supplemental payments to non-rural districts, specifically low-income, inner-city schools that do not have the land for renewable energy projects. While recapture through Robin Hood redistributes some of the wealth from increasing the local tax base in districts with a Chapter 313 agreement, they do not receive any of the benefits from supplemental payments that provide revenue outside of state-aid formulas for improving their district's resources and staff salaries. Future policies and programs should focus on how to include districts that do not have the space for utility-scale solar installations in their community. Future research should examine the plausibility of implementing incentives for rooftop solar energy that may benefit these communities.

Another possible disadvantage of the program, as mentioned by Justin Miller in the Texas Observer, is large companies taking advantage of smaller communities by suing the appraisal districts to receive lower property value estimates or overestimating the projected amount of the

property value will be worth at the end of the ten-year agreement. Future incentives and programs that involve deals between large companies and small communities can ensure that the terms of the agreement prevent situations like the ones mentioned from occurring. Further, many of the older agreements referenced in Miller's critiques were older manufacturing agreements with well-established companies. In contrast, the solar energy agreements are with newer, comparatively smaller solar companies working to establish themselves. The nature of the solar companies working in a developing industry may prevent scenarios like the ones with Motiva from occurring.

The primary concern for the rapid development of utility-scale solar energy comes from local community residents, farmers, and ranchers concerned about how the solar farms will affect their community in terms of agriculture production, land values, loss of undeveloped green space, and aesthetics. Additionally, there is a concern about how the solar plants will affect the wildlife and the environment once the lifespan of the solar farm expires. As far as addressing these concerns, future research should focus on the exact impacts on agriculture production and land values as well as how PV modules can be recycled, reused, or repurposed. Research can also address how utility-scale solar farms affect the environment and surrounding wildlife and how the land can be refurbished or used for another purpose after the lifespan expires.

As with any new, technologically advanced industry, the exact side effects are not always known. We know that our choice is between continuing to develop utility-scale solar energy to reduce carbon emissions from energy production and risk the possible side effects to the land used that are previously mentioned. Alternatively, continue to rely on carbon-intensive forms of energy and experience the consequences of global warming and climate change as CO2 is added to our atmosphere. Additionally, with the failures of natural gas meeting the demands of extreme

weather in the case of Winter Storm Uri, increasing renewable energy capacity on the grid in Texas will be necessary. Additionally, the energy market is becoming less profitable for natural gas and coal than renewable energy because of the associated maintenance, operation, and fuel costs.

Other topics that future research may focus on is if Chapter 313 agreements are improving social acceptance of solar farms or generating more opposition. Additionally, determining if their opinion of a program that incentives solar energy development would change if it included rooftop solar energy. As the solar projects develop and the schools receive their total amounts of payments, more studies can investigate how exactly they have used the additional funds. Additionally, research can study how these projects have affected the students in those districts in their grades, graduation rates, and future careers.

Regarding the next Texas Legislative session in 2023, the legislature should consider renewing or redesigning the Chapter 313 program with the previously discussed concerns and benefits in mind. Additionally, they can redesign the program to focus more on expanding and improving profits for REEG projects instead of focusing on generating capital investment from manufacturing projects. Considering the results and what they may imply for the future of renewable energy incentive programs, benefitting our school districts in Texas is compatible with expanding solar energy as we transition into a less carbon-intensive society.

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