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Clean Energy Education Research Methodology: Curriculum to Change Lives and Address Climate Change

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Clean Energy Education Research Methodology

Abstract

This paper presents research methods, data collection, and analysis focused on the Clean Energy (CE) manufacturing sector to create a specialized worker training and recruitment program. The research questions are "What is the most efficient Clean Energy training/educational method to turn a student into an employment-ready Clean Energy engineering technician?" and "How can career pathways for new entrants into Clean Energy be made accessible to disadvantaged communities?" The research questions determine what skills are essential for CE technicians, what pedagogical methods will best deliver the training, and how to engage candidates from underserved communities.

This study uses a mixed-methods research plan with a qualitative practice interview and a quantitative online survey to better understand the problem and solutions [21]. Mixed methods remove the limitation of simplified statistical analysis of quantitative data, allowing a qualitative component for a more comprehensive analysis of the clean energy transition agenda, which comprises many political, social, and economic forces [21]. Although more labor intensive, it is a trade-off between managing the proper scope of research and providing enough detail for well-founded analysis and conclusions.

The purpose is to determine how to improve educational opportunities for current and future technicians who work in CE industries. Technical training must be designed to vigorously prepare CE program students for energy sector apprenticeships and jobs. The research findings identify best practices and serve as an action plan for creating the most effective clean energy education programs. In addition, this study includes the social justice aspect of providing equal access to these educational resources by building a CE training program to engage with marginalized communities and get students to join this academic pathway to employment.

The research findings aim to provide a balanced solution for companies that find well-trained candidates and for unemployed people who enter the Clean Energy education pathway and obtain living wage employment. The graduates, their families, neighborhoods, and the community will benefit.

I. Introduction: Methodology of Mixed Methods for Clean Energy Education Research

This methodology paper details a clean energy research design and concludes with challenges, strengths, and limitations. The theoretical framework underpinning the research is the Transformative Paradigm. By adopting mixed methods, both qualitative and quantitative approaches to data collection help achieve a complete understanding of the problem.

The research goal is to determine how to improve educational opportunities for current and future technicians who work in clean energy (CE) industries. In addition, the technical training must vigorously prepare CE program students for energy sector apprenticeships and jobs.

Quantitative research questions determine what skills are essential for CE technicians, what pedagogical methods will best deliver the training, and how to engage candidates from underserved communities. Specific quantitative research questions are described in the research methods section, and the survey is shown in Appendix A.

Qualitative research questions are framed with the promotion of social justice, diversity, and equity in mind [1]. Participants from a diverse cross-section of educational, workforce, manufacturing, and community partners will participate in the qualitative analysis interview. Interview questions seek to determine the socio-political and economic challenges that frame the implementation of clean energy education programs. Specific qualitative research questions are described in the research methods section, and the interview questions are in Appendix B.

A researcher's initial approach to a new study combines the researcher's positionality, epistemology, and the theories or conceptual frames that support the inquiry of the subject. This research study aims to provide findings that identify the best practices and serve as an action plan for creating the most effective clean energy education program. In addition, this study considers the social justice aspect of providing equal access to these educational resources by building a CE training program that engages with marginalized communities and gets students to join this academic pathway to employment. Making intentional connections to community groups is a way to recruit underrepresented students who can contribute to educational, social, and economic change in their communities in the Buffalo Niagara Metropolitan area of New York [2]. Detailed qualitative coding, research analysis, limitations, and conclusions on implementing a clean energy education program complete the study.

A. Motivation

To understand the motivation behind this research, Clean Energy Education - Curriculum to Change Lives and Address Climate Change, consider Deleuze and Guattari's theories on Thinking with Desire and how the results will directly benefit others and, on a broader scale, the community and indirectly the environment [3]. Deleuze and Guattari see desire as an internal force driving our relationships, our self-identity, what we produce, and, as researchers, knowledge contribution. "We desire, not because we lack something that we do not have, but because of the

forces and action that are actively becoming" [3]. This research is a continuation of 'becoming' a professional, growing, and constantly evolving.

The US Department of Labor clarifies that apprenticeships combine paid on-the-job training with classroom instruction to prepare workers for highly skilled careers [4]. This study aims to reveal how to improve educational opportunities for current and future technicians in clean energy industries with a focus on the author's home state of New York, which ranks among the top five states for green transition. New York is ranked third by the US Green Building Council and second by the US News & World Report, which looks across three dimensions: environmental quality, eco-friendly behaviors, and climate-change contributions [5].

The greater good and motivational purpose behind clean energy training is its contribution to climate action. Climate change and its "wicked problems" [6] are global realities. Unfortunately, today's leaders tend to focus on the current issues rather than issues that will significantly impact the future [7]. Culturally, many people have not accepted the urgency of climate change. However, renewable energy resources appear to be one of the most efficient ways to curb the environmental problems associated with development [8]. Dincer states that greenhouse gases (GHGs) are the most affected by energy consumption and the resultant pollutants [8]. Improving the energy efficiency of all buildings and the types of energy production used are a big part of the solution to reducing GHGs. Well-trained CE technicians can support these clean energy production and energy efficiency measures. This topic has been more relevant in the last decade.

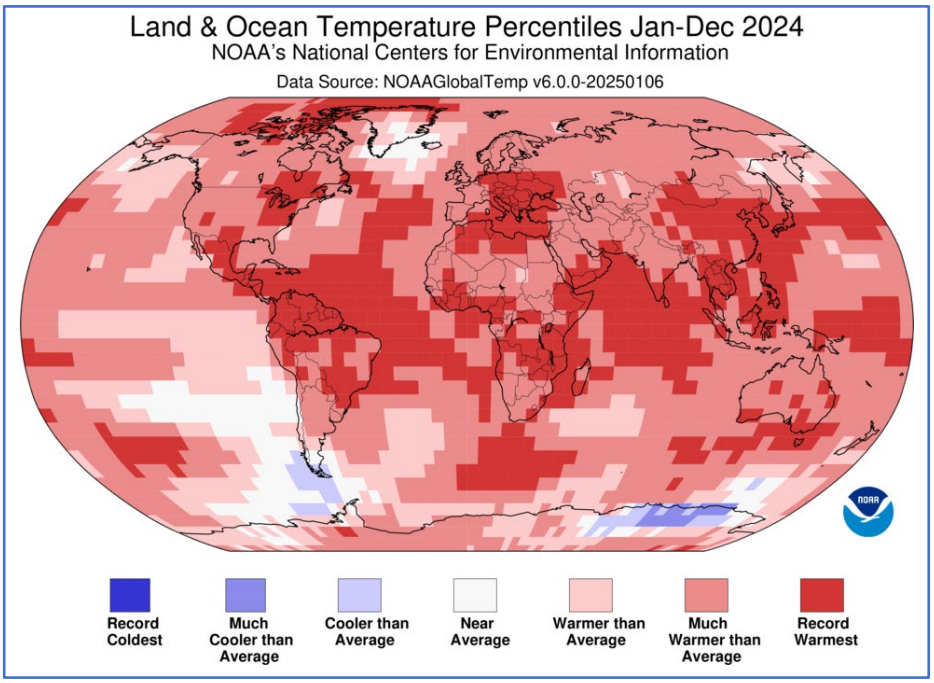

Figure 1. NOAA's 2024 Annual Global Climate Report: Temperature Percentiles [9]

2014–2023 was the warmest decade on record, and 2024 was the world's warmest year on record, as shown in Figure 1. [9]. Physical evidence of climate change is happening across the globe,

such as drought, water and food scarcity, severe weather, and rising sea levels. The socio-economic impacts of these physical effects of global warming continue to grow. These conditions will worsen unless countries commit to climate action on energy transition, including investment in technology, manufacturing, and education to support reducing greenhouse gas emissions [10]. Regarding managing the energy transition, "these adjustments can be best supported through coordinated action involving governments, businesses, enabling institutions, and extending planning and investment horizons. This action should be taken in a spirit of unity for two key reasons: first, the universal nature of the transition means that all stakeholders will need to play a role; second, the burdens of the transition will not be evenly felt [10]. For some stakeholders, the costs will be much more difficult to bear than for others [10]. Federal and state governments fund clean energy research development and education for the transition. In parallel, the industry has unfilled positions and needs well-trained clean energy technicians [11], [12]. Thus, technical education must be designed to prepare students with skills for energy sector apprenticeships and employment.

B. Theoretical Frameworks

Two complementary theories are used in this research design. The transformative theory explores the social mobility potential of providing degrees and apprenticeships in CE education.

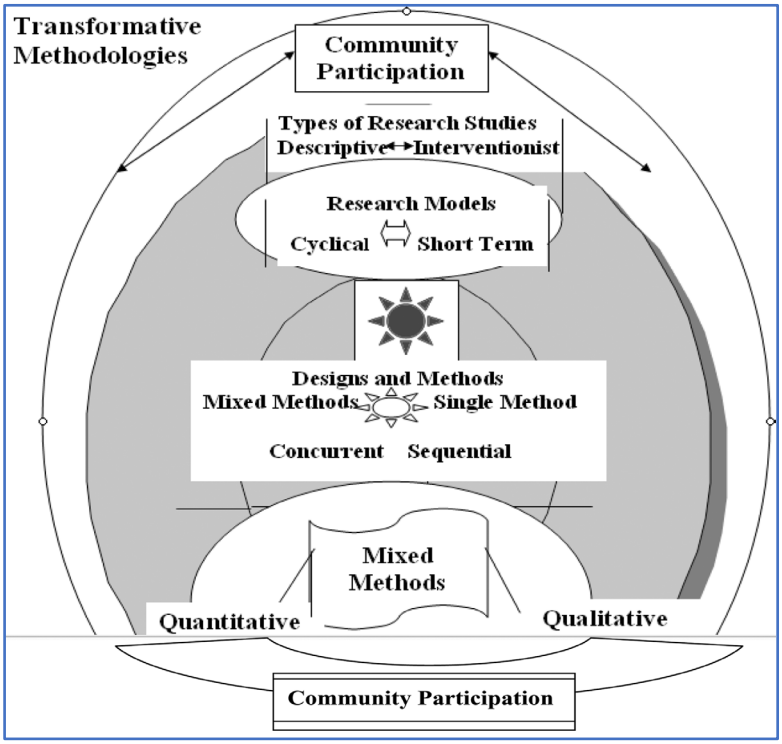

Figure 2. Cyclical Model for Transformative Research [13]

The Cyclical Model, as shown in Figure 2, guides this research [13]. Apprenticeship theory examines the socio-economic demands of 2024 with a perspective of studying the intersection between the workforce and higher education [18].

1. Foundational Transformative Theory for Mixed Methods

The transformative framework and mixed methods research applies to this study of educational pathways to employment because all elements of this study will be cognizant of the needs of marginalized groups wherever they might engage. Mertens describes poverty, oppression, and conflict between immigrants due to prejudice and a lack of jobs that pay enough to sustain a family [1]. This research explores the social mobility potential of providing degreed apprenticeship pathways in three ways: equal access to CE educational investments, engaging in underserved communities, and placing candidates in living wage jobs.

Regional Background: Building a clean energy worker education program is part of a larger New York State initiative in the Climate Leadership and Community Protection Act (CLCPA), signed into law on July 18, 2019 [14]. The CLCPA commits New York to achieve net zero greenhouse gas emissions incrementally by 2050 [14]. The language of the CLCPA includes environmental justice provisions that "Disadvantaged communities" receive 40 percent of the overall benefits from the state's climate programs [14]. Figure 3 identifies the zip code areas marked in purple. Disadvantaged communities are defined in the CLCPA as "communities that bear burdens of negative public health effects, environmental pollution, impacts of climate change, and possess certain socio-economic criteria, or comprise high-concentrations of low- and moderate-income households" [15].

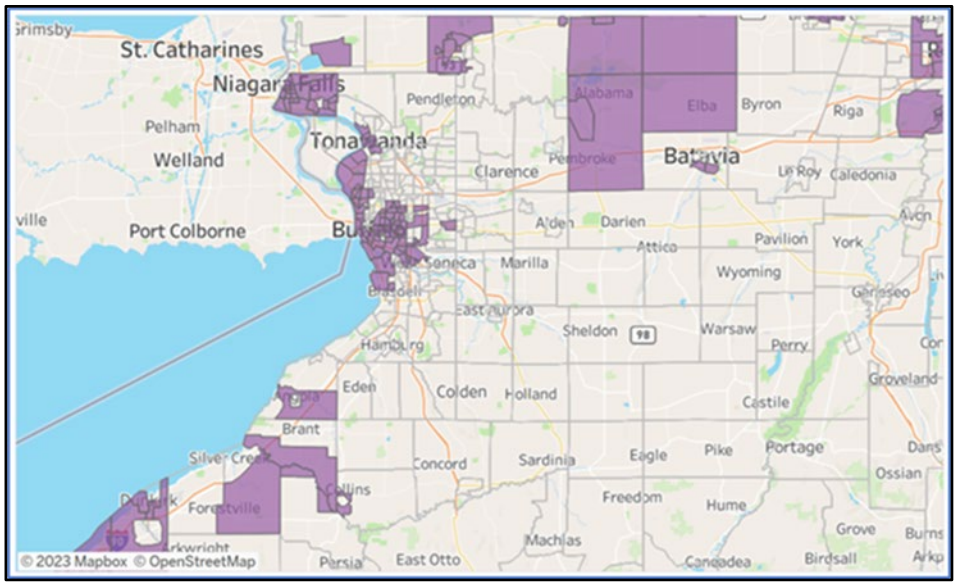

Figure 3. NY State Climate Action Council Scoping Plan-Disadvantaged Communities Map [15]

Additional detail is in the New York State Climate Action Council's commitment to clean energy projects, which are: 1. Development of the workforce and product supply chain and technology innovation in coordination with financial incentives are important to ensure the delivery of affordable building decarbonization solutions that perform well and improve quality of life. 2. These strategies should include creating jobs in clean energy businesses in New York and

businesses that serve Disadvantaged Communities, with dedicated support for minority- and women-owned business enterprises to innovate and actively participate in transforming the buildings sector. 3. Market development also involves increasing public and industry awareness through education, technical assistance and case studies, strategic partnerships, and publicizing private and State buildings that demonstrate high energy performance, lower embodied carbon, and resilient building construction [15].

The research findings are for making action plans for implementing a clean energy program that satisfies the Climate Act goals. They should provide a balanced solution for the manufacturer and the potential employee. The neighborhoods and the community will benefit as unemployed people enter the CE apprenticeship pathway and make a living wage. With proper income, employed graduates can provide necessities such as food, clothing, and shelter, as well as enough income to support other technology that will help the education of low-income groups, such as good Internet and a laptop computer.

2. Apprenticeship Theory of Learning for Curriculum Design

The complementary theory used to bridge the gap between education and industry is the *Theory of Apprenticeship*, which focuses on the mechanics of learning and not so much on the lens of social justice. Many authors developed apprenticeship as a social theory of learning in various areas of cognition and learning. In formulating a theoretical perspective for studying the workforce and higher education, the goal is to revisit apprenticeships and update the theory for the socio-economic demands of 2024. The work of Pratt in 1992 and furthered by Guile & Young in 1998 gives context when developing a curriculum that satisfies CE apprenticeship training. Pratt mentions four main elements in understanding apprenticeship: "the apprentice as learner, the idea of trade or craft knowledge as fixed and unproblematic, the master as teacher and the idea that learning in workplaces is a form of context-bound understanding not conducive to transfer" [17].

Guile and Young suggest that educators move away from the lecture mode, where learning is a simple transfer of knowledge, to "learning as a process in which the apprentice is involved in 'learning by doing' with the 'master' as the major role model" [18]. Understanding the different pedagogies used in formal education versus apprenticeship is essential. Vygotsky defined the zone of proximal development as "the distance between the actual development level determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more able peers" [19].

The transformative theory is a conscious consideration that can be used in research methods to open our views and processes to consider underserved minorities. In contrast, educational theories inform the selection of a pedagogy to determine how the training and curriculum may be delivered most effectively. The crafting and analysis of questions use both transformative and academic theories.

II. Research Design

The mixed methods approach is modeled after Mertens's Cyclical Model for Transformative Research [13]. The project used a combination of qualitative and quantitative research practices. A mixed methods approach allows sociopolitical factors and practical elements of CE education to be analyzed and compared. The research design of Figure 4 is called the Convergent Parallel Design and represents this research plan [20]

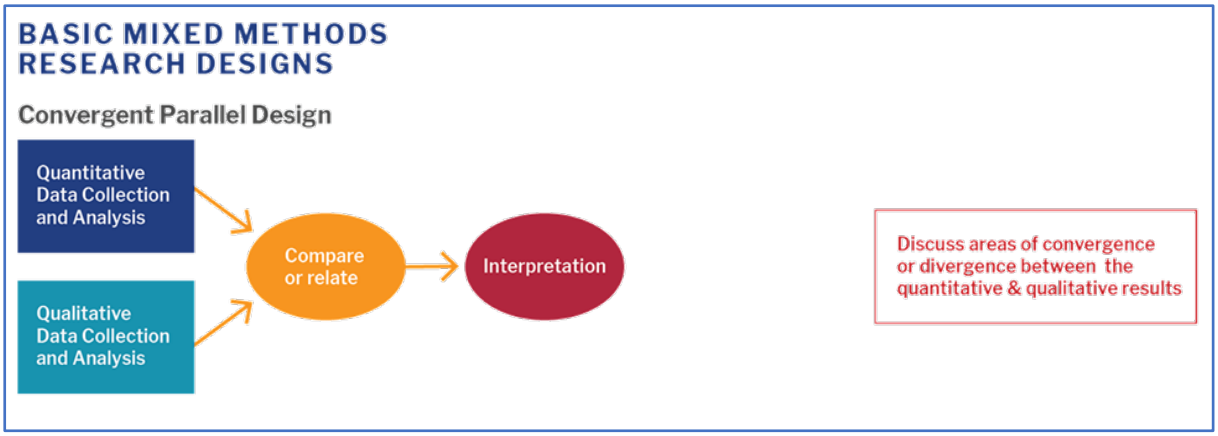

Figure 4. Convergent Parallel Mixed Methods Research Design [20]

A. Data Collection Plan

The opinions of industry, educational, and community leaders are surveyed, collected, and analyzed through surveys and interviews. A practice interview transcript was coded, grouped, and analyzed to present qualitative research findings on the desired attributes, curriculum, and program implementation of a clean energy training program. Additional key stakeholders in these groups are to be interviewed, analyzed and presented in a subsequent results and recommendations paper.

The goal of the research is to improve educational opportunities for current and future technicians who work in CE industries. The CE Education must be designed to prepare clean energy program students for energy sector jobs.

B. Research Questions and Hypotheses

The research questions are as follows "As understood by Clean Energy Education Stakeholders in New York State: 1. What is the most efficient Clean Energy training/educational method to turn a student into an employment-ready clean energy technician? And 2. How can career pathways for new entrants in Clean Energy be made accessible to disadvantaged communities?"

Technical training and apprenticeships lie at the intersection of community college training, employment, and workforce development. For engineers, education and work often exist in the quantitative research category. This research used a mixed methods approach, utilizing data collected through surveys and interviews. Research Questions expand on determining what skills

must be taught and what the most effective pedagogy is. The data collection process details what we expect to find and what questions and answers will lead us there [21]. The questions are derived from the research topic and updated from new understandings.

C. Quantitative Research Survey

Doing Urban Research by Andranovich addresses the two general categories of data collection, primary and secondary. The topic on clean energy education does not have many resources with secondary data that has already been collected and summarized for another purpose. Thus, primary data must be collected, which is the researcher's responsibility.

The data collection plan starts with an online survey to collect and analyze the opinions of industry, education, government, and community leaders [22]. The online survey was administered in the winter of 2024 to approximately 420 participants from the Buffalo Niagara Manufacturing Alliance BNMA, the Educational Institutions of Western New York, and Government and Community student success non-profit organizations leaders involved in Clean Energy Education. The main survey questions asked are:

1. What technical skills do your employees or candidates need?
2. What professional skills (human interaction) do your employees or candidates need?
3. What curricula and topics are desired for training employees or candidates in technical skills?
4. What curricula and topics are desired for training employees or candidates in professional skills?
5. What strategies can be used to recruit candidates in underserved communities? And
6. What incentives can be offered to recruit candidates (hire, then train, sign-on bonus)?

The online survey expands on these themes by adding a demographics section, ranking questions, and open-text questions. The complete survey is presented in Appendix A.

Commonly used types of non-probability sampling are Convenience sampling (nonrandom newspaper polls, TV polls, Internet polls, etc.), Purposive or quota sampling (nonrandom selection of a sample that approximates the population parameter), and Referral sampling (asking survey or interview respondents to identify additional individuals to include in a study in a nonrandom manner) [22]. The random sampling examples could not be used because this survey targets a specific group with relevant experience in Clean Energy education. Because non-probability sampling was used, the ability to generalize from the clean energy sector sample to the general population is limited [22]. However, valuable technical training curriculum and delivery conclusions can be valuable to other industries and education sectors.

D. Qualitative Research

On qualitative content analysis, Hsieh and Shannon inform the reader of three distinct approaches, Conventional, Directed, and Summative Content Analysis, that differ on "coding schemes, origins of codes, and threats to trustworthiness" [23]. The Directed Content Analysis method aligns with the technical training data of this research. Researchers must ensure the questions are all related to the subject matter and that question bias is checked and removed if necessary. Interviews and written notes were recorded to capture several levels of detail from the discussion. Interviewers need to be aware of the tendency for respondents to give socially acceptable answers and mitigate that by ensuring comfortableness.

1. Design of Interview

The second sample is from interviews with key stakeholders from clean energy companies, community support organizations, government, and education and training partners, chosen by being most closely aligned with clean energy training. Thirteen key stakeholders in these groups will be interviewed to share their opinions regarding the desired attributes, curriculum, and Clean Energy training program implementation. The transcripts of this group are analyzed using Computer Assisted Qualitative Data Analysis Software (CAQDAS) or "coding software" instead of analyzing data manually with pen and paper. Distinct codes are created from the transcript texts, and related codes are grouped into categories. The categories are organized and analyzed to derive meaningful themes and conclusions.

a) **Purpose.** The addition of community leader survey interviews will help shape the data to include understanding the socio-economic needs and desired impacts of the clean energy technician training from the community point of view. The New York State Climate Action Council shows its commitment to clean energy projects in that "development of the workforce and product supply chain and technology innovation in coordination with financial incentives are important to ensure the delivery of affordable building decarbonization solutions that perform well and improve quality of life" [15]. Additionally, "market development also involves increasing public and industry awareness through education, technical assistance and case studies, strategic partnerships, and publicizing private and State buildings that demonstrate high energy performance, lower embodied carbon, and resilient building construction" [15]. The findings will provide input into best practices and an action plan for making the most strategic educational investments.

b) **Data.** The data recording can be audiotaped or recorded online in meetings with handwritten notes, and data is used for educational research. Interviewees are protected from any mental, physical, or emotional injury due to this research material by ensuring safe spaces and anonymity. Each participant permitted the interview to be recorded. If desired, the participant will be debriefed and updated on the research after the interview.

c) **Setting.** A private, neutral, distraction-free environment is best to increase the likelihood of obtaining high-quality information. Face-to-face interviews are preferred, but an online discussion using Microsoft Teams or Zoom was offered if interviewees were unavailable.

2. Developing Interview Questions

An initial approach is selected to align with the researcher's philosophy and positionality. However, more questions emerge as we proceed, and different theories or lenses may be more appropriately applied. Researchers must avoid *cognitive dissonance*, "when a person's core belief is challenged internally, and the individual has difficulty mentally reconciling the contradiction" when hearing participants' opinions [24]. Consciously review interview questions and answers.

a) Positionality

The author believes in implementing the CLCPA initiatives on clean energy, which requires knowledge of workforce development, community, government coalitions, funding, and policy. The research activities are to be informed by socio-economic factors to ensure that the transformative theory influences the scope of the findings. We must understand and address workforce development challenges for the most impact in low-income communities.

b) Interviewee and Questions

The sample interviewee's demographics are a professional middle-aged white male with a career in public education. His tenure spanned over three decades in community college, engineering technology programs, apprenticeship outreach, and workforce development. The interviewee now works at a nonprofit corporation whose focus is assisting the formerly incarcerated to reenter society and find gainful employment. A practice interview was conducted to refine the research questions and approach. The answers were analyzed using a trial of coding techniques. The coding helped examine the emerging themes, the researcher's positionality, and the feasibility of the chosen coding methods, before moving on to up to fifteen interviews.

The research interview questions are included in Appendix B. Questions one through three are specific in that they focus on implementing New York's CLCPA funds to achieve investment in clean energy, focusing on disadvantaged communities getting 40% of the benefit. Questions four through six are about training and candidates. Questions seven, eight, and nine discuss collaboration and on-the-job training. Questions 10 through 14 ask for strategies for cooperation between the government, education, community, and the private sector to get the CLCPA initiatives started [16].

Finally, Question 15 is meant to elicit other ideas that may come to mind during the interview. Alternative open-ended questions for question 15, may be used to get more background on what the stakeholders may think of the clean energy training initiative. For example, "What do you see as the biggest challenge in making the CLCPA initiatives happen?" or "What are the most significant opportunities of the CLCPA initiatives?".

3. Data Analysis Plan:

a) Coding of the Practice Interview Transcript

The raw interview transcript must be coded for qualitative research. To avoid bias, open-ended questions may need to be coded by two independent researchers and discussed to resolve any discrepancies [25]. In Saldana's coding manual, different types of theories and techniques for analytic coding are presented [24]. The coding manual has an appendix that suggests coding techniques for the types of research they best fit. Researchers should read the full transcript before choosing a coding type for first-cycle coding schemes. Saldana describes, "First Cycle methods are those processes that happen during the initial coding of data and are divided into seven subcategories," one of which is Elemental Methods [24].

b) First Cycle Coding

The Elemental Method was chosen because it is a focused filter for reviewing the content and preparing for subsequent coding cycles. The output in **Table 1** is from using the specific subtypes, *Initial Coding*- the first significant stage of a grounded theory approach, and *Concept Coding*- giving big picture idea labels from the data [24]. Many important technical, political, and societal themes emerged from coding the renewable energy interview transcript. It is the researcher's responsibility to find commonality and group ideas together.

c) Second Cycle Coding

For deeper analysis, a second coding cycle using the *pattern technique,* where the researcher fits similar first-cycle labels into categories. "Pattern codes are explanatory or inferential codes, ones that identify a theme, configuration, or explanation. They pull together a lot of material from the first cycle coding into more meaningful units of analysis" [24]. Pattern coding condenses large amounts of data into smaller categories and helps the researcher look for higher-level themes, concepts, and other discoveries. A project team can conduct pattern coding as a group through discussion and multi-voting. The second coding cycle results are in **Table 2**, showing themes that emerged from the data.

In summary, the Elemental Method, followed by the Cumulative Coding Method, was used on the interview transcript. The themes that emerged from the coding are shown in Tables 1 and 2 on the following pages. First-cycle coding using Elemental Coding Methods to review the content was conducted in two steps. First, In Vivo coding summarizes passages into single words or phrases that were contained in the transcript, followed by Descriptive Coding, which summarizes the content and the names the code for a word or a noun that encapsulates the contents of that batch of qualitative data [24].

Table 1 Coding Themes That Emerged from First Cycle Coding.

- Clean energy legislation
  - New York is investing in clean energy
  - Covid 19 pandemic delayed the implementation
- Climate action plans
  - Windmills and other renewable energy
- Government investments
  - Should go to disadvantaged communities
  - Help the lowest income citizens up
  - Cause ripple of opportunity
- Training topics needed
  - Mechanical aptitude
  - Clean energy, math, physics, environmental science
- Challenge finding candidates
  - Generational differences
  - Lack of hands-on skills
  - Communicate via the Internet, Facebook, Reddit, etc.
- Where to get training
  - Community colleges, high schools, adult education programs, apprenticeships
- Collaborate to improve employees
- On-the-job training (OJT) is the best recruiting tool
  - Hire them, pay them, train them
- Certification required?
  - Hire them, train them
  - High school is not enough
  - Everyone should get a two-year degree to learn, think, hope, read, and understand
- Strategies to implement clean energy initiatives
  - Get buy-in from businesses, communicate
  - Government is inept and reactionary
  - Get consumer buy-in to use clean energy
- Business connections to trainers- it's up to the trainer to get buy-in, use marketing and meetings
- State government connecting to businesses- get buy-in with advertising and T.V. marketing
- State government connecting to trainers- up to trainers to look/search for RFPs, grants, and other funding
- Trainers connecting with candidates- offer funded programs engage non-profits, offer collaboration on RFPs, grants, and workforce development
- Concerns for clean energy implementation
  - How serious is the state about making this happen?
  - Political divide prevents progress
  - Disbelief in climate change
  - Companies and the public not ready to divest from fossil fuels

Table 2 Coding Themes That Emerged from Second Cycle Pattern Coding.

- New York is investing in clean energy technology with a focus on disadvantaged communities
- Clean Energy technicians need to have mechanical aptitude and math and science knowledge
- Training can be delivered by apprenticeship, adult education, high schools, and community colleges
- On-the-job training and getting certification are essential to attract candidates, then hiring and training them
- Success requires buy-in from the private sector, and candidates need access to funded programs and jobs
- The government, education, and private sector will collaborate through the request for proposals and grants
- Marketing and advertising the need for climate action is required to win over consumers and the private sector

Second-cycle coding uses cumulative coding methods, such as the Pattern Technique, which fits similar first-cycle labels into categories [24]. The goal is to identify connections between the initial codes and then group related codes into ideas, eliminate redundancy, and develop more meaningful, cohesive results.

E. Comparative Analysis of Practice Interview to the Research Area

The Research Area focuses on the status of clean energy initiatives that relate to apprenticeships, employment, and pertinent legislation. The topical areas are theoretical framework, educational apprenticeship theory, understanding the industry and education roles, organizational change theory, and government and business studies.

In general, the interviewees' understanding and opinions of the clean energy initiatives of New York State were well-rounded in terms of industry roles, education roles, organizational change theory, and government and business understanding. However, the questions and the dialogue did not cover theoretical frameworks or apprenticeship theory. Questions on the theoretical approach can be addressed in future interviews as the research progresses or left for inclusion in the research writing.

The interviewee expressed frustration with the delay caused by political issues and socio-economic events. For example, the COVID-19 pandemic caused delays and removed momentum from the rollout of the implementation actions from the 2019 CLCPA legislation [14].

F. Limitations of the Clean Energy Education Study

References and coursework in methodology and data analysis have advised researchers on some of these time, accuracy, and energy limitations. The researcher determines the scope and resource limitations to complete the study and what resources have been acquired or are available to them. Using a mixed methods research plan removes the limitation of the simplified statistical analysis

of quantitative data, giving a more nuanced understanding of the research questions by including qualitative analysis qualified by quantitative guardrails.

Scope and Resource Limitations: The scope is limited to the five counties of Western New York comprising the Buffalo Niagara Metropolitan area. Evaluation of clean energy training strategies and approaches is limited to the United States. Methodology: a mixed methods research approach was used to balance the potential of the overly subjective qualitative questions yet provide depth that an oversimplified quantitative approach could miss.

Resources are limited to approximately one year, and the money available by grant funds related to clean energy training and workforce development. The author's training in renewable energy technologies and manufacturing experience will help make the most use of the available resources. The conclusions and recommended actions are generalizable and could be used to start an examination of other manufacturing sectors.

Method Limitations: The mixed methods approach allows a more comprehensive analysis of clean energy education elements and the clean energy transition agenda comprising many political, social, and economic forces. However, the additional data collection and analysis is more labor-intensive and challenging. It is a trade-off between managing the proper research scope and effort while providing enough detail for well-founded analysis and conclusions.

Type of Survey Tool Limitations: Some data collection methods are limited, such as the limited online survey response rate, and the researcher cannot clarify any questions if the participant finds ambiguity in the survey. Email surveys can be limited by the institution providing the email list or the survey getting filtered out into junk mail and not delivered. The interview method is limited by how many interviews can be conducted and analyzed.

G. Conclusion - Vision and Methodology

The objective of the mixed methods data collection plan is to collect the opinions of the stakeholders who touch clean energy education. As mentioned, they are industry, community, educational institutions, and government. A follow-up article presents the research findings, which will support the broader clean energy training vision, which is to provide a curriculum supporting a pathway from high school to workforce training and the highest achievement in renewable energy, such as doctoral degrees. Workforce training is satisfied by developing a curriculum of certificate courses and 100-level courses with significant hands-on training. State colleges offer clean energy curricula at the 200 and 300 levels, with more math and science behind the topics. By focusing on bridging the gaps between workforce curriculum, non-credit, and credit-bearing certificates, we can provide a progression of stackable courses that build toward successively higher degrees.

A transformative theoretical perspective guided the research in embedding a higher purpose in the research questions, the assembly of stakeholders, and the selection of participants [27]. The transformative research principles address enhancing social justice, equality, and respect for

cultural norms. These broad ideas provide some inspiration and areas to investigate and create risk reduction plans around program liabilities while capitalizing on any program and regional strengths. Finally, the follow-on article, which contains more complete research findings, provides informed background information for action plans to implement a clean energy program that satisfies the Climate Act goals using bold, innovative approaches despite the uncertain outcomes.

Future research should continue to address workforce challenges for the clean energy sector. Climate change is a reality, and clean energy substitutes are a significant part of the solution to reduce green house gases [8]. Most companies have no succession plan to address the issues of an aging workforce. Continued retirements, also known as the “grey wave”, with no skilled trades apprentices behind them, leaves an insufficient number of skilled workers for clean energy sector growth [28]. The need for hands-on and multifaceted clean energy job skills is similar to those of the traditional energy, construction, and manufacturing sectors [28]. Further, the author believes that it is imperative to understand and address workforce development challenges in low-income communities, because technical training can be a means for socio-economic growth. Janet Yellen, Chair of the Federal Reserve System, is convinced that career and technical education has enormous potential to improve the lives of Americans in low-income communities, and that apprenticeships have a larger role to play [29].

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Appendix A: Clean Energy Education Survey Questions

Clean Energy Education - curriculum to change lives and address climate change.

My research goal is to improve the educational opportunities for current and future technicians who work in clean energy industries. The technical training must be designed to prepare clean energy program students for energy sector jobs. Providing training pathways gives the potential for successful placement and social mobility. This study aims to answer the overarching research question: As understood by Clean Energy Education Stakeholders (clean energy manufacturing sector, educational institutions, government and community leaders) in New York State:

1. What is the most efficient Clean Energy training/educational method to develop a student into an employment-ready clean energy technician or engineer?

2. How can career pathways for new entrants in Clean Energy be made accessible to disadvantaged communities?

Section 1

Demographic Information

All of your information is highly confidential and for internal use only. Please contact us if you have any concerns.

1.By agreeing to participate in this study, you are agreeing that: You are at least 18 years old. Your participation in this research is entirely voluntary. You agree to participate in X research, and that he has permission to record your responses during this survey and use the information for his research.[Don't hesitate to contact the investigator, X, at x or X. If you have any questions concerning your rights as a subject, contact X. Required to answer. Single choice.

I agree

I disagree

2.What gender do you identify as? Required to answer. Single choice.

Man

Woman

Non-binary

Prefer to not say

3.What is your age? Required to answer. Single choice.

18-25

26-35

36-45

46-55

> 55

Prefer to not say

4.Which will best describe your status? Required to answer. Multiple choice.

Student

Employed

Unemployed

Retired

5.What is your role or job title? Single line text.

Enter your answer

6.What industry are you employed in? Multiple choice.

Manufacturing

Education

Government

Engineering

Public service

IT (Information Technology)

Financial

7.What is the highest level of education you've completed? Single choice.

High School

Bachelor's degree

Master's degree

Doctorate degree

Prefer not to say

8.What race/ethnicity would you consider yourself as? (Select one or more): Multiple choice.

White

Black or African American

Asian

American Indian or Alaska Native

Native Hawaiian or Other Pacific Islander

Mixed/multiple ethnic groups

9.We plan to invite some participants to join part 2 of this research using a 15-question interview. If you're willing to participate, please provide your email address and so that we may contact you later. Thank you. Multi Line Text.

Enter your answer

Section 2

Clean Energy Sector specific questions on skills, training and recruitment

10.What Technical Skills (mechanical, electrical and shop floor type skills) do your employees or candidates need? (Please Rank them in order of importance 1 (most) through 6) Ranking.

Mechanical
Industrial/tool use
Electrical
Quality and Safety
Problem-solving/Troubleshooting
Technology or Product specific

11.What Technical Skills do employees or candidates need, that wasn't offered in the previous question? On a scale of 1 (most important) to 6 where do you rank it? Multi Line Text.

Enter your answer

12.What curricula and topics are desired/essential for training employees or candidates in Technical Skills (Topics to be included in a robust clean energy training program)? (Please Rank them in order of importance 1 (most) through 6) Ranking.

Mechanical (shop tools)
Basic electricity
Technical math/measurement/instruments
Industrial awareness (manufacturing, materials)
Renewable energy technology or Product specific
Lean/5S/Six-sigma/Quality

13.What curricula and topics on Technical Skills do employees or candidates need, that wasn't offered in the previous question? On a scale of 1 (most important) to 6 where do you rank it? Single line text.

Enter your answer

14.What Professional Skills (human interaction and employment ready behavior) do your employees or candidates need? (Please Rank it in order of importance 1 (most) through 6). Ranking.

Reliability (punctuality, completes the work)
Professional Interaction/HR Standards
Safety Awareness and adherence to protocols
Teamwork (able to contribute and collaborate)
Communication (verbal, written responses)
Financial Literacy

15.What Professional Skills (human interaction and employment ready behavior) do employees or candidates need, that wasn't offered in the previous question? On a scale of 1 (most important) to 6 where do you rank it? Single line text.

Enter your answer

16.What curricula and topics are desired for training employees or candidates in Professional Skills? (human interaction and employment ready behavior) (Please Rank them in order of importance 1(most) through 6). Ranking.

Ethical work practices (punctuality, completes work)
Professional Interaction/HR Standards
Safety Awareness and adherence to protocols
Teamwork/Project management (able to contribute and collaborate)
Communication (verbal, written responses)
Financial Literacy (employment transactions/benefits)

17.What curricula and topics in Professional Skills do your employees or candidates need, that wasn't offered in the previous question? On a scale of 1 (most important) to 6 where do you rank it? Single line text.

Enter your answer

18.Do you recruit candidates for employment/training from underserved communities? (yes, not directly, no) Single choice.

Yes

Not Directly

No

19.What Strategies do you use to recruit candidates in general? Select all that apply. Multiple choice.

Advertising – social media

Advertising – television, radio and newspaper
Public appearances – job fairs, conferences
High School visits
College visits
Community group visits (Centers, Block Clubs, etc.)
Social Services/Dept. of Labor visits

20.Of these recruiting strategies, which are most effective in recruiting candidates from underserved communities? (Please Rank them in order of effectiveness 1 (most) through 7; based on your experience). Ranking.

Advertising – social media
Advertising – television, radio and newspaper
Public appearances – job fairs, conferences
High School visits
College visits
Community group visits (Centers, Block Clubs, etc.)
Social Services/Dept. of Labor visits Other

21.What Novel Strategies do you use to recruit candidates that were not included in the previous question? On a scale of 1 (most effective) to 7 where do you rank it? Single line text.

Enter your answer

22.What employment incentives, if any, do you provide for potential employees? (Select all that apply) Multiple choice.

Hire; then on the job learning

Hire; then structured training on site

Hire; then structured training off site

Sponsorship (mentor and educate before hiring)

Sign-on bonus

Internship - paid

Promise to hire upon completion of training

Tuition reimbursement

Internship - unpaid

23.What novel employment incentive ideas could you use to recruit candidates that were not included in the previous question? Single line text.

Enter your answer

Appendix B: Clean Energy Education Interview Questions

1. How familiar are you with the CLCPA or New York State clean energy investment in general?

2. Do you consider your institution a member of the clean energy sector? Are you actively working on any Climate Leadership and Community Protection Act (CLCPA) elements?

3. How relevant is the CLCPA to your business or institution's goals and operations?

4. What workforce training topics do you think are needed for Clean Energy technicians?

5. What are some challenges or barriers to finding good candidates to hire, or to enter training; in general, and specifically from disadvantaged communities?

6. Where do you think candidates can get the proper training to support clean energy job openings?

For questions 7, 8, & 9: if you are not an employer, what do you think of the ideas?

7. Would you be willing to collaborate with state/local government to contract training for employees?

8. Do you use on-the-job training for new employees? Or what do you think of OJT for new technicians?

9. Do you require qualifications prior to hiring, and if so, what are they? Or what do you think of required clean energy qualifications before hiring?

10. What Strategies do you think are needed to get the CLCPA scoping plan initiatives (Technician training and community investment) started?

11. How do you currently connect with training providers as a Clean Energy sector-related business? How can the process be improved?

12. How does the State (NYSERDA/funding entities) currently connect with Clean Energy businesses? How can the process be improved?

13. How does the State (NYSERDA/other funding entities) currently connect with training providers? How can the process be improved?

14. How do training providers currently get the information out to disadvantaged community candidates? How can the process be improved?

15. What is the biggest challenge in making these CLCPA initiatives happen? The biggest opportunity?