Sustainable Development Goal 12:
Responsible Consumption and Production

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Contents

1. Introduction:

Green energy consumption in developed countries has a significant environmental and social impact on developing countries. The above statement may sound a little illogical. In this case study, I attempt to substantiate this statement. This case study shows the energy conservation undertaken in developed countries and its environmental and social impacts in developing countries. It elucidates the importance of SDG 12: Responsible Consumption and Production. The study is narrowed down and primarily focused on the shift of technology from fossil fuel to rechargeable batteries utilized in electric vehicles and its net impact on the climate crisis. It is true that the environmental impact in developed countries is reduced due to responsible production of electric vehicles. However, the environmental impact in the countries of extraction of the minerals required for the rechargeable batteries or disposal of the rechargeable batteries is immense. This case study is primarily meant to create awareness among the people of developed and developing countries on how greener energies have a negative environmental impact in developing countries and the need to efficiently utilize electric vehicles to reduce the environmental and social impact on developing countries and the planet.

2. Brief Review of Relevant Literature:

The literature review was conducted with the perspective of encouraging the execution of SDG 12 of Responsible Consumption and Production. It was felt that SDG 12 was a qualitative goal, and its achievement could not be quantified by usual data analysis. This posed a problem in the research as the topic is scientific and the research design had to be qualitative. Insights from previous literature related to Responsible Consumption and Production have been utilized to build the research of this article. Many published papers did not have a specific research design. The insights obtained from the descriptive and content analysis of the published papers were used to improvise the research questions and research methodology. A few of those insights are discussed below:

Goal 12 of the 2030 Agenda for Sustainable Development aims to ensure sustainable consumption and production patterns. It states: “We (Countries) commit to making fundamental changes in the way that our societies produce and consume goods and services. Governments, international organizations, the business sector and other non-state actors and individuals must contribute to changing unsustainable consumption and production patterns, including through the mobilization, from all sources, of financial and technical assistance to strengthen developing countries’ scientific, technological and innovative capacities to move towards more sustainable patterns of consumption and production. We encourage the implementation of the 10-Year Framework of Programmes on Sustainable Consumption and Production. All countries take action, with developed countries taking the lead, taking into

account the development and capabilities of developing countries" (2030 agenda for SDG as cited in Chan et al, 2018).

SDG target 12c: Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities (SDG target 12c as cited in Chan et al 2018).

A comparative analysis of sustainable consumption and production in developed and developing economies by Wang et al (2018) aided the literature review comprehensively by its systematic literature review. Due to different economic conditions and socio-cultural factors, sustainable consumption and production require a diverse focus in developing and developed economies. These fundamental differences in developed and developing economies call for more research and analysis to illuminate various themes, focus areas, and commonalities, which to our knowledge, is rare within this research domain (Wang et al, 2018). This case study attempts to fill this gap by focusing on the transportation sector utilizing green energy.

Moreover, to aid in the research process a paper on Li-ion batteries was reviewed. It discussed specific aspects of electric vehicles as well. The paper mainly concentrated on the responsible disposal of Li-ion batteries. However, it was useful to understand the environmental competitiveness of electric vehicles (Fan, 2020). Though electric vehicles do not enhance CO_2 emissions directly, electricity utilized for operating the vehicles contributes to CO_2 emissions during production. While our general consumption (which is composed of food, means of transport, housing, and other goods) is capable of generating negative impacts on resources and the quality of the environment, people could contribute by making the right choices when deciding what they consume (Dogaru, 2020).

The research literature related to both consumption and production has been analyzed and there are not many research papers that discuss responsible consumption and production of electric vehicles and the rechargeable batteries used in the electric vehicles and their environmental impact in developing countries.

2.1. Research Questions:

The research is built to conceptualize whether the technological advancements adopted to improve lives in developed and developing countries have any net impact on the climate crisis. This may require extensive study to understand the impact of technological change in developing and underdeveloped countries, specifically countries that play a role in the supply chain of production of those technologies. In this study, we are concerned about technology

adoption to shift to electric vehicles from fossil fuel technology. The research is limited to raising questions to people on their views of change in technology and their insights on the environmental and social impacts of rechargeable batteries used in electric vehicles in developing countries. The major research questions are:

RQ1. What are the environmental and social impacts of electric vehicles on developing countries, where mining of minerals for rechargeable batteries is done?

RQ2. Is there a net positive impact on the climate crisis in adopting electric vehicles in developed countries?

3. Research Method and Approach:

3.1.1. Research Tradition and Assumptions:

In this research, the philosophical assumptions made were originally axiological and later methodological. The research was initiated with my own values and biases in the selection of the topic and interview initiation. After reviewing the literature and interviewing two experts it was more of an inductive type and bottom-up approach and the assumptions are methodological. Hence, I used both these concepts in the research process of making assumptions, designing the research, and carrying out the qualitative research. In this qualitative research, I examine and write the study findings based on evidence from data which are gathered from in-depth interviews and focused observations. Through this case study, I attempt to inspire curiosity about the universal problem of sustainability and the best way to address it. These concepts guided me to design a qualitative study that could complement and provide background knowledge for the research.

The study attempted to focus on every detail and utterance of the interviewees and the observation relevant to the study. Generally, qualitative research is supported by both insights and data. This qualitative research started with the assumption of philosophical inquiry and later the support of methodology to finalize the scientific research. I used the interpretive framework based on pragmatism as the case study focused on the outcomes of the research like the actions of consumption and production, situations, and consequences of inquiry.

3.1.2. Research Methodology:

The research was meant to interview the users of the technology of electric vehicles and rechargeable batteries to give them insight into the social and environmental impact this has on developing countries. The study is designed such that interviewees include experts in the field of climate and energy, academicians, students, and other users of technology. I conducted two interviews, one with an expert and another with an academician in the field, and two observations of classes related to the topic.

After going through the list of courses conducted at the University of California, Berkeley I observed two classes after obtaining due permission from the lecturers. One of the courses was Environmental Economics, and the class I observed was on Public Goods Provision, which covered transportation as well, but covered mostly economics related to energy consumption, which was beyond the scope of the study, hence, it is not discussed in this paper. The other course was Climate and Energy Policy, and the class I observed was on Supply-Side Policy, the lecture was relevant to the research subject and this observation was used for this case study.

3.2.1. Data Collection:

In the interview, the participants' views on development and the ways their lives have become comfortable after the use of electric vehicles were questioned. They were questioned if they knew the conditions of life of people in developing countries who work in the mineral extraction required for rechargeable batteries. They were shown pictures of artisanal mining in Africa and then asked about their views on the comforts available due to the rechargeable batteries. The important excerpts of the interview are produced in the paper and the interview transcript is attached as an appendix to this paper.

The data collection was planned primarily among students who are consumers of electric vehicles and experts in the field of climate energy. The interviews were limited to two at this stage and those were conducted with experts in the field. Their views on the development of shifting to electric vehicles using rechargeable batteries and the impact it has on the lives of people in developing countries were analyzed in the case study.

3.2.2. Interview Data:

The interviews were analyzed after coding interview data and constructing a data matrix to identify the emergence of commonality, negotiation, and drift of different explanations. This matrix allowed me to identify the similarities between the interviews and the observation. Moreover, since the interviewees in both cases were experts (one was an expert, another an academician) in the field of climate and environment, it led to similar views being expressed by the interviewees. If the interviewees were from different backgrounds, mixed perspectives could have emerged from the interview been expressed by them.

Excerpts from the interview:

The interviewees expressed their opinions on the importance of responsible consumption and production. They advocated optimization and maximization of consumption of the products. Two excerpts from one of the interviews are presented here:

Excerpt 1:

We could do a better job of doing the mining in a safe way and making sure those people benefit. Make sure the people who live there are actually better off rather than the worse off. So, whatever equitable measures we can have in terms of protecting their human rights, labor rights, health, their future, financial benefits and so on and so forth. I think, we should do, whatever, it takes to make sure that happens. I mean, this pretty much applies to any resource that attract(s) extraction anywhere in the world, not just these minerals. It applies to, you know, fossil fuels. It applies to the agricultural sector, you name it. These problems are endemic everywhere. We could do (a) much better job of doing this extraction.

Excerpt 2:

The main thing is that we need to reduce our consumption of everything. You know there is this whole, I guess, concept, of thinking about live within your reach. So, extracting any kind of resources for consumption, maybe throwing away clothes, you know, wasting food, or wasting water, it's the same thing. But we should try and minimize our consumption, we should try and minimize what we take, to try and have whatever lifestyle or life that we want to have. So, first is (the) minimization of that. Second, we should try and optimize with what we are taking. So, make sure that we are using whatever stuff we are taking in the most efficient way. So, you know, just because you have, you know, a battery, should try and optimize its performance, rather than using it in a wasteful manner, or whatever, yeah, not taking good care of that, using it in conditions that are not good for (consumption). So, there is minimization, there is optimization, and then, you know, whatever we need to consume, we want to make sure there are no externalities associated with it such as what you were seeing in these pictures, for example, (right). In that, you know, if we are going to consume food, right, you know, whether it is, you know, whether it is wheat or corn or meat or milk or dairy, well let's make sure that people and animals are least affected by it. If they are affected by it, how can we compensate them fairly for it and so on. There is kind of, like, a hierarchy, loading order of things that we could do to try and minimize our environmental and social impacts. Again, these things apply to everything. This is not just about modern gadgets or rechargeable batteries. This is something that has, that can apply to our entire history and the current point in time.

3.2.3. Observation Data:

As discussed earlier, one of the lectures observed was more relevant to the research project on Responsible Production and Consumption. The lecture discussed the issues involved in low-carbon energy transition. As the sociotechnical systems for fossil fuels are well established, it becomes difficult for the new entrants/challengers to fight the incumbents, establish new sociotechnical systems, and achieve grid parity. Moreover, the incumbents are commercial firms like PG&E that support the centralized generation, and the challengers are the residential and community producers of distributed generation and their associations.

We can observe in the lecture field notes attached as an appendix that although the climatic and physical conditions were similar in California and Arizona, due to the monetary power of the centralized distribution system in Arizona, distributed generation could not succeed in Arizona to the level of California, where the unions and associations were much stronger. The shift to solar energy was massive in California compared to other states in the US, mainly due to the energy policy and the strength of the challengers. The lecture discussed how the energy policy can affect the source from which energy is produced.

Excerpts from the observation:

Two excerpts from the observation field notes that were relevant to the research are included in this case study. The observation was on the contents of the lecture and discussion in the class and not on the activities or students in the classroom.

Excerpt 1:

The students were mostly taking notes in the physical notebook rather than using laptops, and after the lecture was over, I enquired about this to the lecturer. She specified that it was a conscious decision so that the students had little distraction and studies have shown better absorption of lectures when notes are taken by traditional means. She also added that it saves energy consumption as 70 students using laptops at a time leads to more energy consumption. She had instructed the students to use handwritten notes at the beginning of the semester and most students follow that meticulously.

Excerpt 2:

Student 2: I don't understand what is lock-in?

Lecturer: Let me explain this with an example:

We know QWERTY keyboard. There is another keyboard type – Dvorak keyboard. Though the Dvorak is easy to use and better than the QWERTY, as many people got used to it and it is well established, we have an inertia to move from that to Dvorak. This is QWERTY Lock-in. Can someone tell when lock-in occurs?

(Students lift their hands, and the lecturer asks one student to answer.)

Student 2: Lock-in occurs when a system's path dependency creates inertia.

Lecturer: That's correct. Thanks. In the energy sector, we have what is called the carbon lock-in. Early industrialized countries established fossil fuel-based sociotechnical systems. Over time leading industrialized countries have become locked-in to these systems, as many other technological systems, organizations, industry practices/business models, societal preferences,

and governing institutions …all become invested in maintaining the status quo of the current energy system. Strong political resistance from incumbent coalitions rooted in these systems can effectively block changes to the fossil-fuel status quo. There are many socio-technical lock-in sources. I can state a few with examples to understand easily.

3.3. Analysis of the Data:

3.3.1. Coding Strategy:

Inductive and deductive coding methods were used to code the interview data. The close-ended type of interview questions was designed based on my assumptions and those were coded by the deductive method. Data on the consumption of rechargeable batteries by the interviewees and the ownership of gadgets and electric vehicles were coded by deductive coding methods. Replies of the interviewee to the open-ended questions seemed to infuse fresh insights and were coded by deriving the codes from the data by the inductive method. Codes like impact, minimization, optimization about the utilization of resources, and sustainability of production were coded on inductive coding methods. Coding was entirely based on the inductive method for the observation as I did not have any insights on the lecture, and it shared different insights on energy production. Coding the data helped to convert the interview and observation details into a database to conduct qualitative research more scientifically.

The various codes framed are listed below:

- Consumption
- Ownership
- Requirement
- Extraction
- Feeling
- Insights
- Awareness
- Impact
- Minimization
- Optimization
- Sustainability

The codes are categorized based on their method of coding as listed below:

Deductive codes	**Inductive codes**
Consumption	Impact
Ownership	Minimization
Impact	Optimization

Requirement	Sustainability
Extraction	
Feeling	
Insights	
Awareness	

3.3.2 Data matrix:

Data matrix was prepared by connecting the codes in the two interviews and the observation. The data matrix showed the interviewees had similar insights like walking, using bicycles, public transit, etc. It could be interconnected with the observation like minimal or no use of laptops, which was observed in the class. The concept of lesser impact on the environment like the transition to low-carbon energy, and shift to the production of renewable energy sources like solar PV installations, can be linked between the interview and the observation. This helped in analyzing the data and interpreting the findings.

Furthermore, various new themes emerged from the data matrix based on the insights shared by the interviewees and the observation and those are listed below:

- Conservation of energy by minimal use of gadgets and minimal use of vehicles.
- Reduced ownership of vehicles leads to the conservation of energy.
- Impact on the environment due to irresponsible mining and disposal of lithium-ion batteries.
- Shift to renewable energy sources like solar power.
- There can be equitable measures for better treatment of people in the sustainable supply chain.
- Negative social and environmental impacts like the exploitation of men and materials are endemic in all fields.
- Minimization measures like not wasting food or water.
- Sustainable measures like ensuring people and animals are least affected in the food chain or supply chain of production are to be practiced.
- Sustainable production is difficult in competitive business markets.

4. Research Findings:

The data showed that the interviewees had responsible consumption and one or no ownership of electric vehicles. They had adequate knowledge of the mineral requirements for the rechargeable batteries and extraction of minerals. They ensured minimal consumption and optimal utility of resources. Moreover, they had similar views as they were experts in the field of climate, energy, and environment.

This case study aimed to create awareness and reduce the consumption of rechargeable batteries and the use of electric vehicles to the bare minimum requirements to ensure that development is sustainable environmentally and socially. It is done as a case study to understand the consumption patterns of people and their perspective on the impacts of technological development on the environment and people. It attempted to learn more about the people's knowledge of the impact of technological developments in the producing countries and the need for responsible consumption and production. The interviewees were experts in the field, and the research showed their extensive knowledge in the field and their commitment to responsible consumption and sustainability. The observation data showed how the energy policy can affect the source of energy production, how energy can be responsibly produced and consumed, and how it can directly impact SDG 12 of Responsible Production and Consumption.

5. Discussion of Findings:

The case study was limited due to time and resource constraints and the interview was conducted with two experts in the climate, energy, and environment sector. It provided me with insights into their knowledge and understanding of environmental impact. Furthermore, I was amazed by their way of life in following certain aspects of responsible consumption. It will have the expected impact when we administer the case study among the public and students who are the targeted participants to create awareness and change their consumption patterns. The students and the common public should understand the consequences of mindless use of technology and modify their ways to responsible consumption and production.

SDG 12 stresses the importance of Responsible Consumption and Production and the role of developed countries in helping developing countries achieve this goal. In the pursuit of establishing Responsible Consumption and Production in the energy sector, developed countries are flouting these in developing countries. Increased consumption of alternative production technologies creates negative social and environmental impacts in the producing countries.

The decrease in the impact of the production of goods may be accomplished through ecological design and eco-innovation. These two methods significantly contribute to the betterment of the ecological performance of products during their entire life cycle (Dogaru, 2020). Generally, developing the economy is always a top priority in developing economies where sustainability has been overlooked over the last decades (Wang et al, 2018).

In developed economies, established mature production technologies limit the fundamental change of environmental burden from the manufacturer (Moors et al, 2005 as cited in Wang et al, 2018). On the other hand, facing excessive, wasteful and inefficient resource use,

considerable effort is being undertaken to alter over-consumption patterns (from the consumption perspective) resulting in reduced material and energy intensity (Jonkute & Staniskis, 2016; Staniskis, 2012 as cited in Wang et al, 2018). Only a responsible consumer can demand responsible production by reducing demand in the competitive markets. The negative environmental and social impacts of production in developing countries can be reduced by responsible consumption and production.

6. Reflections:

6.1. Reflections of the Research Process:

During the interview, I was uncomfortable handling the questions in a few instances. The interview had brief pauses in between, and I did not ask the questions promptly. I asked one question that was not relevant and was not resourceful enough to modify the question based on the interviewee's response. I felt I was overtalking instead of allowing the interviewee to do the talking. I could improvise in conducting a better interview in the future.

After the interview was conducted, the interview response was more elaborate and the reply by the interviewee was very comprehensive, I felt it would be difficult to convert the interview data into a database. After coding the data, I sensed confidence that the data could be converted to a database and qualitative research could be completed.

The data matrix appears to be a handy technique for analyzing huge data. In this case study the interview was restricted to two and the observation field notes to one, which was very little. However, the data matrix helped arrive at the findings more scientifically. I firmly believe that this data matrix will be more helpful when the case study is conducted on a larger scale.

6.2. Next Steps:

The case study had a few limitations such as the interviewees were experts in the field and hence, it lacked heterogeneity. Nevertheless, the case study could track responsible consumption through the interview and responsible production by observing the lecture on the transition to low-carbon-emission energy systems. Furthermore, more responsible production in developing economies and more responsible consumption in developed economies should complement each other for sustainable development. From the case study, I could not arrive at how impactful the study was to create awareness, as the participants were experts/academicians. If the participants are randomized from different sections of the community, then it can lead to remarkable results. Hence, in the future, I plan to conduct this case study among the students and the public to develop this case study into a more meaningful one.

Furthermore, I want to expand this research on Sustainable Development Goal 12 of Responsible Consumption and Production to the institutions and policy-making bodies in the future to have a larger impact. I am keen to study the net impact of shifting to electric vehicles on the environment as the main source of electricity production is still fossil fuels in many countries. Hence, if we need to reduce environmental impact and ensure sustainability it must be through responsible consumption.

Moreover, to ensure responsible production, apart from the efforts from the industry, there must be support from the governments and policies should be unambiguous and explicit in supporting the efforts. Suitable policy measures and support from the government should avert the inertia of the existing fossil fuel industry. Research and Development should be impressed with the replacement of fossil fuels in the real sense and identify industries that do not use fossil fuels at any level of the supply chain.

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Appendix A - Interview Transcript

Responsible production and consumption

Your opinion is confidential, and anonymity will be strictly adhered to in the research paper.

Disclaimer: This is not against the use of electric vehicles, development, modernization, or support use of fossil fuels. This is about responsible consumption and production.

Personal Profile

Name: _____

Gender: Male

Age: 40 and above

Profession: Expert in Climate and Energy

Interviewer: (0:52) Do you use gadgets with rechargeable batteries? How many gadgets do you use?

Interviewee: (0:57) Ok. Well, I guess, phone, laptops. I guess probably two or three of them.

Interviewer: (1:12) Ok, do you have electric vehicles with rechargeable batteries?

Interviewee: (1:18) No (unintelligible)

Interviewer: (1:19) Okay, so you have only electric vehicles, right.

Interviewee: (1:21) I don't have a vehicle actually.

Interviewer: (1:24) Okay, but then you use cars, buses, or hybrid vehicles?

Interviewee: (1:30) Well, I would rent a car sometimes or use bus. I think there are buses and cars. I think it depends on what you can rent these days, you can get regular petrol or hybrid or electric, so all of them, depending on what's available.

Interviewer: (1:40) Ok, so, you have used the electric vehicles, like even the buses here are hybrid vehicles

Interviewee: (1:56) yeah... hmm..

Interviewer: (1:58) This does not make sense here. How many vehicles does your family own?

Interviewee: (2:03) Nothing.

Interviewer: (2:04) If you are not presently using an Electric Vehicle, do you plan to purchase electric vehicles in the future?

Interviewee: (2:16) Maybe an electric bike, bicycle.

Interviewer: (2:20) Ok, I mean, in future whenever, you get, you will hopefully get an electric car or hybrid or I mean a petrol vehicle like?

Interviewee: (2:30) Well, I mean, who knows about the future. It will electric most likely, I see very little chance that it could be a petrol vehicle.

Interviewer: (2:44) hm..yeah..ok. What do you think is the impact you make on the environment by shifting to electric vehicles?

Interviewee: (2:52) hmm... Ok, well it is the obvious, I guess, lower emissions, that is the primary impact, I guess. I don't think there are any other impacts. Yeah. That's the only impact I can think of.

Interviewer: (3:18) Ok, do you know what minerals are required for rechargeable batteries used in electric vehicles and gadgets, like?

Interviewee: (3:28) I don't know have a lot of knowledge about the latest technology, but, well, yes, lithium, cobalt, nickel, copper, there is, obviously iron, steel, there is probably a whole bunch of carbon used with the iron to make steel and so forth, and I am guessing there is oil and gas used in some shape or form for the plastics in the car. You are talking only of batteries or the resources...

Interviewer: (4:02) I mean, yes, it is mostly about the batteries.

Interviewee: (4:05) Ok, so, I think it is the first, probably first four minerals, not the other ones

Interviewer: (4:10) Ok, fine. Do you know where these minerals are mined?

Interviewee: (4:21) Yes, they are mined in South America, Africa, Indonesia, in the US and China. Those are the main locations will be six.

Interviewer: (4:38) Ok, China, South America, Africa, Indonesia, China, and US.

Interviewee: (4:45) Yeah.

Interviewer: (4:46) Ok, please glance through these articles, I am showing, I am just sharing with you.

Interviewee: (4:50) Ok, how do I?

Interviewer: (4:55) No, I am just sharing. You are able to see my screen, right?

Interviewee: (4:58) Hmm.. Not anymore.

Interviewer: (5:00) Yeah, now, let me share now.

Interviewee: (5:05) Oh, there you go. Oh, yeah, yeah.

Interviewer: (5:15) This is the article on artisanal mining, which is happening and how the shrinking of the city is happening due to the extension of the mines. (hmm.. yeah, yeah). This is like you know, I am just limiting it to Africa (Ok) So I am just showing the articles relevant for Africa. (Ok) These are the cobalt mining sites, like where the satellite images show the shrinking of the places where people live.

Interviewee: (5:55) Yeah, I have seen many of these photos in the past, yes. (hmm. Ok)

Interviewer: (6:14) So, this is another article on the same Congo, how the industrial mining (hmm.) and artisanal mining happens (yeah). How the forced eviction of people is happening, and the homes demolished to extend the mines.

Interviewee: (6:48) yeah... ok.

Interviewer: (7:18) This is like, all the rechargeable batteries, how they are mined, like how people work in the mines exactly. This is the photo of the Shabara mines, in the DRC, how people work.

Interviewee: (7:54) Hmm. Hmm.

Interviewer: (8:06) Ok, these are the articles I had. So, now. So, now, what do you think is the impact you make on the people and environment in these developing countries where the minerals required for the rechargeable batteries are mined?

Interviewee: (8:43) Yeah. We could do a better job of doing the mining in a safe way and making sure those people benefit (can you say that again). Make sure the people who live there are actually better off rather than the worse off. So, whatever equitable measures we can have in terms of protecting their human rights, labor rights, health, their future, financial benefits and so on and so forth. I think, we should do, whatever, it takes to make sure that happens. I mean, this pretty much applies to any resource that attract extraction anywhere in the world, not just these minerals. It applies to, you know, fossil fuels. It applies to agricultural sector, you name it. These problems are endemic everywhere. We could do much better job of doing this extraction.

Interviewer: (9:57) Ok. I mean, now what is your insight on the environmental and social impact of shifting to electric vehicles, I mean, this is not against any development or as such, but then, it's about responsible consumption and production, like what is that, not just on production, on consumption also, like what is your insight on the impact created?

Interviewee: (10:19) So, the main thing is that we need to reduce our consumption of everything. You know there is this whole, I guess, concept, of thinking about live within your reach. So, extracting any kind of resources for consumption, maybe throwing away clothes, you know, wasting food, or wasting water, it's the same thing. But we should try and minimize our consumption, we should try and minimize what we take, to try and have whatever lifestyle or life that we want to have. So, first is minimization of that. Second, we should try and optimize with what we are taking. So, make sure that we are using whatever stuff we are taking in the most efficient way. So, you know, just because you have, you know, a battery, should try and optimize its performance, rather than using it in a wasteful manner, or whatever, yeah, not taking good care of that, using it in conditions that are not good for (unintelligible). So, there is minimization, there is optimization, and then, you know, whatever we need to consume, we want to make sure there are no externalities associated with it such as what you were seeing in these pictures, for example, right. In that, you know, if we are going to consume food, right, you know, whether it is, you know, whether it is wheat or corn or meat or milk or dairy, well let's make sure that people and animals are least affected by it. If they are affected by it, how can we compensate them fairly for it and so on. There is kind of, like, a hierarchy, loading order of things that we could do to try and minimize our environmental and social impacts. Again, these things apply to everything. This is not just about modern gadgets or rechargeable batteries. This is something that has, that can apply to our entire history, and the current point in time.

Interviewer: (12:43) Yeah, thank you so much, you know, you have almost given all the points I should say. Thank you so much for your insights and time as well.

Interviewee: (12:55) Good luck with your research.

Appendix B – Interview Protocol

Interview Protocol

Responsible production and consumption

Your opinion is confidential, and anonymity will be strictly adhered to in the research paper.

Disclaimer: This is not against the use of electric vehicles, development, modernization, or support use of fossil fuels. This is about responsible consumption and production.

Personal Profile

Name:

Gender:

Age: under 18, 18-25, 25-40, 40 and above

Profession:

1. Do you use gadgets with rechargeable batteries? How many gadgets do you use?

2. Do you use electric vehicles with rechargeable batteries, in any way like cars, buses, or hybrid vehicles?

3. How many electric vehicles does your family own?

4. If you are not presently using an Electric Vehicle, do you plan to purchase electric vehicles in the future?

5. What do you think is the impact you make on the environment by shifting to electric vehicles?

6. Do you know what minerals are required for rechargeable batteries (lithium-ion batteries) used in electric vehicles and gadgets?

7. Do you know where these minerals are mined?

8. Please glance through these articles about the mining of cobalt in the Democratic Republic of Congo. What is your reaction to these articles?

https://drive.google.com/file/d/1nSEr7n3ooAMmUJ7HWhtxOXVwymqgkt94/view?usp=drive_link

https://drive.google.com/file/d/1MKoymivzJWmlT0143w8lIDCW8JQ_nb7F/view?usp=drive_link

https://drive.google.com/file/d/1dcswPgnwGjTc-2YpKr_PfoLzL79dmlTc/view?usp=drive_link

9. Now, what do you think is the impact you make on the people and environment in these developing countries where the minerals required for the rechargeable batteries are mined?

10. What is your insight on the environmental and social impact of shifting to electric vehicles and development accomplished with modern gadgets using rechargeable batteries?

Appendix B1 - Pictures of environmental and social impact

Pictures of environmental and social impact

Appendix C - Observation Field Notes

Observation Field Notes

I observed lecture 19 of ESPM 102 D - Climate and Energy Policy, which was an undergraduate class. I got permission to observe the class from Lecturer Ms. Abigail Noelle Martin through email. The class was conducted in Mulford Hall No. 159, which had an auditorium-type room of 150 capacity. The session was on March 3rd, 2024, Tuesday at 5.00 to 6.29 pm. There were around 70 students in the classroom. The lecture was on Power Market Battles – A Case Study of Distributed Generation in Arizona and California.

The students were mostly taking notes in the physical notebook rather than using laptops, and after the lecture was over, I enquired about this to the lecturer. She specified that it was a conscious decision so that the students had little distraction and studies have shown better absorption of lectures when notes are taken by traditional means. She also added that it saves energy consumption as 70 students using laptops at a time leads to more energy consumption. She had instructed the students to use handwritten notes at the beginning of the semester and most students follow that meticulously.

The lecturer made a brief recap of previous lectures in the beginning:

Lecturer: In previous classes, we assumed that well-designed policies could drive R&D, demonstration, and deployment of low-carbon technologies. However, energy systems are complex, and one-dimensional policy interventions may not be effective for low-carbon energy transitions.

(Then she started discussing the Power market battles that exist between the incumbents and the challengers in power systems when shifting to renewable energy systems. The discussion was mainly focused on the solar energy supply chain.)

Lecturer: Adoption of a new energy source depends on the socio-technical system. Low carbon energy transition faces socio-technical lock-in. Now tell me what is Socio-technical system?

(Students lift their hands, and the lecturer asks one student to answer.)

Student 1: It comprises task, structure, technology, and people. I remember we discussed it in a class before.

Lecturer: You are correct. A “sociotechnical system” is built from many different actors’ agencies, materials, technologies, and institutions, and is subject to various social forces.

In this, path dependency is a very important concept, and it refers to the idea that there are increasing returns once an established set of practices/technologies achieves economies of scale, as well as increasing costs for changing away from established practices/technologies. This concept prevents the policy-making authorities/institutions shift from one established practice to a new one. When inertia is created due to path dependency to move from a system lock-in occurs.

(Students lift their hands, and the lecturer asks one student to speak.)

Student 2: I don’t understand what is lock-in?

Lecturer: Let me explain this with an example:

We know QWERTY keyboard. There is another keyboard type – Dvorak keyboard. Though the Dvorak is easy to use and better than the QWERTY, as many people got used to it and it is well established, we have an inertia to move from that to Dvorak. This is QWERTY Lock-in. Can someone tell when lock-in occurs?

(Students lift their hands, and the lecturer asks one student to answer.)

Student 2: Lock-in occurs when a system's path dependency creates inertia.

Lecturer: That's correct. Thanks. In the energy sector, we have what is called the carbon lock-in.

Early industrialized countries established fossil fuel-based sociotechnical systems. Over time leading industrialized countries have become locked-in to these systems, as many other technological systems, organizations, industry practices/business models, societal preferences, and governing institutions …all become invested in maintaining the status quo of the current energy system. Strong political resistance from incumbent coalitions rooted in these systems can effectively block changes to the fossil-fuel status quo. There are many socio-technical lock-in sources. I can state a few with examples to understand easily.

For technological lock-in source – examples are dominant design, standard technological architectures and components, compatibility

Organizational lock-in source – examples are routines, training, departmentalization, customer-supplier relations

Industrial lock-in source – examples are industry standards, technological inter-relatedness, co-specialized assets

Societal lock-in source – examples are system socialization, adaptation of preferences and expectations

Institutional lock-in source – examples are govt policy intervention, legal framework, departments/ministries

Now pick a sociotechnical system that contributes to our overall 'Carbon Lock-in' problem. Identify 2-3 sources of lock-in.

(The lecturer gives this in the system, and students answer it through the quiz. Then she resumes the lecture.)

There is multi-level lock-in occurring in some instances:

Institutional lock-in – occurs in National and local institutions

Technological lock-in – occurs in user technologies and supporting infrastructures

Behavioral lock-in – occurs in individual behavior and culture and social practice

(The lecturer shows the schematic presentation of the lock-in for gasoline-powered automobiles.)

The sources of lock-in may be located at specific scales. Sources can also work across different scales.

Lock-in implies that the development of a low-carbon energy system requires the following:

A. Adopting a suite of policies and new business models to allow for systems change.

B. Putting a price on greenhouse gas emissions as the primary policy instrument.

C. Pursuing industrial policies focused on research, development, and deployment of low-carbon technologies.

There are various social and political challenges that discourage automobile usage:

- Tax law
- Ownership burdens
- Dis-incentivizing car usage – higher parking cost
- Pedestrians given preference
- Driving annoying in some states like California
- Criminal law – stringent for rash driving
- Dependent level
- In some countries laws are not stringent for bikers - wearing helmets is not made mandatory.

So far we have discussed sociotechnical system lock-in and carbon lock-in.

Let's move to the second part of the lecture. Let's discuss the incumbents & challengers in the power generation systems.

There is a Battle for Change between the Incumbents and the Challengers in shifting to new energy:

• Incumbents are those actors/firms benefiting from an existing socio-technical system.

• Challengers are those actors/firms aiming to change/disrupt a dominant system.

• Incumbents and challengers battle over the direction of technological change.

E.g., electric utilities vs. renewable energy generators

E.g., ICE auto manufacturers vs. EV manufacturers

Now answer this question in the system, who are challengers?

A. Small, entrepreneurial start-up firms trying to capture a share of an existing market from incumbent firms.

B. Any-sized firm or other actor that wants to introduce a new technology into an existing market.

C. Powerful firms with the resources to block/ limit changes that could devalue their assets or cause losses in market share.

(The lecturer gives this in the system, and students answer it through the quiz. The lecturer responds A and B are correct answers, and C is Incumbents)

Now let's see the Solar PV installations distribution in the US

(The lecturer shows a graph)

This graph shows the solar PV installations in the residential, non-residential, and utility sectors. Renewable energy is generated in two ways distributed and centralized generation methods.

Now tell me what is grid parity? (no one raises their hand, and the lecturer continues)

Grid parity occurs when an alternative energy source can generate power at a levelized cost of electricity. To shift alternative renewable energy sources this is very vital.

Now tell me what is Distributed Generation (DG)? (no one raises their hand, and the lecturer continues)

Distributed generation usually refers to the on-site generation of renewable energy in the residential and commercial buildings sectors, such as electricity from solar photovoltaics (PV) and small wind turbines. It includes community-scale distributed generation.

Residential and commercial – approximately 5 to 500 kilowatts

Community-scale – approximately 500 kilowatts to 5 megawatts

Now can someone tell what is Centralized Generation (CG)? (no one answers and the lecturer continues)

Centralized Generation refers to utility-scale generation. It is approximately 20 + megawatts. Power enters the grid via transmission lines and is distributed to customers.

(The lecturer shows the schematic presentation of the various generation models on the screen and continues)

Now let's compare the Centralized and Distributed Generation

The Centralized Generation has various pros and cons. The potential pros are - Economics of scale, System stability, and "High-road" jobs. The potential cons are – Vulnerability, Large capital investments, and Land-intensive - competes with other land uses & potentially harmful to environment/wildlife.

Similarly, the Distributed Generation has various pros and cons. The potential pros are - Distribution of benefits, "Energy democracy", Lower transmission losses, Lower investment risks, and may be higher resilience for certain groups. The potential cons include - Lower economies of scale, maybe lesser access for certain groups, may increase costs to electricity consumers, "low-road" jobs

Now answer this question in the system, what do you consider preferable?

A. Centralized utility-scale generation

B. Distributed generation

C. 50/50 mix of both

D. 20/80 mix of centralized utility-scale and distributed generation

(The lecturer gives this in the system, and students answer it through the quiz.)

Now tell me why do the "incumbents" (utilities) oppose distributed generation?

S**tudent 3:** Fear of business loss.

Student 4: Infrastructure setup will be futile.

Lecturer: Yes, there are many reasons for the utilities to oppose the distributed generation.

Also, there are various support mechanisms for "Challengers" (DG renewable power producers)

One is Demand-side policy (subsidies) for DG wind/solar

a) Feed-in-tariffs (FIT): A policy designed to support the development of renewable energy sources by providing a guaranteed, above-market price for producers.

b) Net-energy metering (NEM): This is a billing mechanism established by utility regulators. It requires a bidirectional meter or two unidirectional meters. It enables the utility customers to become distributed generators that can sell unused electricity back to the grid i.e. "prosumers" (producer-consumers).

Next is Third-party ownership & financing models for DG: A third-party makes upfront capital investment to build and own solar PV systems that consumers who want renewable energy can access.

a) Power-purchase agreements (PPAs): Consumer purchases power from a third-party owned PV system at a fixed rate for a set time-period (typically lower than the utility's rates) – common for commercial DG.

b) Solar lease: Consumer pays third-party to install a PV system on-site (monthly payments), which is used for some combination of self-consumption and selling excess power back to the grid – common for residential DG.

Now let us move on to the next part of the lecture - Case study of Arizona and California in installing solar energy

(The lecturer shows the graph of Total MW installed solar in the US, 2015)

Lecturer: The graph shows the total solar energy generating capacity of different states in 2015:

California – 9976 MW

Arizona – 2103 MW

Solar energy generating capacity in 2021 shows

California to have 34,950 MW, 1,445,305 installations and 68,677 jobs and

Arizona to have 5,643 MW, 209,513 installations and 7,346 jobs

If we compare the conditions in Arizona and California

Arizona has sun-rich landscape, implemented Renewable Portfolio Standard i.e. RPS and net-metering, Erected barriers for net-metering

Who do you think are the winners - Incumbents or challengers?

Students: Incumbents

Now let's see the case of California. **California** has sun-rich landscape, implemented Renewable Portfolio Standards (RPS) and net-metering, expanded RPS and net-metering

Now who do you think are the winners - Incumbents or challengers?

Students: Challengers

Student 5: What is Renewable Portfolio Standard?

Lecturer: A very good question. Renewables Portfolio Standard (RPS) is one of California's key programs for advancing renewable energy. The program sets continuously escalating renewable energy procurement requirements for the state's load-serving entities. Generation must be procured from RPS-certified facilities. The California Energy Commission verifies RPS claims.

The general DG Challenges faced in Arizona and California are:

Utilities argue that because of net-metering, rooftop solar customers/prosumers are -

1. compensated above the level of benefit their panels provide to the electric grid (compared to centralized energy production & distribution models); and
2. not paying their fair share of infrastructure costs.

There were some net-metering battles in Arizona:

In 2007, state regulator set new RPS target:

– 15% by 2025

– Solar carve-out: 30% must be DG, of which 50% must be residential

In 2013: The Investor-owned utilities (IOU) Arizona Public Service (APS) proposed to end NEM and institute a $50-100 monthly fee for solar customers.

We can see the politics of Net Metering in Arizona:

DG solar supporters raised concern that the monthly fee will halt solar expansion

– The Alliance for Solar Choice (TASC) and Tell Utilities that Solar Won't Be Killed (TUSK) were formed

– They had the framing - Consumers want “choice”

– Spent $336,000 on lobbying and PR in the solar battle

Arizona Public Service argued that this fee is necessary to offset higher costs & revenue losses.

– Spent $3.7 million on lobbying and PR in the solar battle

- ultimately it appeared that APS supported their wealthy customers for the tax dollars

In contrast, the outcomes of California’s net-metering battle were like:

In 2013 - AB 327 was passed allowing the California Public Utilities Commission (CPUC) to adjust the tiered residential rate structure, which requires updates to utility net metering programs.

Utilities requested the ability to add:

– fixed monthly charges for all residential customers

– demand charges (per kWh) for rooftop solar customers

– large cuts to the rate paid for electricity generation from solar customers.

In 2016, CPUC allowed minor changes to rates for rooftop solar customers, but largely left the NEM structure in place – which was a victory for the solar industry.

In 2021, CPUC proposed NEM 3.0, which included:

– A lower NEM rate for rooftop sales

– A new $8/kw monthly fee to cover the cost of grid maintenance.

– IOUs claim this creates an incentive for accelerated battery storage technology

NEM 3.0 took effect on April 15, 2023:

- The value of credits for excess solar exported to the grid will be reduced by roughly 20-40% from what is currently being received under NEM 2.
- Customers can lock in retail rates for only 9 years, which was 20 years previously.
- On November 16, 2023, California Public Utilities Commission voted to exclude schools, farms, apartments, and businesses from the benefits of solar energy.

California Solar Storage Association opposed this stating the CPUC works for the benefit of big utilities like PG&E. The utilities and utility supporters have been propounding the cost-shift arguments in their support.

In summary, we can see in California the challengers had more success compared to Arizona which resulted in more solar PV installations. We can conclude that in the battles with incumbents, challengers can mobilize people/labor to pressure regulators, but they have less financial, political, and technical means to sway cost-focused regulators compared to incumbents.

Now let us do a quiz before we end the lecture:

(The lecturer gives this in the system, and students answer it through the quiz.)

In installing solar and wind power generation capacity

Who benefits?

A. Households
B. Landowners
C. Firms

(Majority of the students selected A and B)

Who loses?

A. Households
B. Landowners
C. Big utilities

(Majority of the students selected C)

Now the mid-term evaluation is available. All of you do complete that. Enjoy your spring break.

(Class ends and students disperse. Then I thanked the professor for allowing me to observe the lecture and left.)

From my perspective, the class lecture was more relevant to the research project on Responsible Production and Consumption. The lecture discussed the issues involved in low-carbon energy transition. As the sociotechnical systems for fossil fuels are well established, it becomes difficult for the challengers to fight the incumbents, establish new sociotechnical systems, and achieve grid parity. Moreover, the incumbents are commercial firms like PG&E that support the centralized generation, and the challengers are the residential and community producers of distributed generation and their associations.

As we can observe in the lecture, although the climatic and physical conditions were similar in California and Arizona, due to the monetary power of the centralized distribution system in Arizona, distributed generation could not succeed in Arizona to the level of California, where the associations were much stronger. The shift to solar energy was massive in California compared to other states in the US, mainly due to the Energy policy and the strength of the challengers. The lecture discussed how the Energy Policy can affect the source from which energy is produced, how energy is produced and consumed, and how it can directly impact Responsible Production and Consumption.

Appendix D - Codebook

Interview Coding

List of codes with definitions:

Consumption:

Usage of gadgets with rechargeable batteries - Yes/No

Usage of electric vehicles (EVs) with rechargeable batteries - Yes/No

Ownership:

Number of gadgets owned – Numbers

Number of EVs owned - Numbers

Requirement:

Minerals required for rechargeable batteries - Yes/No/Do not know

Extraction:

Place of mineral mining - Name of places/countries

Feeling:

Condition of the people - Feeling shocked/horrified/sad/bad

Insights:

Perception of the issue of shrinking cities - Feeling shocked/horrified/sad/bad

Awareness:

Knowing the facts - Yes/No/Do not know

Impact:

Impact on the environment (environmental impact) - Yes/No/Do not know

Impact on the people (social impact) - Yes/No/Do not know

Minimization:

Minimize consumption - Yes/No/Do not know/will try/in future

Optimization:

Optimize utility - Yes/No/Do not know/will try/in future

Sustainability:

Responsible production and consumption - Yes/No/Do not know/will try/in future

Coding strategy:

A combination of inductive and deductive coding methods was used to code the interview data. Initially, the interview questions of close-ended type were coded by the deductive method and the replies of the interviewee to the open-ended questions were coded by deriving the codes from the data by the inductive method.

Appendix E - Data Matrix

Data Matrix

Code	Description	Connection in interview	Connection to observation	Summary /emerging themes	Connection to other codes
1. Consumption	Usage of gadgets with rechargeable batteries	• iPhone, • iPad, • laptops, headphones	Minimal use of laptops by students during class, use of notebook	Conservation of energy	Consumption (1&2)
2. Consumption	Usage of electric vehicles with rechargeable batteries	• Electric cars, • Electric buses, • Hybrid buses	Minimal use of vehicles	Minimal use of vehicles	
3. Ownership	Number of gadgets owned	• 2/3			Ownership (3&4)
4. Ownership	Number of EVs owned	• 0/1		One or No ownership of vehicles	
5. Impact	On the environment	• Lower emissions, • good for climate, • ability to lower carbon footprint	Low-carbon energy transitions	Irresponsible mining and disposal of lithium-ion batteries	Impact (5&11)
6. Requirement	Minerals required for rechargeable batteries	• Lithium, • Cobalt, • Nickel, • Copper, • Lead			Minerals (6&7)
7. Extraction	Place of mineral mining	• South America, • Africa,	Renewable energy source –	Consume renewal energy sources	
		• Indonesia, • US, • China, • Australia	solar PV installations		
8. Feeling	Condition of the people	• Pathetic working conditions of people in the mines			Feeling and insight (8&9)
9. Insights	Perception of the issue of shrinking cities	• Mines encroaching on cities			
10. Awareness	Knowing the facts	• Aware		Not interested in electric vehicles	
11. Impact	Impact on the environment/people (environmental/social impact)	• Can do a better job of mining/extraction, • People involved in extraction be treated better off, • Think about reducing the use		• There can be equitable measures for better treatment of people. • Endemic in all fields	
12. Minimization	Minimize consumption	• Minimal usage of battery, • Walk a little more, • Use bicycles,	Minimal use of gadgets - laptop	Not wasting food or water.	Responsible sustainable consumption (12, 13, & 14)