THE ENERGY TRANSITION:

DECARBONIZATION IN PRACTICE

A Record of Study

by

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Submitted to the Graduate and Professional School of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF ENGINEERING

Chair of Committee,	Chuck Wolf
Committee Members,	Craig Marianno Jasen Castillo Galina Tsvetkova
Head of Department,	Timothy Jacobs

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Major Subject: Interdisciplinary Engineering

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ABSTRACT

This Record of Study represents the culmination of a lifetime of learning and personal advancement of the professional practice of engineering. This doctoral pursuit began with the objective of meaningfully advancing the energy transition, both as a practicing engineer and as an advocate for new technologies. As a sole proprietor and leader of a professional energy engineering firm, Mr. Schaper felt a need to expand the reach of his practice beyond petroleum engineering. This Record of Study describes his efforts to incorporate new and impactful engineering disciplines into existing professional engineering practice. This Record of Study addresses a Doctor of Engineering degree plan focused on constructing a unique skillset, adding depth of knowledge in new energy domains, and capitalizing on acquired expertise by converting it to commercial opportunity.

DEDICATION

This Record of Study is dedicated to Mr. Schaper's grandparents, who have supported his lifelong learning efforts.

ACKNOWLEDGEMENTS

Mr. Schaper would like to acknowledge Dr. Chuck Wolf for his unwavering guidance throughout this degree. Dr. Wolf's invaluable advice and feedback contributed a great deal to the direction of Mr. Schaper's studies. He would like to thank Ms. Angie Dunn for supporting a novel degree plan. Together, Dr. Wolf and Ms. Dunn ensured requirements for this degree were satisfied.

Mr. Schaper would like to thank committee members Dr. Craig Marianno, Dr. Jasen Castillo, and Dr. Galina Tsvetkova for their willingness to contribute to his academic pursuits. These professors provided engaging course material, educational guidance, and insights into the professional application of technical studies.

Finally, he would like to thank his girlfriend, Christina Miller, and his parents, Leroy and Laurie Schaper. Without their commitment to this effort and unending support for his academic pursuits, none of this would be possible.

CONTRIBUTORS AND FUNDING SOURCES

Contributors

Committee Members

A Record of Study committee consisting of Dr. Charles Wolf, Professor of Practice in the Civil & Environmental Engineering Department (as Chair), Dr. Craig Marianno, Professor in the Nuclear Engineering Department and Deputy Director for the Center for Nuclear Security Science and Policy Initiatives, Dr. Galina Tsvetkova, Professor in the Department of Nuclear Engineering, and Dr. Jasen Castillo, Professor in the George H.W. Bush School of Government and Public Service and Co-Director for the Albritton Center for Grand Strategy oversaw this work.

Other Contributing Parties

During the second phase of the student's internship, Mr. Jonathan Chesebro of the U.S. Department of Commerce's International Trade Administration played a pivotal mentorship role. Pursuant to this experience, the student participated in a directed study focused on the reliability and decarbonization of electric power grids. Published works resulting from this study were supervised by Dr. Le Xie, Professor and Presidential Impact Fellow, and Mr. Rayan el Helou of Electrical & Computer Engineering. Mr. Schaper conducted the remainder of the doctoral studies independently.

Funding Sources

Works prepared under the guidance of Dr. Le Xie were made possible by support from the Texas A&M Energy Institute and the National Science Foundation under Grant CMMI-2130945. Schaper Energy Consulting LLC provided further funding as part of an ongoing investment in Mr. Schaper's continuing education.

The author alone has opinions, findings, conclusions, or recommendations expressed in this material. They do not necessarily reflect the views of the National Science Foundation, Texas A&M University, or Schaper Energy Consulting LLC.

NOMENCLATURE

The terminology presented in this document with relevance to the doctoral studies is abbreviated using the following rubric.

A&D	Acquisitions and Divestitures
CARB	California Air Resources Board
CCS	Carbon Capture and Sequestration
CCUS	Carbon Capture, Utilization, and Storage
DOC	Department of Commerce
DOE	Department of Energy
EOR	Enhanced Oil Recovery
FOAK	First-of-a-Kind
HDEV	Heavy-duty Electric Vehicle
HR	Human Resources
ITA	International Trade Administration
KPI	Key Performance Indicator
LCFS	Low Carbon Fuels Standard
OEEI	Office of Energy and Environmental Industries
RFP	Request for Proposal
SEC	Schaper Energy Consulting LLC

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1. INTRODUCTION

The Doctor of Engineering program at Texas A&M University is a constituent offering of the Department of Multidisciplinary Engineering. The stated objective of this program is to advance the professional practice of engineering and encourage 'students to work at the highest levels of the engineering profession.' As such, the effort is 'not intended as a research degree nor as preparation for a faculty position at a research university.' The Doctor of Engineering program instead requires the completion of a year-long internship to satisfy a requirement for professional practice to ensure adequate preparation for a career of advanced engineering leadership.

As part of the program requirements, Mr. Schaper submitted an internship proposal approved on January 3rd, 2021. The proposal described phases of both internal and external internship efforts, which would contribute to the culmination of this Record of Study. Mr. Schsper conducted the first and third phases of the internship within his consulting company, Schaper Energy Consulting LLC ("SEC"). The second phase involved an external unpaid internship with the Department of Commerce's International Trade Administration.

Internship phases are presented below, along with the critical objectives of each step.

1.1. Spring 2021: Prepare SEC for Business Transition

- Identify new energy disciplines to pursue

- Assess appropriate marketing channels for new lines of business
- Investigate business opportunities in both public and private industry
- Spearhead changes required to conduct business in adjacent industries

1.2. Summer 2021: Office of Energy and Environmental Industries (OEEI) Internship & Independent Power Studies

- Establish expertise in civil nuclear trade and renewable energy technologies
- Augment OEEI to support energy export competitiveness by spearheading public-private partnerships
- Build relationships that will benefit future government contracting initiatives

1.3. Fall 2021: SEC Business Planning & Assessment

- Organize lines of business around acquired domain expertise
- Select marketing strategies to address each line of business
- Implement organizational and technology growth plan
- Assess progress against KPIs and detail future strategy

An overarching objective of these doctoral studies is to enhance Mr. Schaper's breadth of engineering knowledge in energy transition disciplines. A secondary aim of the internship is to position SEC to pursue new lines of business and foster improved engineering consulting opportunities. The program succeeded in advancing the first objective and contributed significantly to the second objective, as illustrated in this Section 5.4.

2. PREPARE SEC FOR BUSINESS TRANSITION

2.1. Identification of Relevant Transition Fields

It is important to note that Schaper Energy Consulting LLC ("SEC"), the consulting business for which Mr. Schaper is the sole owner and principal engineer, was founded in 2014 with a core focus in petroleum engineering and adjacent services. Before 2020, the company practiced extensively in the petroleum engineering sub-discipline of reservoir engineering, even providing expert witness services connected to hydrocarbon valuation and subsurface matters. SEC's sole and exclusive focus was petroleum engineering consulting before this doctoral study commenced.

At the outset of the doctoral program, Mr. Schaper and Dr. Wolf outlined academic and professional objectives. These studies center around 'Energy Transition' topics, including the decarbonization of heavy industry, renewable fuels, and sustainable electrification. These disciplines overlap significantly with topics of heightened public interest and new commercial opportunities in the energy industry. Thus, advancing knowledge in these areas and addressing professional expansion to capture consulting opportunities represented fundamental objectives.

Significant progress toward establishing commercial opportunities did not come until four semesters into the doctoral study. By that stage, Mr. Schaper had completed coursework that dealt with alternative energy generation and decarbonization of energy

production, transport, and use in the global economy. With the benefit of an academic foundation in electrical engineering, specific adjacent engineering disciplines emerged as the focus areas for the remainder of the Doctor of Engineering degree plan and the subsequent focus on engineering consulting practice areas. These lines of business are detailed below.

2.1.1. Nuclear Energy

A fundamental goal of the Doctor of Engineering degree plan was introducing a deep understanding of nuclear engineering, with a specific focus on new technologies, safety, and sustainability. Coursework selected for this degree phase fortified the student's knowledge of environmental impacts, accident preparedness, and security of nuclear generation. Nuclear energy holds great promise for decarbonizing electricity production and providing high-reliability power in times of need. The weather events surrounding Winter Storm Uri reinforced the relevance of this study.

One key takeaway from the nuclear engineering studies is that the civil nuclear industry suffers from a historically poor public perception and resultant over-regulation, both in the U.S. and overseas. During the program, Mr. Schaper explored this challenge to the nuclear industry by securing an internship with the Office of Energy and Environmental Industries. This group within the Department of Commerce's (DOC) International Trade Administration (ITA) advances the U.S government's assistance to firms in the civil nuclear industry as they seek to form public-private partnerships and prosecute

worldwide exports. A multi-jurisdiction embrace of civil nuclear power is a key to sustainability-based energy policy, especially in Europe, where developed economy adoption can reduce regulatory burdens and drive costs. Worldwide adoption of standards and investment support is needed to overcome a history marred by accidents and negative press. One overriding realization throughout the program is that the most significant opportunities in the nuclear industry over the next decade are likely to be facilitating funding for deployable technology; outside of this function, commercial opportunities in the space remain somewhat limited.

2.1.2. Electric Power

One academic goal during the program was to 'catch up' on technologies that had developed in the thirteen years since graduation in 2007 as a classically trained electrical engineer with an undergraduate degree oriented toward power systems and electro-physics. The significant loss of power incidents and related freeze damage that occurred during Winter Storm Uri in February 2021 profoundly impacted the trajectory of Mr. Schaper's academic and professional pursuits. The event crystallized the importance of power reliability. Aside from being personally affected, many family members dealt with extreme and unrelenting cold while attending to children and elderly relatives. Avoidable hypothermia or carbon monoxide-related deaths fatally impacted others.

In response to the event, Mr. Schaper conducted a root cause analysis based on disclosure from ERCOT, which the Electrical and Computer Engineering Department

supported through research grants. The student contributed to two (2) technical papers focused on grid reliability co-authored with Dr. Le Xie and members of his research group (detailed in Appendices A and B). Aside from demonstrating Mr. Schaper's thought leadership in the space, this work was impactful to SEC as the company developed new business lines. The dissemination of self-published analyses and academic journal articles led to multiple commercial engagements with insurance companies and law firms in support of claims made by Texans with losses during the incident. This work is ongoing as of the time of this Record of Study.

2.1.3. Carbon Capture, Utilization, and Storage

Carbon capture, Utilization, and Storage ("CCUS") also developed as a key focus area during these doctoral studies. In addition to being a key decarbonization initiative intended to reverse the effects of anthropogenic GHG emissions, the skills required to implement CCUS are closely related to the practice of petroleum engineering. Petroleum engineers have, for many decades, implemented CO_2-aided enhanced oil recovery (EOR) projects. This experience is beneficial in the pursuit of reducing emissions through CCUS.

Critically, during the program, there were many critical developments in the CCUS space which served to spur industry engagement and advancement of several significant projects. These included the following catalysts:

1. A legislative proposal to enhance the federal 45Q tax credit for both EOR and permanent sequestration applications
2. A considerable increase in the trading frequency and prevailing prices of regulated and voluntary carbon offset credits
3. The emergence of dedicated private equity and public market funding vehicles aimed at decarbonization efforts

These happenings increased public interest in the space and served as a tailwind for consulting initiatives detailed in the Business Plan section of this document.

2.2. Works Contributing to Business Transition Goals

Throughout the degree, several opportunities were available to go beyond the scope of required courses and provide novel contributions in electric grid reliability and carbon capture. The below sections summarize those opportunities and the resulting works.

2.2.1. Natural Gas and Electric Power Coupling

In the summer of 2021, Mr. Schaper studied under the guidance of Dr. Le Xie (Texas A&M Electrical Engineering Professor) to investigate the role of natural gas generation in the Winter Storm Uri power outages. What began shortly after the Storm as an informal root-cause investigation into ERCOT disclosures developed into a formal presentation of the work at the 51st Annual North American Power Symposium. The resultant publication in IEEE is attached to this Record of Study in Appendix A.

2.2.2. Heavy-Duty Vehicle Electrification

Dr. Le Xie supported an initiative investigating the projected impact of widespread heavy-duty vehicle electrification on the Texas electrical grid. This work spurred further interest in the effects of electrification on reliability and led to the pursuit of coursework in smart grid dynamics and numerical analysis methods. The pre-print version of this work is in Appendix B.

2.2.3. Carbon Capture Site Survey

As part of the studies conducted, Mr. Schaper produced a comprehensive survey of carbon capture sites in the United States. The report detailed the method of capture, the capacity of each site, and the stakeholders in each project. This Record of Study includes the document as Appendix C. The calendar year 2021 brought about a significant industry 'pull' to address CCUS from the standpoint of asset development, much of which originated in upstream oil and gas related to the consulting practice. This trend continues to strengthen as of the time of this writing.

2.3. Business Outcomes Connected to Academic Pursuit

SEC closed the year in 2021 by forming a mutually beneficial joint venture (J.V.) with a prominent consulting firm whose practice focuses almost exclusively on the renewable fuels space. The purpose of the J.V. is to conduct CCUS asset development consulting, focusing on education, feasibility, pre-development, monitoring, reporting, and

verification of carbon offsets. The J.V. group also intends to establish a reliable conduit between project developers and carbon markets, going as far as to address implications of carbon offset trading, hedging and insurance products. An example diagram outlining these service offerings is presented below in Figure 1.

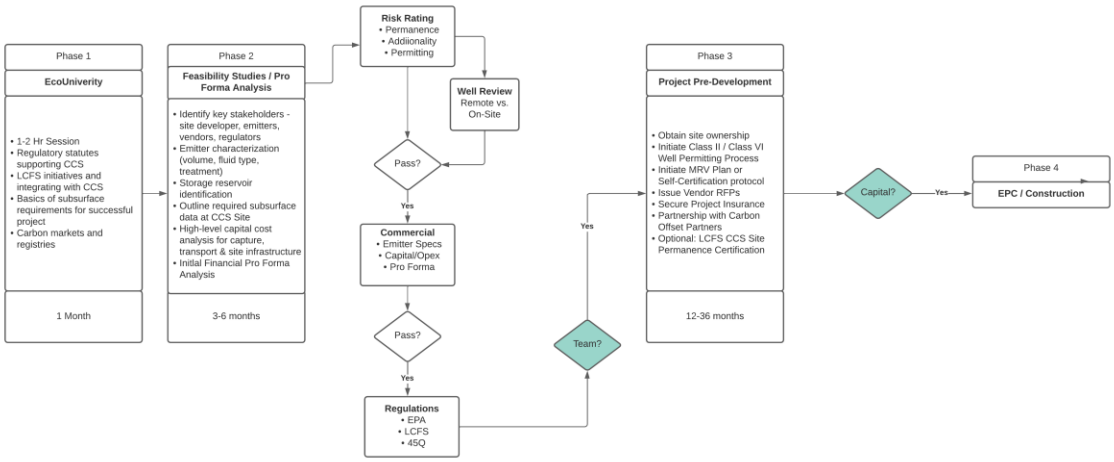

Figure 1 - Illustrative CCS Services Offering

SEC established a core client base of CCUS asset developers throughout 2021. The group includes Lambda Carbon Solutions, a Michigan Basin operator whose repurposing Niagaran pinnacle reefs for permanent storage may constitute the most prominent application in history. Mr. Schaper was instrumental in drafting novel materials as part

of the company's application for site permanence certification with the California Air Resources Board (CARB). This process qualifies the storage site to meet CARB's Low Carbon Fuels Standard (LCFS) CCS protocols[1]. He was also instrumental in preparing the Monitoring, Reporting, and Verification (MRV) Plan for submittal to the EPA. This certification elevates Lambda to a peer group of only ten (10) firms with EPA certification for greenhouse gas sequestration.

[1] https://ww2.arb.ca.gov/resources/documents/carbon-capture-and-sequestration-protocol-under-low-carbon-fuel-standard

3. OEEI INTERNSHIP AND RELATED STUDIES OF NUCLEAR TECHNOLOGY

3.1. Background of OEEI Internship

During the Fall of 2020, Mr. Schaper participated in a Nuclear Engineering course offered by Dr. Kenneth Peddicord, which focused on emerging nuclear energy technology, especially microreactors and small modular reactors. The curriculum introduced the participants to a variety of professionals who had dedicated their careers to the advancement of civil nuclear power. The presenting group of professionals included scientists, lobbyists, vendors, government employees, and various other advocates. The course provided an opportunity to interact with industry personnel and learn of the promise and challenges of nuclear power in the 21st century. Mr. Schaper met Mr. Jonathan Chesebro, a senior trade representative at the Office of Energy and Environmental Industries (OEEI), through the industry presentations.

3.2. Introduction to OEEI

OEEI is a U.S. Government (USG) agency that is part of the International Trade Administration branch of the Department of Commerce. The group's mission is to 'advance the competitiveness of U.S. industries by leveraging in-depth sector expertise to identify their most pressing trade challenges and top opportunities and coordinating public-private sector responses.' A vital responsibility is to liaise between USG and industry participants to advance policies and programs directed at renewable energy,

smart grid initiatives, civil nuclear energy, fossil energy, transmission and distribution of power, and water and air resources management.

3.3. Rationale for OEEI Internship

Mr. Schaper initiated the OEEI internship segment through a preliminary conversation with Mr. Chesebro. As multiple working groups within OEEI overlapped with initiates in this doctoral study, the work was additive to this program's academic and professional objectives. An agreed aim for this internship period was to gain a more comprehensive understanding of the planned advancements in civil nuclear trade; a secondary goal was to contribute to global coordination to address problems faced by civil nuclear programs worldwide. One example of an obstacle faced by nuclear energy advancement is the technology's exclusion from 'green' taxonomy in Europe and elsewhere which precludes both financing and governmental support.

3.4. Contributions to OEEI during Internship

The primary focus of this internship segment was to assist OEEI in advancing global collaboration on civil nuclear trade matters through public-private partnerships. The scope included cooperation with staff members to draft summaries of country-specific talking points delivered to the Assistant Secretary of the Department of Commerce. The Assistant Secretary later relayed these points to partner governments supporting civil nuclear trade initiatives. The responsibilities also extended to coordinating public-private summits to solicit feedback from industry leaders in companies like Exelon and

Holtec International, are responsible for advancing civil nuclear technology, and have done so for decades as operators and construction vendors.

3.5. Key Learnings

The OEEI internship revealed the depth of the UGS's involvement in advancing international civil nuclear trade. While this finding was particularly encouraging, it was also apparent that the group was not as focused on domestic advancement or the construction of new reactors. Instead, the focus remained on broadening civil nuclear power adoption internationally. New nuclear technology tends to struggle under the weight of the First-of-a-Kind (FOAK) problem, which is the phenomenon to describe elevated costs incurred by early adopters owing to high regulatory hurdles and unknowable manufacturing costs. The USG seemed to adopt the position that advancing international adoptions amongst several eastern European governments who were already comfortable with nuclear technology would be the most seamless path to rapid adoption, especially for SMRs where demonstration projects were more palatable.

Industry panels and summits revealed another nuance of the nuclear business: the degree to which European countries disagree on the treatment of nuclear energy is a significant barrier to further adoption, even amongst countries where the technology enjoys overwhelming popular support. Policies adopted in all European Union member states mean that disagreement on classifying nuclear energy as 'sustainable' can prevent advantageous financing arrangements. Despite these headwinds, it seems that the USG's

civil nuclear engagement in eastern Europe is wise, as it enhances the likelihood of new technology adoption and facilitates a broader embrace of SMRs. Factory-built reactors could change the landscape of sustainable energy generation for decades to come; therefore, OEEI's mission to strengthen public-private partnerships remains essential.

3.6. Conclusion of Internship

The internship concluded with a verbal review from Mr. Chesebro. Mr. Schaper covered learning objectives and answered the remaining questions to the satisfaction of Mr. Chesebro. This internship segment provided an invaluable window into international civil nuclear trade. It also served to refine SEC's commercial objectives in the sustainable generation space and elucidate the challenges and opportunities in the civil nuclear domain.

4. SCHAPER ENERGY CONSULTING BUSINESS PLAN

4.1. Business Positioning

Entering the Doctor of Engineering program, SEC was positioned solely as a professional petroleum engineering and financial advisory firm that occasionally assisted on expert witness matters. The firm's repositioning broadens the scope of energy services into the decarbonization space.

4.2. Lines of Business

As part of the new business positioning, the company formally developed new lines of business as the Doctor of Engineering Program progressed. Those new lines of business are described below and elaborated on the company's new website.[2]

4.2.1. Carbon Strategies

The carbon strategies business is broadly defined by SEC to include efforts by clients to decarbonize industrial processes. This work is directed at carbon capture & sequestration (CCS) asset development consulting in many cases. Specifically, the services rendered include education, feasibility, pre-development and development, and Monitoring/Reporting & Verification (MRV) phases. A fundamental workflow within the pre-development stage is the process of developing permitting material for clients

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[2] https://schaperintl.com/carbon-strategies/, https://schaperintl.com/electric-power/, https://schaperintl.com/sustainable-generation/

who are pursuing the development of new carbon sequestration assets, including converting or drilling new Class II or Class VI injection wells. SEC works with these clients to develop a view on the feasibility of the projects from a commercial and engineering perspective and follows up that phase of the engagement by shepherding the technical permitting process through to completion.

4.2.2. Electric Power

An additional line of business that developed as an outgrowth of work in the Doctor of Engineering program was the Electric Power practice. This line of business primarily involves assisting clients in electric power system analysis and reliability matters. To date, a dominant component of this work has centered around the events before and during Winter Storm Uri. The precursors to these engagements were the self-published articles that provided analysis of the root cause of the outages. The company continues its work today providing expert support to the efforts of several insurance companies seeking to uncover weaknesses in the physical and regulatory environment that caused the severe outages.

4.2.3. Sustainable Generation

The final new line of business developed as part of this business repositioning is 'Sustainable Generation.' This last line of business is a 'catch-all' to address advocacy work conducted for nuclear energy and other sustainable generation initiatives. As previously stated, the commercial case for this line of business is not yet fully

developed. However, Mr. Schaper believes that the company should be exceptionally well-positioned to participate in commercial endeavors in this space in the coming years through its public advocacy of nuclear generation.

4.3. Marketing and Advertisement

SEC historically marketed itself exclusively through referral, with clients supporting the business by recommending the company or its principal engineers. This marketing method has advantages in that it builds high-trust, long-lasting partnerships with valued clients. The notable disadvantages are the restricted reach of this approach and resultant limitations on business growth. SEC implemented a three-pronged strategy to bolster market presence to resolve this issue.

4.3.1. Web Presence & Organic Traffic

The revised marketing plan would incorporate an enhanced web presence to drive online engagement and, ultimately, inbound customer conversions. This effort began in 2020, concurrent with both the beginning of this doctoral program and SEC's addition of new lines of business. A self-published blog was added to the company website in late 2020 and enhanced through self-publishing in early 2021. This medium serviced the company well, increasing visibility of the site and organic search traffic, as seen in Figures 2 and 3.

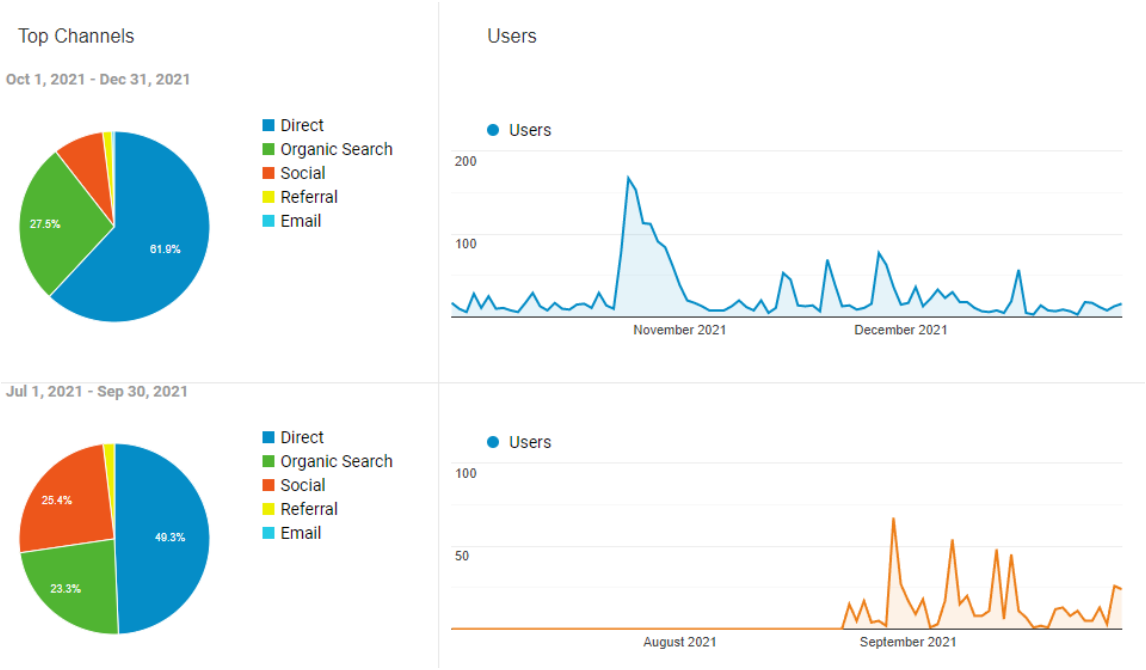

Figure 2 - SEC Website Traffic via Google Analytics

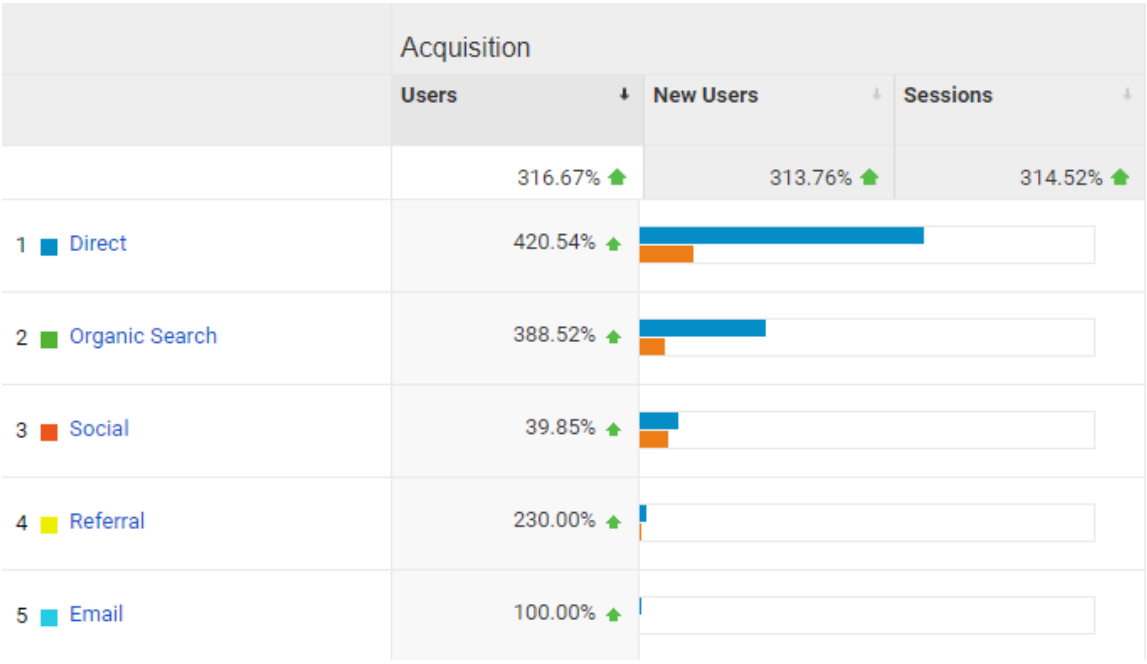

Figure 3- SEC website Traffic via Google Analytics (Cont'd.)

The company has invested funds in search engine optimization, and organic traffic builds as articles are self-published on several energy transition topics. Figure 4 includes several topics covered in the company's blog.

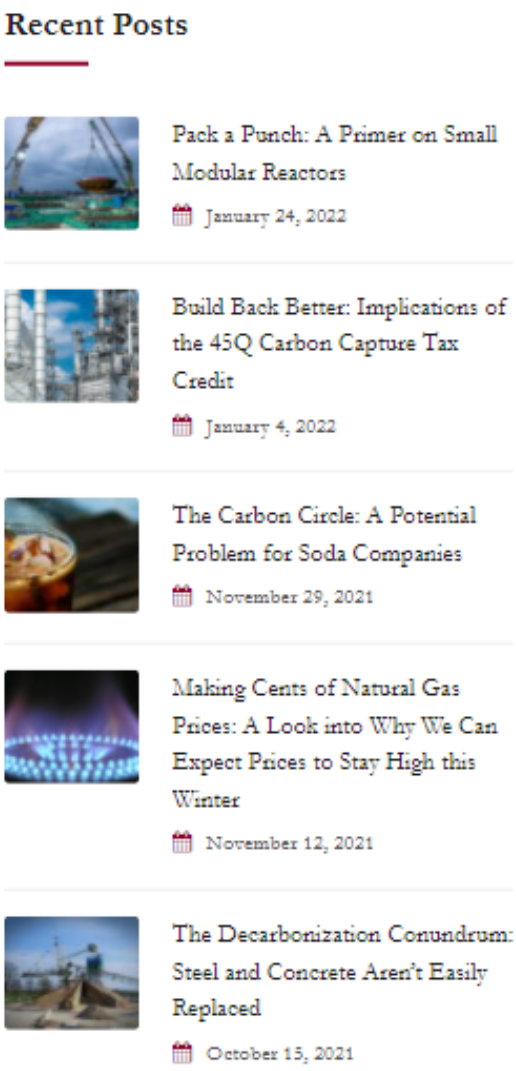

Figure 4 - Representative Blog Articles

The company realized several direct conversions of clients from articles published during and after the February 2021 Winter Storm event. These new clients directly

impact revenues in the “Electric Power” segment (company financials found in Section 5.4 of this document). Law firms and insurance companies dominate this group; they seek expert consulting assistance to deepen their understanding of events or investigate the root causes of losses. These new client engagements are ongoing and continue to expand in scope as of this writing.

4.3.2. Social Media

Mr. Schaper began providing regular commentary through the company and personal social media channels on energy transition topics in early 2021. The posts drew followers, modest engagement, and incremental web traffic. The company improved market connection throughout the pandemic through regular publishing on the redesigned website and social media. Multiple clients confirmed they were encouraged to engage with the company and solicit Requests for Proposals (RFPs) based on a blog post or content provided on social media.

One primary avenue for social media publishing and commentary was LinkedIn, with Twitter acting as a supporting secondary outlet. The company used both social media platforms extensively to drive client conversion through direct inquiries and the company’s website. Figure 4 contains a typical example of a LinkedIn post published by Mr. Schaper as part of this outbound marketing effort.

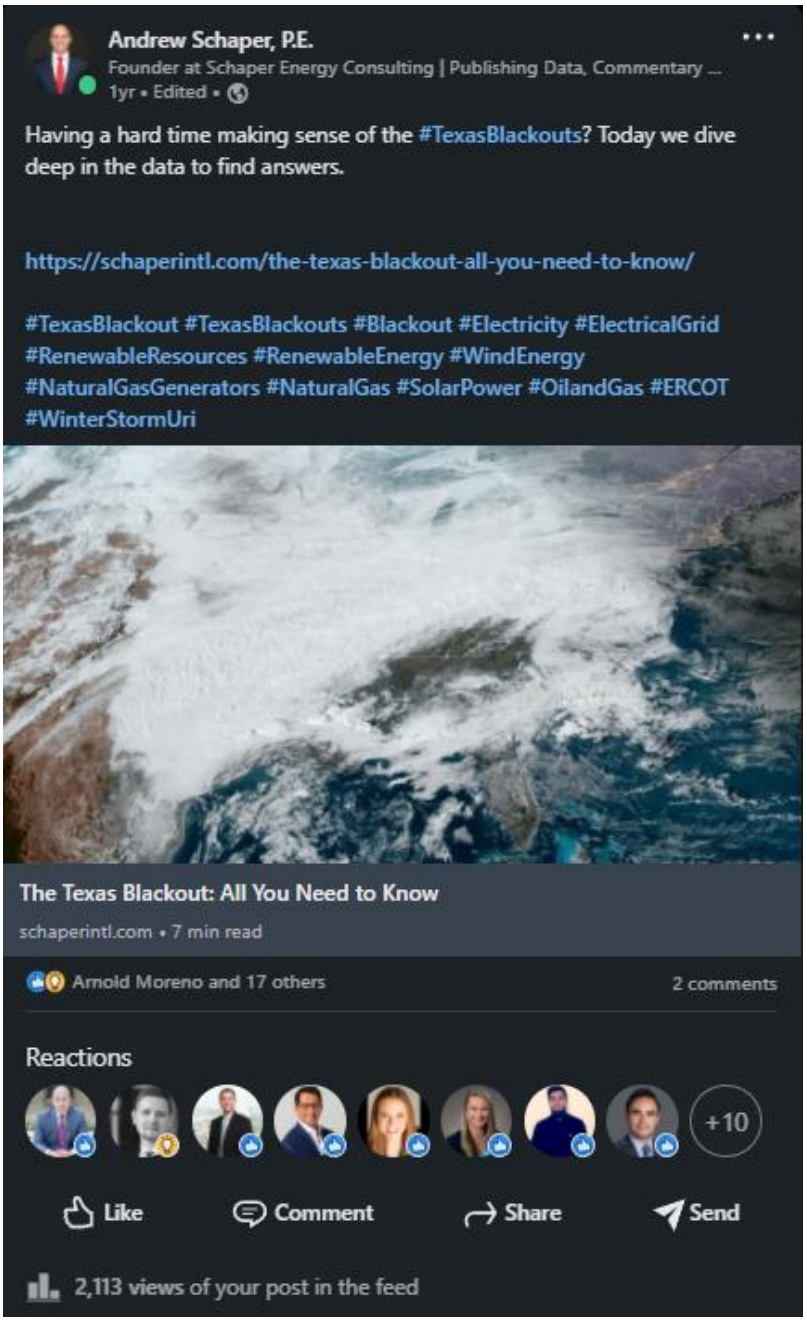

Figure 5 – LinkedIn Content Example

4.3.3. General Services Administration Government Contract Offer

SEC identified significant overlap between the scope of past USG contract solicitations by agencies like the Department of Energy and those services offered by the company. As a result, the company sought to provide its energy engineering services directly to the government as a prime contractor on the GSA schedule. This pursuit constituted the introduction of a third marketing prong alongside organic traffic and social media publishing.

The contractor certification process involved a detailed disclosure to the GSA to verify the business could manage government contracts. The GSA was explicitly concerned about the business's financial capability, capital access, audit/quality control systems, human resources management (hiring, benefits), professional licensing, and insurance. The advantage to the company of pursuing GSA prime contractor status is that the U.S government allocates nearly 22% of its contracts to small businesses.

While this marketing channel was slower to initiate and materialize, the GSA contract process provides SEC with access to a new customer base with the potential to drive considerable revenues. The company received a contract from the GSA as this Record of Study was finalized which allows it to respond to solicitations from government buyers.

4.4. Financial

An investigation of the company's historical revenues reveals the concentration of the business. Before the degree program, the company derived nearly all its revenue from Oil & Gas-related services. Specifically, the company performed reserves engineering, buy-side acquisitions and divestitures (A&D) analysis, and expert witness services.

4.4.1. Historical Revenues

Mr. Schaper analyzed SEC's historical revenues derived from consulting by client type from the initiation of doctoral studies in January 2020 through January 2022 monthly. Figures 6 and 7 present this data as a time series static representation for 2021, respectively.

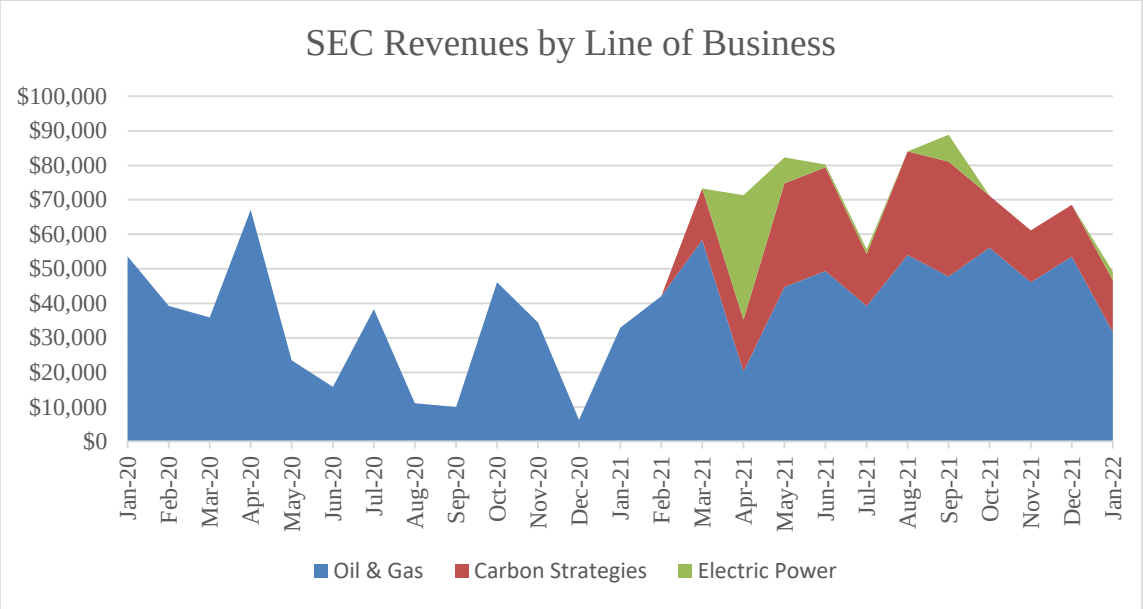

Figure 6 - Revenues by Client Type (Time Series)

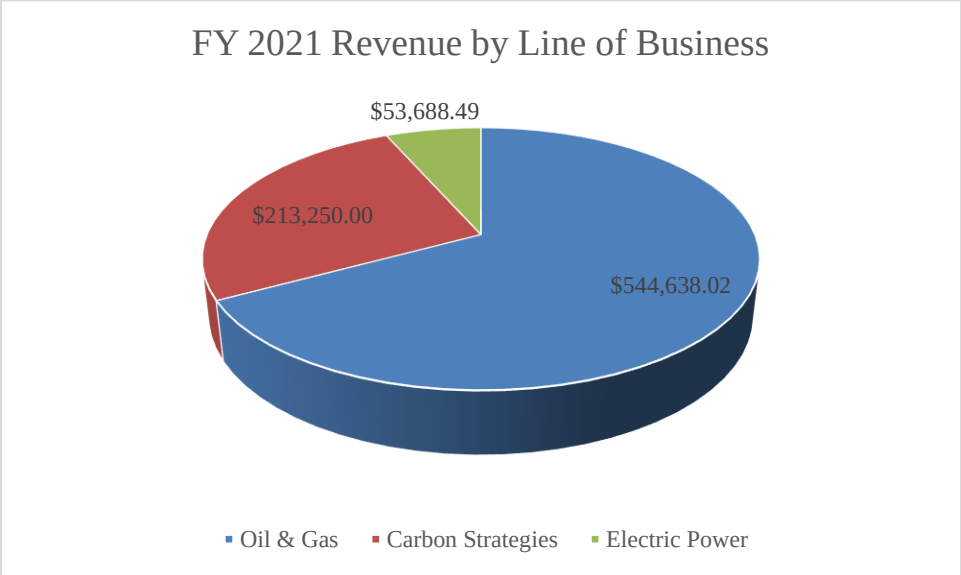

Figure 7 - Revenues by Client Type (FY2021 Totals)

There are two key findings from this analysis:

- COVID-induced lockdowns drove a significant reduction in the volume of Oil & Gas related client engagements and related revenues
- The introduction of new business lines significantly aided the company in recovering from the pandemic and diversifying away from Oil & Gas exposure

Notably, the company expanded its work in the Carbon Strategies and Electric Power arenas, with the two lines of business constituting 26.3% and 6.6% of FY2022 revenues, respectively. The diversification into new fields reduced the company's reliance on Oil & Gas to 67.1% of total net revenue for FY2021.

4.4.2. Budgeted Revenues

The company prepared a budget projection for FY2022 which included views on the outlook for the Oil & Gas, Carbon Strategies, and Electric Power lines of business. The company's core growth driver in 2022 is a joint venture in the Carbon Capture space which will drive new site development consulting revenues. Figure 8 depicts this anticipated growth.

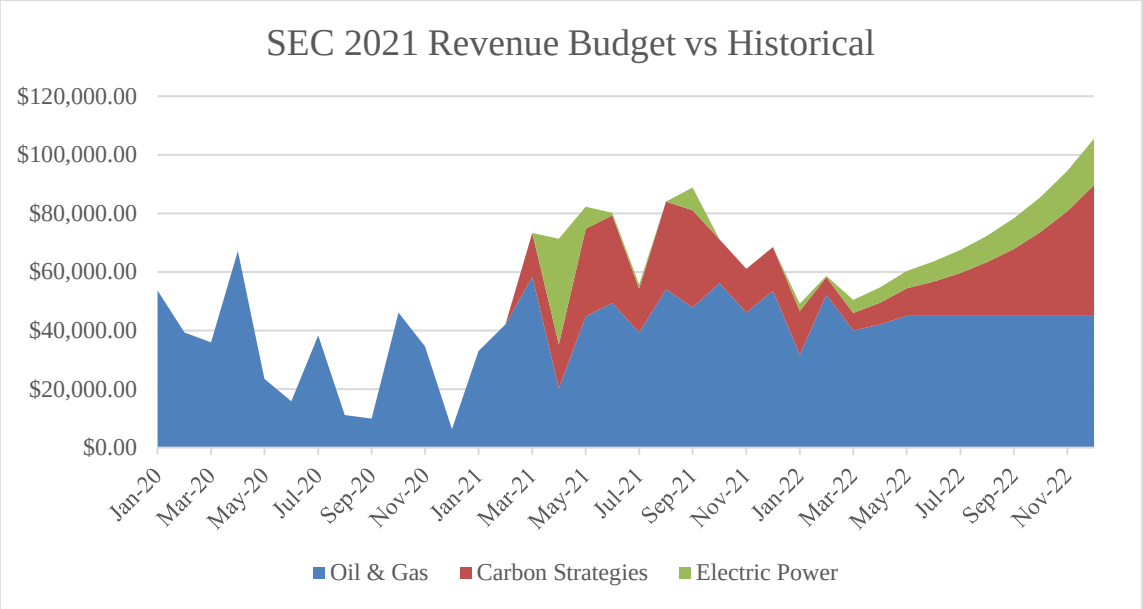

Figure 8 - Budget Revenue Projection

The company projects revenues from Oil & Gas clients to be flat to slightly increasing. The Carbon Capture and Electric power segments should experience 35% and 15% monthly growth, respectively.

4.5. Company Management

As the company plans for additional growth, it identified the need for improved technology deployment and human resources systems. The company needed to recruit personnel, onboard new team members, and train effectively to accommodate rapid growth. Sections 5.5.1 and 5.5.2. elaborate on crucial elements of these requirements.

4.5.1. Technology

The company solicited feedback from other small business operators and began instituting project management and Human Resources (HR) software systems in early 2020. Specifically, the company selected Gusto as its HR management software, facilitating onboarding and improving talent retention. The company also introduced the Notion open-source project management software to manage its new remote workforce more effectively. Notion allows for more interactive task assignments and monitoring. The company rounded out these technological improvements by implementing Microsoft Teams for chat and video communication, both necessary during remote work.

4.5.2. Hiring

The company identified two key employee roles it should fill to address the increased workload of client projects in the new lines of business:

- Engineering Technician
- Carbon Strategies Analyst

Both are entry-level roles at the company. This new personnel should allow additional staffing to address client needs and ultimately capture more revenue.

4.5.3. Organizational Structure

SEC's organization diagram will expand beyond the current five-member team to a seven-member team based on the identified personnel needs. Figure [] depicts this anticipated addition to SEC's personnel.

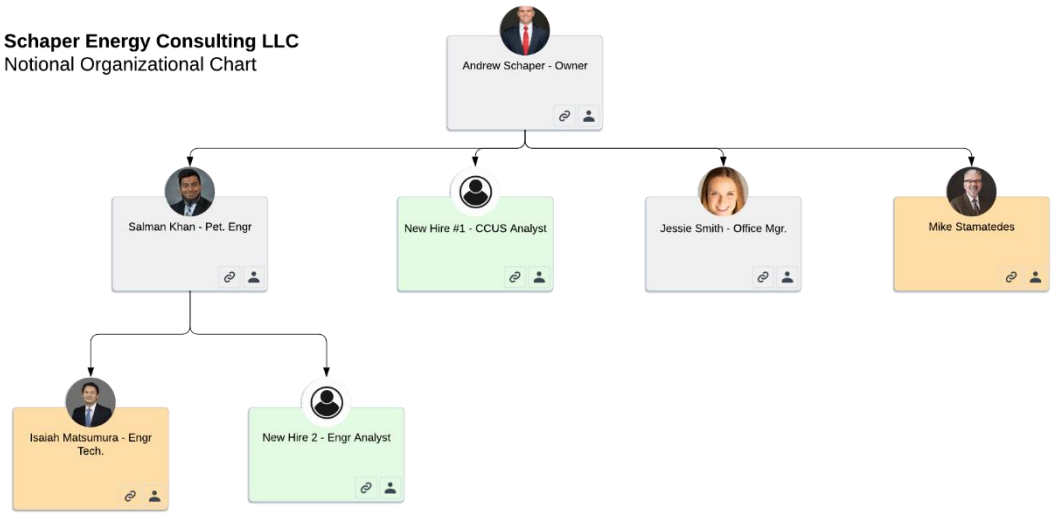

Figure 9 – Proposed SEC Organizational Chart

Those team members shown in gray are full-time employees, those represented in orange are contractors, and those in light green are future hires. This new team structure will

allow the company to be more competitive in the energy transition space while maintaining a presence in Oil & Gas.

5. CONCLUSION

The internship conducted for this degree and resulting experience and business plan outlining diversifying a consulting practice has been enriching. A dedicated effort to expand one's skill set and a commitment to marketing one's learnings can direct professional growth and commercial opportunity. While many elements of the described business plan have not been realized fully at this writing, significant progress toward the objectives laid out in this Record of Study is evident. The body of experience during the internship, coupled with opportunities to contribute to energy transition-themed publications, drove professional development consistent with the degree objectives. The contribution of this intellectual pursuit to Mr. Schaper's professional opportunity set is immeasurable.

REFERENCES

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APPENDIX A:

A CONCEPTUAL MODEL FOR ANALYZING THE IMPACT OF NATURAL GAS ON ELECTRICITY GENERATION FAILURE DURING THE 2021 TEXAS POWER OUTAGE

Published in 2021 North American Power Symposium (NAPS) by

IEEE on December 30th, 2021

(https://ieeexplore.ieee.org/document/9654761)

Abstract

The inter-dependence between electrical grid operations and natural gas infrastructure in Texas has been steadily increasing in recent years. The trend has been driven, in part, by the persistent decommissioning of coal-fired power plants and the increasing penetration of renewable generation. Moreover, changes to the type and deployment of natural gas generation facilities over the previous decade have increased the reliance on "just-in-time" natural gas delivery, which places the system at an increased risk of failure. The purpose of this paper is to delineate under-explored drivers of natural gas system operation previously, present a novel conceptual framework characterizing the integrated system inter-dependencies and outline possible policy measures which would promote enhanced system reliability.

Document appended hereto

APPENDIX B:

THE IMPACT OF HEAVY-DUTY VEHICLE ELECTRIFICATION ON LARGE POWER GRIDS: A SYNTHETIC TEXAS CASE STUDY

Submitted to: Advanced in Applied Energy

Abstract

The electrification of heavy-duty vehicles (HDEVs) is a nascent and rapidly emerging avenue for the decarbonization of the transportation sector. This paper examines the impacts of increased vehicle electrification on the power grid infrastructure, focusing on HDEVs. We utilize a synthetic representation of the 2000-bus Texas transmission grid and realistic representations of multiple distribution grids in Travis County, Texas, and transit data about HDEVs to uncover the consequences of HDEV electrification expose the limitations imposed by existing electric grid infrastructure. Our analysis reveals spatiotemporally correlated voltage problems that, with the mobility of HDEVs, may occur even at modest penetration levels. We find that as little as 11% of simultaneous heavy-duty vehicle charging can lead to significant voltage violations on the Texas transmission network that compromise grid reliability. Furthermore, we find that it only takes a few dozen HDEVs charging simultaneously to cause voltage violations in the distribution network.

Document appended hereto

APPENDIX C:

A SURVEY OF ACTIVE U.S. CARBON CAPTURE PROJECTS

Deliverable of Carbon Capture coursework, Summer 2021

Abstract

This report provides a comprehensive survey of active carbon capture and sequestration ("CCS") projects in the continental United States. The document includes CCS projects either in development, operational, or suspended. The scale, stage of development, variety, and uses of CCS facilities will be detailed to understand the current state of CCS projects and their future potential to contribute to greenhouse gas emissions reductions.

Online sources, including governmental agencies, state regulatory agencies, private CCS consortiums, private & public company disclosures, news reports, and academic literature, contributed to the development of this report. Aggregated lists of U.S.-based projects provided raw data, which could be compared and used to validate the existence of each project. The primary sources for this phase of the project were the Scottish Carbon Capture & Storage project (via the University of Edinburgh), the Global Carbon Capture & Storage Institute, the CCS Project Database at the Massachusetts Institute of Technology, and the National Energy Technology Laboratory (U.S. Department of Energy). Lack of disclosure limited the details available for specific pre-operational projects. In those cases, company press releases were relied upon to estimate operational parameters to the extent possible.

Key learning in this project is that there are three classes of CCS projects which are most common: 1) early pilot projects funded with federal research grants, 2) projects focused on carbon capture for industrial emissions, and 3) projects seeking to minimize the cost of CCS at commercial scale. Historical site development was economically challenged. CCS is likely to be influenced positively by planned enhancements to tax subsidies (e.g., 45Q). Today, there are 11 operational projects domestically injecting 40 million tonnes per annum (Mtpa) of CO_2 into underground geologic storage or enhanced oil recovery (EOR) projects. Notable facilities include the Century Plant operated by Occidental in Pecos, Texas, which injects at a rate of 8.4 Mtpa (largest facility by rate). The Exxon Mobil Schute Creek Plant is the second largest in Wyoming, injecting at 7 Mtpa. Together, the two facilities comprise >35% of all CO_2 sequestration in the U.S. today and appear the most effective at successful sequestration. The longest-lived project began in Val Verde County, Texas (Terrell) in 1972, nearly 49 years ago, to source CO_2 for local oilfields.

Document appended hereto

APPENDIX D:

SCHAPER ENERGY CONSULTING - GSA CONTRACT OFFER

Submitted to: General Services Administration

Outline

SEC submitted a contract offer to the General Services Administration to become a recognized prime contractor for the USG. Once approved, the company can offer services directly to the USG, including engaging with contract officers in various USG agencies like the Department of Energy or the Department of Commerce. The attached letter constitutes our Best and Final Offer for services pricing to the USG. This offer is under consideration by GSA at the time of this writing.

Document appended hereto