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From Energy Learning to Career Thinking: How an Interdisciplinary Sustainable Energy Course Shapes Undergraduate Students' Career Motivations

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Abstract

Preparing students to navigate the sociotechnical complexity of energy transitions requires more than technical training. It demands that students connect disciplinary knowledge to policy, ethics, and societal responsibility. Yet little is known about how specific interdisciplinary courses shape the career thinking of individual students, particularly across engineering and non-engineering majors. The goal of this study was to investigate how students narrated their career motivation and career aspirations in relation to an interdisciplinary Sustainable Energy course, as described in post-course interview accounts. Using semi-structured interviews with 20 undergraduates who completed the course in Spring 2024 (n=10) or Spring 2025 (n=10) at a large public US university, we conducted thematic analysis of students' career-related narratives. Social Cognitive Career Theory (SCCT) served as a theoretical lens to examine how students described self-efficacy beliefs, outcome expectations, and career goals in relation to their course experience. Five career orientation themes emerged: (1) direct interest in energy transition work, (2) policy, law, and governance pathways, (3) research and public engagement, (4) corporate responsibility and ethics, and (5) values-driven concern without a defined career path. Notably, the largest single group (seven students) expressed strong sustainability values but could not articulate how those values might connect to a specific career. We call this pattern the "awareness-agency gap": students leave the course knowing they care but not knowing what they can do. Findings carry direct implications for engineering education and broader sustainability programs that aim to translate concern into professional pathways.

Keywords: Social Cognitive Career Theory, career motivation, interdisciplinary energy education, sustainability education, engineering education, qualitative research, awareness-agency gap

1. Introduction

Energy and climate change represent the defining sociotechnical challenge of this generation. In a global survey of 16-25-year-olds, Hickman et al. (2021) reported that 85% of respondents were at least somewhat concerned about climate change and 59% were very or extremely concerned. This concern is increasingly shaping students' academic and career choices: Stafford (2025) found that students who had taken a class focused on climate were considerably more likely to report that climate had influenced their major or post-graduation career options than students who had not.

Sustainability-focused courses, in other words, may play a meaningful role in shaping how students think about their professional futures.

Yet it remains unclear how this happens, through what mechanisms, and for which students. Most existing studies aggregate sustainability learning across whole programs or disciplines (Gutierrez-Bucheli et al., 2022; Yuan et al., 2024), which makes it difficult to see how a single, specific course functions as a mechanism of change. Mixed-methods studies of energy literacy further suggest that students engage with energy not only cognitively but also affectively and behaviorally (DeWaters & Powers, 2011, 2013; Solanki et al., 2025a). Because of this, qualitative inquiry into how students narrate their own career thinking after a specific course is a productive complement to survey-based work.

This study sits squarely within engineering education research. The course examined is co-taught by mechanical engineering and political science faculty and serves both engineering majors and students from across the liberal arts. As the engineering education community broadens its commitment to sociotechnical learning (Chen et al., 2023; Forbes et al., 2022; Lord et al., 2019), there is a growing need to understand how interdisciplinary courses connect to the professional formation of both engineering and non-engineering students who will work alongside engineers in energy transitions. By focusing on career narratives at the level of a single course, this study contributes to engineering education research on sociotechnical professional formation and on the role of interdisciplinary learning experiences in shaping how students see themselves participating in energy work.

Social Cognitive Career Theory (SCCT) provides a useful framework for analyzing how learning experiences shape professional development. SCCT proposes that self-efficacy beliefs, outcome expectations, and goals interact, with learning experiences positioned as core antecedents and as contextual supports or barriers (Lent, Brown, & Hackett, 1994; Lent et al., 2008). However, SCCT research has remained largely quantitative (Sheu et al., 2010; Lent & Brown, 2019), which can obscure how students themselves interpret a particular learning experience.

This study addresses these gaps in two ways. First, it examines how students from both engineering and non-engineering majors describe their career goals and motivational influences in relation to a single interdisciplinary sustainable energy course. Second, it uses SCCT as an interpretive lens for qualitative interview data, allowing us to see how self-efficacy, outcome expectations, and goal clarity vary across students who shared the same course but came in with different disciplinary backgrounds. The guiding research question is: How do students narrate the role of an interdisciplinary sustainable energy course in their career plans and career motivations, as described in post-course interviews? A secondary question asks: In what ways do SCCT constructs

help explain differences in how engineering and non-engineering students narrate their career orientation after taking the course?

2. Background

2.1 Sociotechnical Energy Education and the Engineering Curriculum

Energy transitions are sociotechnical: they involve coupled changes in technology, regulation, infrastructure, markets, and sociocultural meaning, and they are shaped by politics and governance as much as by engineering design (Geels, 2011; Markard et al., 2012; Kohler et al., 2019; Meadowcroft, 2011). Science and Technology Studies scholarship on energy emphasizes that sociotechnical perspectives are now central to how researchers analyze energy systems, public engagement, and policy (Hess & Sovacool, 2020). Because of this framing, energy-related engineering practice now requires competence beyond technical design including the ability to reason about policy, ethics, and societal consequences (Jenkins et al., 2018; McCauley et al., 2019; Quelhas et al., 2019).

However, engineering curricula often separate "technical" from "social" knowledge, a structural pattern Cech (2013, 2014) and Faulkner (2007) have called the technical/social dualism. This separation is reinforced when engineering programs treat sustainability and societal content as electives or "added content" rather than as core to engineering identity (Cech & Finelli, 2024; Mosyjowski et al., 2025; Niles et al., 2020; Rulifson & Bielefeldt, 2019). The consequence for student development is significant: students socialized into a technical/social dualism may come to see sustainability and policy work as someone else's domain, even when they care about it personally. In response, scholars have argued that engineering education should explicitly cultivate "critical sociotechnical literacy" (McGowan & Bell, 2020) students' ability to critically understand the relationships between people, communities, and the built environment that engineering shapes.

Interdisciplinary energy courses are one response to this pattern. Studies of such courses report that students develop more sociotechnical perspectives on the roles and responsibilities of engineers (Forbes et al., 2022; DeWaters et al., 2021; Hoople et al., 2018; Lord et al., 2019), although outcomes are uneven and context-specific (Arefin et al., 2021; Gatti et al., 2019). More recent work shows that sociotechnical curricular approaches can serve as a counter-socializing force against the culture of disengagement, particularly when courses bring social, political, and economic dimensions of engineering into students' first-year experience (Ozkan, 2025). At the level of student reasoning in crossdisciplinary courses, students develop sociotechnical frames while also retaining dualistic frames that separate the technical from the social (Ozkan, Campbell, & Detrois, 2026). What remains less examined is how these framings connect to students' career thinking that is, what students say they will do after the course, not just how they reason about energy systems.

2.2 Career Motivation, Energy Literacy, and Social Cognitive Career Theory

Career motivation in energy and sustainability is shaped by what students know, what they feel, and what they believe they can do. Energy literacy frameworks have long argued that knowledge alone is insufficient to drive action; affective engagement and behavioral intention also matter (DeWaters & Powers, 2011, 2013; Heeren et al., 2016). More recent scholarship has expanded this view, proposing holistic conceptual frameworks for energy literacy that integrate technical, sociocultural, and ontological dimensions of how students relate to energy (Gladwin & Ellis, 2023), and reviews of the field consolidate evidence that energy literacy is a multidimensional construct combining knowledge, attitudes, and behavior (Ramachandran, Ellis, & Gladwin, 2024). Studies of student energy discourse confirm this multidimensional view, showing that students engage with energy through cognitive, affective, and behavioral channels simultaneously (Solanki et al., 2025a, 2025b).

Social Cognitive Career Theory (SCCT) offers a useful lens for connecting these dimensions to career outcomes. Building on Bandura's (1986) social cognitive theory, Lent, Brown, and Hackett (1994) proposed that career interests, choices, and performance are shaped by three interacting constructs: self-efficacy beliefs (a person's confidence in their ability to perform tasks in a domain), outcome expectations (beliefs about what following a path will yield), and goals (specific intentions to act). Learning experiences function in SCCT both as antecedents that shape efficacy and outcome beliefs, and as contextual supports or barriers (Lent et al., 2008; Lent & Brown, 2019). Meta-analytic evidence supports the model in STEM domains (Sheu et al., 2010; Byars-Winston & Rogers, 2019).

SCCT is particularly suited to examining how a single course functions as a learning experience for career development. Yet most SCCT research in engineering education has been quantitative, often using survey instruments to test relationships between constructs (Lent et al., 2018). Qualitative SCCT-informed work at the level of a single course remains rare, particularly work that includes both engineering and non-engineering students.

2.3 The Gap This Study Addresses

Three gaps motivate this study. First, while there is broad evidence that sustainability courses can shift career interest in aggregate (Probst et al., 2019; Yuan et al., 2024), there is little fine-grained evidence about how a specific interdisciplinary energy course functions as a mechanism for individual career thinking. Second, qualitative SCCT-informed research at the course level is scarce, despite the fact that SCCT was designed to account for individual meaning-making about learning experiences. Third, most engineering education research on energy and sustainability has centered engineering students, leaving the experiences of non-engineering students in

interdisciplinary energy courses comparatively under-examined even though those students will work alongside engineers in policy, advocacy, ESG, and research roles.

This study addresses all three gaps. It examines a single, specific interdisciplinary energy course; it applies SCCT as an interpretive lens to qualitative interview data; and it deliberately includes both engineering and non-engineering students, allowing direct comparison of how disciplinary background shapes the form that career motivation takes after the same course.

3. Methods

This qualitative study examined how an interdisciplinary Sustainable Energy course shaped 20 undergraduates' career motivation and career planning. We used semi-structured interviews and thematic analysis, with SCCT as an interpretive framework.

3.1 Institutional and Course Context

The study was conducted in an upper-level undergraduate course on sustainable energy at a large public university in the Northeastern United States. The course is crossdisciplinary and co-taught by faculty from political science and mechanical engineering. It has been offered for more than a decade and serves engineering, social science, and other majors as either an elective or a general education course. Students complete weekly analyses and an interdisciplinary group project on a real-world energy issue, with groups intentionally formed across majors.

3.2 Data Collection

We invited students by email after course completion and conducted semi-structured interviews via Zoom or Microsoft Teams (50–60 minutes). Interviews were audio-recorded, transcribed using Otter.ai, and reviewed for accuracy. All identifying information was removed. The protocol included questions such as:

1. How would you say your thinking on energy systems and energy transitions has changed (or not) over the past few years and during this interdisciplinary course?
2. How are you feeling about an energy transition?
3. Do you see yourself pursuing this type of work in the future? What is motivating you?

Data were managed in Taguette and Excel. Institutional Review Board approval was obtained (University IRB Protocol H23-0706).

A total of 20 undergraduate students were interviewed (Spring 2024, n=10; Spring 2025, n=10). One additional student originally interviewed in Spring 2025 was identified during analysis as a graduate-level researcher rather than an undergraduate and was excluded to maintain a consistent undergraduate sample. The group included six engineering majors (Chemical Engineering;

Materials Science Engineering; Multidisciplinary Engineering / Industrial Design; Electrical and Electronics Engineering) and 14 students from political science, environmental science, environmental studies, journalism, philosophy, finance, environmental resource economics, community health, molecular biology, and German studies. Of the 20, 13 identified as women and 7 as men.

Table 1. Demographics of Interviewed Participants (N=20)

Semester	Label	Major(s)	Year	Gender, race & ethnicity
Spring 2024	Eng_11	Chemical Engineering	Fourth year	White woman
Spring 2024	Eng_17	Chemical Engineering	Fourth year	Latine woman
Spring 2024	FinancePoliSci_03	Finance, Political Science	Third year	White man
Spring 2024	EnvStudJournalism_04	Environmental Studies, Journalism	Third year	White woman
Spring 2024	PoliSci.EnvSt_21	Political Science, Environmental Studies	Third year	White man
Spring 2024	EnvSci.PoliSci_06	Environmental Science, Political Science	Fourth year	White woman
Spring 2024	MolBioCommunitySt_02	Molecular Biology, Community Health	Fourth year	White woman
Spring 2024	PoliSciPhiloso_13	Political Science, Philosophy	Third year	White woman
Spring 2024	PoliSciEnv_10	Political Science, Environmental Science	Third year	White man
Spring 2024	PoliSci.Insurance_18	Political Science, Insurance	Third year	East Asian man
Spring 2025	2025_02	Multidisciplinary Engineering, Industrial Design	Fourth year	Multiracial Latine and Asian woman
Spring 2025	2025_07	Material Science Engineering	Second year	Black American man
Spring 2025	2025_14	Chemical Engineering	Third year	Asian American woman
Spring 2025	2025_15	Electrical and Electronics Engineering	Fourth year	White Latine man

Spring 2025	2025_20	Environmental Studies and Political Science	Fourth year	White woman
Spring 2025	2025_21	Environmental Studies and Human Rights	Fourth year	White woman
Spring 2025	2025_26	Political Science and German Studies	Fourth year	White Turkish woman
Spring 2025	2025_44	Political Science	Fourth year	Black African American man
Spring 2025	2025_51	Political Science, Spanish and French	Fourth year	White Portuguese American woman
Spring 2025	2025_54	Environmental Resource Economics	Third year	White woman

Table 2. SCCT Constructs as Interpretive Lenses for Student Career Narratives

SCCT Construct	Meaning in This Study	What to Look for in Interviews	Example Interpretation from Data
Self-Efficacy	A student's belief in their own ability to perform tasks required for an energy-related career	Confidence ("I have the skills"), doubt ("I don't know if I'm qualified"), or domain-specific ability claims	"I feel really confident in my skills... because I'm chemical engineer" [Eng_17] high self-efficacy grounded in disciplinary training.
Outcome Expectations	A student's belief about the results of pursuing a particular career path	Statements about anticipated impact, meaning, or barriers	"Being able to have something that I can leave a legacy with has been really what I've been passionate about." [2025_54] outcome expectations centered on long-term societal impact.
Career Goals / Intentions	Specific, developing, or absent career direction in energy or sustainability	Specific roles, vague directions, or absence of direction	"One of the career paths that I've been looking at is being a legislative assistant in Congress." [PoliSci.Insurance_18] specific named role.
Learning Experiences	The course itself, prior coursework, internships, or research that shaped career-related beliefs	References to course/projects as turning points	"The sustainability class really helped with the foundation of really assuring that I wanted to go into it." [2025_15] course reinforced existing orientation.
Contextual Supports / Barriers	Environmental factors that enable or constrain pursuit of sustainability careers	Job availability, disciplinary norms, visible/invisible pathways	"I don't think that I would consider like, full blown energy line of work." [2025_02] perceived disciplinary boundary functions as barrier.

Positionality: The research team is interdisciplinary by design. The all authors have backgrounds in engineering and engineering education research. The third author, who serves as faculty mentor,

has research expertise in sociotechnical engineering education, sustainable energy systems, offshore wind energy systems, and sense of belonging for minoritized students in engineering education. We approached this study with the belief that students' post-course accounts are a meaningful form of data about career meaning-making rather than only post-hoc rationalization. The first and second authors conducted the interviews, alternating lead roles. All authors collaborated on data analysis and theme development through regular team discussions.

3.3 Analytic Approach

Thematic analysis was applied to students' descriptions of their career goals and motivations. SCCT was not built into the interview design but used as an interpretive framework after themes were identified. Coding proceeded iteratively: (1) reading transcripts to gain an overview; (2) initial open coding of statements about career goals, motivations, doubts, and perceived course impact; (3) grouping codes into career-orientation themes; (4) checking themes for internal consistency and distinctiveness, including a search for disconfirming evidence.

4. Results

4.1 Distribution of Career Orientation Themes

Five career orientation themes emerged from the 20 interviews. Themes 1 through 4 each represent a distinct configuration of self-efficacy, outcome expectations, and goal clarity. Theme 5, the largest group, is characterized by strong values and outcome concern alongside weak self-efficacy and absent career goals. We refer to this pattern as the "awareness-agency gap."

Fig. 1 plots each of the five career orientation themes onto a two-by-two matrix defined by the SCCT constructs of self-efficacy (low to high) and career goal clarity (absent to defined). The horizontal axis distinguishes students whose statements showed confidence in their ability to perform tasks required for an energy-related career from those whose statements showed doubt or perceived disciplinary barriers. The vertical axis distinguishes students who named specific roles or sectors from those who expressed concern without articulating where their career might land. Reading the matrix, Theme 1 (Energy Transition) sits in the upper-right quadrant: high self-efficacy combined with defined goals. Theme 2 (Policy, Law, and Governance) sits in the upper-left: defined goals supported by civic and policy efficacy rather than technical skill. Theme 3 (Research and Public Engagement) sits in the lower-right: confidence in the ability to do research, but goals still exploratory. Theme 4 (Corporate Responsibility) and Theme 5 (Values-Driven, No Defined Path) both sit in the lower-left quadrant- the "awareness-agency gap" zone where strong concern and outcome expectations are not yet matched by a sense of professional agency in the energy domain. Theme 5 is highlighted because it contains the largest single group in the sample (n=7) and is the conceptual center of this paper.

Fig. 1. SCCT Conceptual Matrix: Career Orientation Themes by Self-Efficacy and Career Goal Clarity

	LOW Self-Efficacy	**HIGH Self-Efficacy**
DEFINED Career Goals	**Theme 2:** Policy / Law / Governance (n=4) [Strong outcome expectations and named pathways; self-efficacy grounded in policy and civic competence]	**Theme 1:** Energy Transition (n=6) [Most complete SCCT profile; engineering and industry-experienced students with prior orientation toward energy work]
EMERGING / ABSENT Career Goals	**Theme 5:** Values-Driven, No Defined Path (n=7) LARGEST GROUP The "awareness-agency gap" zone **Theme 4:** Corporate Responsibility (n=2) [High value-based outcome expectations; low energy-specific role clarity]	**Theme 3:** Research and Public Engagement (n=1) [Outcome expectations on community understanding; goals exploratory]

Fig. 1b. Bar Chart of Theme Frequencies (N=20)

Theme 5: Values-Driven / No Path	n=7
Theme 1: Energy Transition	n=6
Theme 2: Policy / Law / Governance	n=4
Theme 4: Corporate Responsibility	n=2
Theme 3: Research / Public Engagement	n=1

Fig. 1b shows the frequency distribution of the five themes across the 20 interviews. Bars are ordered from largest to smallest. Theme 5 (values-driven without a defined career path) is the largest group with seven students; Theme 1 (energy transition) is second with six; Theme 2 (policy, law, and governance) accounts for four; Theme 4 (corporate responsibility and ethics) accounts for two; and Theme 3 (research and public engagement) accounts for one student after the exclusion of one graduate-level researcher (see Section 3.2). The frequency view complements Fig. 1 by showing the sample weight behind each quadrant of the matrix. Together, the two figures emphasize that the "awareness-agency gap" zone in the lower-left quadrant of Fig. 1 contains the most students in the sample.

Table 3. Career Orientation Themes Identified from Student Interviews (N=20)

Theme (n)	Description	Authentic Student Quote	SCCT Interpretation
Energy Transition (n=6)	Students wanted to work directly in energy systems, infrastructure, or decarbonization	"I would love to, personally, to, like, have a career, like, involved in energy transition... that would be my dream job." [2025_07]	High self-efficacy + defined career goals + strong outcome expectations.
Policy, Law, and Governance (n=4)	Students framed future work around legislation, regulation, or public decision-making	"One of the career paths that I've been looking at is being a legislative assistant in Congress." [PoliSci.Insurance_18]	Strong outcome expectations focused on societal impact + developing or defined goals.
Research and Public Engagement (n=1)	Student emphasized learning from communities affected by energy decisions	"It would be nice to go to a community nearby, and talk to people who have felt the effects." [PoliSciEnv_10]	Outcome expectations centered on community knowledge; exploratory goals.
Corporate Responsibility / Ethics (n=2)	Students situated energy within ESG, human rights, and corporate accountability	"I'm more interested in social responsibility for companies and ensuring... the human rights of their different supply chains are being considered." [2025_21]	High value-based outcome expectations; low energy-specific role clarity.
Values-Driven / No Defined Path (n=7)	Strong concern without an articulated career direction (largest group)	"Probably not specifically in energy... I don't think that I would consider like, full blown energy line of work." [2025_02]	High motivation + concern, low self-efficacy specific to energy, and absent career goals = "awareness-agency gap."

4.2 Theme 1: Interest in Energy Transition and Related Careers

Six students wanted to work directly in the energy sector. Most were engineering majors, and one was a non-engineering student already interning in the renewable energy industry. Each described a desire to apply disciplinary knowledge to renewable energy, grid reliability, batteries, or energy efficiency.

A second-year materials science engineering student described his post-graduation aspiration:

"I would love to, personally, to, like, have a career, like, involved in energy transition, because, like that that is essentially, like, once I'm finished with, like, my education, that would be my dream job. Because, like, even as far back in high school, like, I took a class in environmental science, and I my kind of main takeaway in the class was that the big problem to tackle would be

solving the problem of energy. Because, like, so I because the emissions from like our current forms of energy, those triggering, like climate change and the greenhouse effect"

[2025_07].

This student articulated a defined career goal ("dream job"), a clear outcome expectation (addressing emissions and climate change), and high self-efficacy grounded in technical training. The orientation predates the course, suggesting the course functioned as a values amplifier rather than the source of the orientation.

A senior electrical engineering student described an existing path that the course strengthened:

"I was looking to meet one of the requirements in my course catalog and sustainability. Sustainability industry is one of the industries I would look like to work in. So seems like perfect solution, the class I want, I needed to take, and also one that I wanted to take and would benefit from... I was also a part of an independent study where we're doing energy analysis on manufacturing buildings, and I was planning on and continuing to go into power systems and sustainability"

[2025_15]

His career direction was already specified before the course; what the course added was reinforcement and contextual knowledge of policy. His self-efficacy is grounded in NSF research experience on carbon-free power systems.

A senior chemical engineering student bridged academic content directly to her post-graduation job:

"It was kind of cool to be to see it being put into more context, like, I don't know freaking Carnot cycle or something that we learned in thermo[dynamics]. And then now, it's being applied to something that I might see in my future career. That was cool. I think in general, because I'm going to work for an electric utility, everything that they like talked about in terms of the failing rates, not failing but needs to be improved and has deficiencies. All that I really liked and connected with"

[Eng_11]

This student bridged thermodynamics content directly to a job at an electric utility. The course functioned as a connector between disciplinary coursework and the technical realities of her future career: a clean example of high alignment between learning experiences, self-efficacy, and goals.

A fourth student described going into batteries and electric vehicles consulting:

"I'm actually doing so I'm really working for an engineering consulting company. And my client is [Car Company] and so they're looking to develop... these batteries for their future hybrid and electric vehicles which go into like the transportation space of clean energy and kind of electrification of our world, which I think is really awesome. I'm feeling really excited"

[Eng_17]

She frames the energy transition through the specific role of designing more efficient batteries, locating her contribution as small but concrete consistent with high self-efficacy in disciplinary practice without overclaiming systemic transformation.

A junior chemical engineering student linked her major to sustainability:

"I think Chemical Engineering is a big contributor to sustainability. In terms of developing technologies and developing sustainable fuels, that's a big thing people are working on hydrogen fuel cells and things like that... Chemical engineering is also very heavy, heavily intertwined with energy efficiency. So in the like in the industry, that means making all your processes more energy efficient, less wasteful, things like that. And those are things that I really value, which is why I got into chemical engineering"

[2025_14]

This student treats chemical engineering as inherently aligned with sustainability work. Her stated motivation is being able to "make an active difference that I can see with my eyes." Self-efficacy is rooted in disciplinary identity rather than in the course itself.

A non-engineering student already working in the renewable energy industry said:

"Energy is also my job. So right now, I'm interning with Company D, a renewable energy company, and I every single day really is about learning about energy and learning about sustainable energy, selling energy, selling energy solutions"

[2025_26]

Her case shows that career entry into the energy industry is not exclusive to engineering majors. Self-efficacy here is rooted in current professional experience, and her values-based motivation is explicit: "*If I do not help, or if I don't at least try to do my part... I'm too scared of what will happen if I don't."*

Across these six students, the SCCT profile is consistent: defined career goals, strong outcome expectations, and self-efficacy rooted in either disciplinary training or current professional experience. Importantly, every student in this theme described a career direction that pre-dated the

course; the course functioned as a values amplifier, confirming and contextualizing existing orientations rather than creating new ones.

4.3 Theme 2: Policy, Law, and Governance Oriented Career Plans

Four students framed their future work in legislation, regulation, advocacy, or public decision-making. They were motivated by influencing regulations and public decisions and frequently described their pathways as outside "traditional" technical energy roles.

A junior political science student named a specific career target:

"Sure. So I think one of the career paths that I've been looking at is being a legislative assistant in Congress. So the job of a legislative assistant to a member of Congress is to have a portfolio of different policy areas. So it could be healthcare could be women's rights, it could be energy, or gun rights. So in taking this class, I wanted to get a better understanding of energy as a whole, to maybe be a legislative assistant down the road, just so I have that portfolio of different topics"

[PoliSci.Insurance_18]

This student treats the course as building a topic portfolio for a specific named role. Career goal is defined; outcome expectations are policy-focused; self-efficacy is grounded in policy and political competence rather than technical skill.

A junior environmental resource economics student tied environmental values to a deliberately chosen path:

"I think it's come from how I was raised. I grew up spending a lot of time outside and really valuing the environment, and then in high school, I took a few environmental classes that really sparked my interest, and that's why I came into college, studying Environmental Economics. And I feel in this major, I've really developed what I want to do, and going into policy has been something I've been interested in in the past few years. So I really just want to be able to make a difference in the policy slowly. But being able to have something that I can leave a legacy with has been really what I've been passionate about"

[2025_54]

She frames her career as policy-based incremental change with strong outcome expectations centered on legacy and difference-making. Goal direction is clear (federal environmental policy work), even if the specific role is not.

A senior political science student named two possible policy roles:

"I guess I would see myself pursuing this type of work, whether it be as a legislature, where I could make laws regarding energy transition and making access to renewable energies more welcome, or I could also see it as being a policy advocate for an environmental group lobbying lawmakers to vote for um these type of changes to renewable energy"

[2025_44]

He offers two concrete career options (legislator or policy advocate) tied to a clear cause (renewable energy access). The course shaped how he understood the complexity of the policy landscape: "It is a whole lot more complicated than what I had initially thought."

A junior political science / philosophy student in the four-plus-one MPA pipeline said:

"I'm in the four plus one Master's of Public Administration path. So I have to do my formal application for the graduate school in February... I think they do have like a sub-concentration or something where you can look at energy policy or social policy with a concentration in environmental, which would be really cool... I do credit this class for, you know, putting me on that path. Because I didn't know a lot before. So now I know more"

[PoliSciPhiloso_13]

She credits the course directly with shaping her graduate school direction toward an energy-policy concentration. The course operated as a learning experience that translated existing political-science training into a sustainability-specific pathway.

All four students in this theme were non-engineering majors (political science, environmental economics, philosophy). They show strong outcome expectations focused on societal influence and clearly developing or already specific career goals. Their self-efficacy is rooted in civic and policy competence rather than technical skill. A distinction with practical implications for how engineering education values policy-oriented students.

4.4 Theme 3: Research and Understanding Public Perceptions of Energy

One student fit this theme. (A second student originally in this category was identified during analysis as a graduate-level researcher and was excluded; see Section 3.2.) The remaining student emphasized learning from lived experience and community impact rather than from technical implementation alone.

When asked how she would approach her project topic if it were her job, the student said:

"I mean, if this was like my job, I probably would have wanted to go out in the field, and maybe interview people that worked at coal power plants, and the ones that like managed them. Because if anyone knows, like, the direct impacts of working with that type of energy, it would be

them. So it would be good to have like a firsthand testament as to how coal energy in the pollution it creates effects a person. And then also with like, the people that have been affected in communities, it would be nice to go to a community nearby, and talk to people who have felt the effects as opposed to having to read it from a website"

[PoliSciEnv_10]

Her outcome expectations center on understanding lived experience and community knowledge rather than on technical implementation. Career goals are exploratory and oriented toward research practice. With only one student fitting this theme, this category should be read as a distinctive case rather than a robust pattern in the sample.

4.5 Theme 4: Energy in the Context of Corporate Responsibility and Ethics

Two students viewed energy issues through corporate responsibility and ethics. Neither planned to enter the energy industry directly. They emphasized ethical behavior in energy-related corporations: human rights in supply chains, ESG, and corporate accountability.

A senior environmental studies and human rights student described her orientation:

"I'm more interested in, like, social responsibility for companies and ensuring they're like, the human rights of their different supply chains are being considered. So that's not to say that I wouldn't work for like, an energy company. I'm not sure, though, necessarily, if it's the exact avenue that I would want to pursue, like personally, so I think more so a lot of my involvement, like the energy transition and stuff like that, would be on, like, a local level"

[2025_21]

She articulates a clear ethical orientation but explicitly leaves the energy-sector role open. Her post-graduation direction is a master's in social responsibility and impact in business; energy is one of several sectors where her values could apply.

A junior finance / political science student approached energy through ESG analysis:

"I just have some familiarity, but not much. I mean, I knew what ESG stood for and kind of like what it's like the goals were. But I would say... our prompt like addressed greenwashing of like, okay, the effects of it, and like how do you stop it... I definitely think I may have been a victim of greenwashing. Because all the companies that I chose, I was like..."

[FinancePoliSci_03]

He approached the energy industry from a finance lens, focused on corporate transparency and the integrity of ESG claims. His self-efficacy was grounded in business analytical training rather than in technical or policy domains.

Both students show high value-based outcome expectations but lower career goal clarity specific to the energy sector. The course deepened their ethical awareness without narrowing them toward a specific energy-sector role.

4.6 Theme 5: Values-Driven Concern Without a Defined Career Path

Seven students voiced strong values about climate change and sustainability, but none identified a specific energy career path. This was the largest group and the clearest instance of the "awareness-agency gap": students fully convinced the energy transition matters, and uncertain about what they personally can do about it.

A senior multidisciplinary engineering / industrial design student said:

"Probably not specifically in energy, but that will be something that I'll have to consider in the future. Like I said, designing designing spaces, like smaller spaces within a larger whole, is something that is going to require a lot of like, understanding of energy consumption and what is required of a certain space or system. So that's definitely something that I'm going to have to be considering, which is why I took the course. I felt like it would have helped a lot, and it did, and yes, but I don't think that I would consider like, full blown energy line of work"

[2025_02]

She understood how energy connects to her future practice, took the course deliberately, and came away with useful knowledge. Yet she still framed energy as something she would "consider" rather than as a career direction. The course produced awareness without a sense of professional agency in the energy domain.

A senior political science student stated plainly that the course did not affect her career:

"I mean, I remember learning about the pros and cons of like, I mean, you can pick any of them, and no I just, it's just interesting to learn, but it didn't, it doesn't really have an impact on my career. I'm working in financial services now"

[2025_51]

She explicitly decoupled the course from her career direction. Her case is a clean example of a student who acknowledges the importance of energy issues but does not see herself acting on them professionally.

A senior molecular biology / community health student channeled her concern into law school via international human rights:

"With my urban community studies, I want to go to law school. And I want to do international human rights. So I think that is what I want to do. Which is because it also incorporates public

health, health, criminal justice, anything you can think of environmental health, because they're all intersectional"

[MolBioCommunitySt_02]

She frames environmental and energy concerns as one of many "intersectional" issues she will address through human rights law. Energy is part of her concern but not a specific career destination.

A junior political science / environmental studies student described how a climate seminar shaped her broader trajectory:

"That was really, really cool... I didn't know, necessarily what I wanted to do very much when I came here. I went to community college first. But while I was in community college, I got the opportunity to go to the Oxford Consortium for Human Rights in England at Oxford University. And it was a whole, like, kind of week long lecture seminar thing specifically about climate change... And that really motivated me to to study that kind of thing when I came here"

[PoliSci.EnvSt_21]

She traces her motivation to a specific seminar experience rather than to a defined career path. She came away from the sustainable energy course "slightly more optimistic," but did not name a specific role she would pursue.

A senior environmental science / political science student articulated a future grounded in environmental work without a specific role:

"I know, for a fact that whatever I end up doing career wise, like I want it to be grounded in addressing environmental problems and kind of like being a part of the solution, I guess, even if it's not the full solution"

[EnvSci.PoliSci_06]

Her phrasing "whatever I end up doing" captures the awareness-agency gap precisely. Values are firm; the professional pathway is undetermined.

A junior environmental studies / journalism student reflected that the course helped clarify what she did not want:

"I was interested in like environmental policy at one point, not sure if I still want to do that, just because it does seem very complicated. Important, but definitely, you know, it takes a lot of skill to be, you know, in that field. So, I think I learned a lot, but it kind of helped me understand that I might not necessarily want to go down that path"

[EnvStudJournalism_04]

Here the course produced negative goal clarity: it ruled out environmental policy as a path without offering a concrete alternative. This is a different version of the awareness-agency gap, where exposure narrows rather than opens future possibilities.

A senior environmental studies / political science student described an aspiration toward energy politics graduate school but uncertain post-college direction:

"Yeah, definitely like, want to be part of the solution, and like, working towards energy transition. And I think being involved in like research and like conversations with other people has been, like, really interesting. And like something I'm really glad I've gotten the experience as an undergrad, but, yeah, definitely something I'm interested in the future and hoping to keep exploring"

[2025_20]

She wants to "*be part of the solution*" and is "*exploring*" energy politics through research and graduate school. Her goal direction is forming but not yet defined; she sits on the boundary between Theme 5 and Theme 1.

Across these seven students, the SCCT pattern is consistent: high motivation and concern, with low or absent self-efficacy specific to energy and weakly defined career goals. We argue this awareness-agency gap is not a personal failing. It is a structural outcome of courses that successfully raise concern without scaffolding professional identity development. These students do not need more information about why energy transitions matter; they need structured opportunities to translate values into a sense of professional agency.

4.7 Comparing Engineering and Non-Engineering Students

Distributing the six engineering and fourteen non-engineering students across the five themes reveals a sharp pattern. Engineering students cluster in Theme 1: five of the six engineering majors expressed direct interest in working in the energy sector, with the sixth (Industrial Design / Multidisciplinary Engineering) appearing in Theme 5. Non-engineering students, by contrast, are distributed across all five themes: one in Theme 1 (already in the renewable energy industry), four in Theme 2 (policy / law / governance), one in Theme 3 (research and public engagement), two in Theme 4 (corporate responsibility and ethics), and six in Theme 5 (values-driven without a defined path).

Three patterns are visible in this comparison. First, engineering students arrived at the course with energy-related career interests already in place. Five of the six described pre-existing trajectories such as utility work, NSF research, batteries consulting, sustainability industry and treated the

course as a context for refining and connecting those existing trajectories rather than as the source of them. The course's career-development effect on this group was real but modest: it amplified what was already there. Second, non-engineering students showed a much wider range of orientations. Four developed clear policy and governance directions; two articulated corporate responsibility and ESG framings; one developed a community-engaged research orientation. The course appears to function more as a career-broadening experience for these students than for engineering majors, expanding their sense of what counts as energy-relevant professional work. Third, the awareness-agency gap is concentrated in non-engineering majors: six of the seven Theme 5 students were non-engineering. The single engineering student in Theme 5 (industrial design) explicitly framed her major as outside the "full blown energy line of work," echoing what Cech (2013) and Faulkner (2007) have described as the technical/social dualism in engineering identity but in reverse: a student trained in engineering who nonetheless sees the energy domain as outside her professional self.

Table 4. Distribution of Engineering and Non-Engineering Students Across Themes

Theme	Total (n)	Engineering	Non-engineering
Theme 1: Energy Transition	6	5	1
Theme 2: Policy, Law, Governance	4	0	4
Theme 3: Research and Public Engagement	1	0	1
Theme 4: Corporate Responsibility / Ethics	2	0	2
Theme 5: Values-Driven / No Defined Path	7	1	6
Total	**20**	**6**	**14**

5. Discussion

Twenty undergraduates completed an interdisciplinary sustainable energy course and described their career thinking in semi-structured interviews. Five career orientation themes emerged: direct interest in energy transition work (n=6); policy, law, and governance pathways (n=4); research and public engagement (n=1); corporate responsibility and ethics (n=2); and values-driven concern without a defined career path (n=7). Engineering students clustered in the energy transition theme; non-engineering students distributed across all five themes, with the largest concentration in the values-driven group. Across themes, the course was rarely the origin of a career direction; it was more often an amplifier, a context, or a space for clarification.

Through the SCCT lens, these themes correspond to systematically different configurations of self-efficacy, outcome expectations, and goal clarity. Theme 1 represents the most complete SCCT profile: students who entered with strong technical self-efficacy and pre-existing career orientations left the course with energized and contextualized career plans. Theme 2 students had self-efficacy in policy and civic competence rather than technical skill, and the course provided an integrative learning experience that translated their disciplinary training into an energy-specific direction. Themes 3 and 4 represent partial profiles: students with strong outcome expectations but exploratory or open-ended goal clarity. Theme 5, the largest group, is the inverse of Theme 1: high outcome expectations and strong values, but low energy-specific self-efficacy and absent career goals.

We call this final pattern the "awareness-agency gap," and we argue it is the central conceptual contribution of this study. Sustainability courses that succeed in raising concern without scaffolding professional identity may inadvertently produce students who care deeply but cannot see themselves as actors in the systems they care about. This is not a failing of the students. It is a structural outcome of how interdisciplinary energy education is currently designed. The engineering vs. non-engineering comparison sharpens this point: the awareness-agency gap is concentrated among non-engineering majors, even as several of those same majors (in Theme 2) developed clear policy directions when the course content connected to their disciplinary strengths. The difference between Theme 2 and Theme 5 non-engineering students is not in concern; it is in whether they could see a professional pathway that fit them.

Practically, the findings suggest that interdisciplinary energy courses cannot rely on awareness-raising alone to shape career outcomes. The largest single group in our sample left the course motivated and unclear. Closing the awareness-agency gap requires structured activities that bridge values and professional identity: in-class career mapping of practitioners across roles, panels featuring policy advisors, ESG analysts, and community researchers alongside technical engineers, and reflection prompts that ask students to name a role they could see themselves in and explain why. These small structural additions could plausibly move students from Theme 5 toward Themes 2, 3, or 4 categories where outcome expectations are matched with at least developing goal clarity.

Theoretically, the findings extend SCCT in two ways. First, they show how an interdisciplinary course can produce qualitatively distinct configurations of efficacy, outcomes, and goals depending on students' disciplinary entry point supporting the contention that learning experiences in SCCT are not uniform inputs (Lent & Brown, 2019). Second, they identify a recognizable SCCT profile (high outcome expectations, low self-efficacy, absent goals) that has been less attended to in the SCCT literature on engineering students, where the dominant focus has been on building self-efficacy in students who already have goal clarity. The awareness-agency gap names this profile.

For engineering education research specifically, the findings argue for a broader conception of who counts as relevant to sustainability workforce development. Non-engineering students in this course developed coherent professional orientations toward energy work in policy, ESG, research, and corporate ethics roles that engineers will rely on in practice. Engineering education research that examines only engineering majors will miss a substantial portion of the workforce that energy transitions actually require.

Several limitations qualify the findings. The single-course, single-institution design limits generalizability. Students who volunteered for interviews may have been more reflective or more committed to sustainability than non-volunteers, which could inflate the values-driven orientation observed in Theme 5 (a form of social desirability bias). Career orientations were assessed shortly after course completion through self-described narratives, not through observed employment outcomes; stated motivations may evolve. Theme counts are descriptive and should not be read as representative or predictive of larger populations. We also cannot determine from post-course interviews alone whether orientations preceded or emerged from the course, although several students explicitly attributed shifts in their thinking to course experiences. Finally, the sample includes only 20 students; the engineering vs. non-engineering comparison should be read as exploratory rather than statistical.

Recommendations for Future Research: First, longitudinal designs could test whether the awareness-agency gap persists, closes, or widens after students engage with internships, advising, or mentorship after the course. Second, intervention studies could compare students who received structured career-pathway activities during the course (career panels, role-mapping exercises, reflection prompts) with those who did not, allowing direct evaluation of whether such activities move students from Theme 5 toward more goal-clear orientations. Third, comparative research across multiple interdisciplinary energy courses at different institutions could test whether the five themes identified here are stable categories or specific to this course design. Mixed-method work combining qualitative interviews with SCCT survey instruments (Sheu et al., 2010; Lent & Brown, 2019) could further connect students' narratives to validated measures of self-efficacy, outcome expectations, and goal clarity.

6. Conclusion and Implications

This study set out to understand how undergraduates narrate their career motivation in relation to a single interdisciplinary sustainable energy course, and how Social Cognitive Career Theory might help interpret those narratives. Twenty students described career thinking that fell into five distinct configurations of self-efficacy, outcome expectations, and goal clarity. The largest single group seven students out of twenty left the course motivated and concerned, but without a defined career direction. We named this pattern the "awareness-agency gap."

The finding matters because it complicates a common assumption in sustainability and engineering education: that raising concern about climate and energy is, by itself, a contribution to the future workforce. Our results suggest it is not, at least not alone. The students with the most complete career profiles: Theme 1 arrived at the course already oriented toward energy work; the course amplified what they brought. The students with the largest gap between concern and action: Theme 5 left the course with their concern intact and their professional identity unchanged. Closing this gap is not a matter of more awareness. It is a matter of professional pathway scaffolding, and it is the next design challenge for interdisciplinary energy education.

Theoretically, the study extends SCCT by identifying a recognizable course-level pattern (the awareness-agency gap) and by showing how disciplinary entry point shapes which SCCT configuration a student lands in. It also adds a qualitative, course-level account to a literature that has been dominated by survey-based work. For engineering education research, the study argues for an expanded view of who counts as part of the energy-transition workforce: non-engineering students in this course developed serious professional orientations toward policy, ESG, research, and corporate ethics roles, and treating them as peripheral to engineering education would miss a meaningful fraction of the workforce that energy transitions require.

Practically, three implications follow. First, sustainability educators should explicitly surface the full range of roles that energy transitions require including policy, advocacy, ESG, research, and community engagement through career-mapping activities, practitioner panels, and structured reflection. Second, programs should add at least one structured activity that links course content to career pathways: a semester-end prompt asking students to name a role they could see themselves in and explain why is a low-cost intervention that could plausibly move students from Theme 5 toward more goal-clear orientations. Third, advising and program design in engineering education should validate non-traditional energy career paths for political science, environmental studies, environmental economics, and related majors who already enroll in interdisciplinary energy courses.

Limitations qualify these contributions. The single-course, single-institution design limits generalizability; volunteer bias may inflate Theme 5; post-course interviews capture stated rather than observed career outcomes; and the sample size restricts the engineering vs. non-engineering comparison to exploratory analysis. Future research should pursue longitudinal tracking, intervention studies that test whether structured career-pathway activities close the awareness-agency gap, and comparative studies across multiple interdisciplinary energy courses.

The students in this study did not lack motivation. They lacked maps. The awareness-agency gap is not a failure of individual students; it is a structural outcome of courses that raise concern without scaffolding professional identity. If higher education is to prepare students for the full

sociotechnical work of energy transitions, courses must focus not only on what students know but on how students see themselves participating in what they are learning about. Helping students move from worry to professional agency is the next challenge and the most consequential one for interdisciplinary energy education.

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