ENERGY/ENVIRONMENT TRANSITION TRACK:

Sustainable Products for Green Energy Transition(s)

MEMP EGRMGMT 590.08

6:15-9:00 PM on Thursdays – Beginning 1/11/2024

SPRING 2024

Professor: Guerry L. Grune, Ph.D., PA (757) 570-0883 /ggrune@duke.edu and ggrune@epatentmanager.com
Room 126 Wilkerson

Syllabus Updated 11/27/2023

In-person: Thursdays the entire Semester
Distance: When necessary

Instructor	Teaching Assistant
Guerry Grune, PhD, PA **ggrune@duke.edu** **guerry.grune@duke.edu** **Off campus office hours: Mondays 7-10 PM** or email/text Guerry to schedule appointment **Office Phone:** (757) 486-2088 **Cell Phone:** (757) 570-0883	**Simranjeet Dua**

INTRODUCTION

The push for a "Green Sustainable Energy and Environment Policy" throughout the planet is well established and ongoing. This course has been developed to teach student how products can be designed to ensure that energy transitions for existing and new products can be managed properly and effectively while providing sustainability for worldwide consumption. The world's energy economy and the products and processes used to manufacture them remains driven primarily by fossil fuels. The shift to green, sustainable, alternative processes, products and services requires a multivariable approach which includes both risk assessment and gap analysis. This methodology is useful in order to reach the goals established by the WHO (World Health Organization) and supported by the WTO (World Trade Organization) as well as by most country centric governments.

Students will also be introduced to environmental, social, and governance (ESG) initiatives which are driving the next revolution in products introduced to the retail and wholesale markets. As consumers, regulatory bodies, and governments increase pressure on businesses to demonstrate their commitment to sustainability and ethical labor practices, it's critical that retailers effectively, profitably, and efficiently integrate ESG into their broader sourcing and supply chain strategies as products are developed.

In order to develop management and engineering skills to acquire the ability to achieve these goals, many tools will be introduced during the course of the semester. These include the use of Life Cycle Assessment (LCA) as it pertains to ISO 14000 (International Standards for Environmental Management Strategy) as well as implementing the ability to understand the importance of intellectual property with

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regard to prior art using a set of principles and techniques required to maximize product value. These tools include SciFinder, PatBase, EcoChain, LCAPIX, and Clarivate among other proprietary software systems to be utilized during the semester. Many students may have already been exposed to innovation and commercialization as well as green sustainable product models, but rarely provided an understanding regarding the use of valuation techniques to leverage technology driven solutions. This course will provide the student with the ***extraordinary ability*** to more fully understand all aspects of sustainably focused technologies that can all be brought together for application of these newly introduced skills in order to create products that meet new and existing governmental policies. Teams from the class (and perhaps several teams) ***may enter the MEMP GCI EXECUTIVE CHALLENGE March 2024 with a distinct advantage by taking this course***. Additional optional competitions students have competed in and won or placed with similar course material include Licensing Executive Society's SHALLOWAY GRADUATE STUDENT LICENSING COMPETITION or equivalent outside competitions including the Oak Ridge National Laboratory GLOBAL VENTURE ENERGY COMPETITION as well as the DUKE START-UP CHALLENGE.

Description: It can be argued that the economy is a subset of the energy sector and needs for energy on our planet. There is no doubt that the energy and transportation industries are some of the most capital-intensive and fastest-growing industries in the world. Emerging economies are rapidly building infrastructures to meet the rising needs of their citizens, while developed markets are evolving their systems to balance product needs with services, costs, consumer preferences, and environmental load considerations. In this course, we will apply principles from life cycle assessment (LCA) and environmental management strategies ISO 14000 to help understand *energy transitions*, with a focus on developing new or existing green sustainable products that are energy efficient and profitable. Specifically, we will explore how market supply and demand, industry infrastructure, technology, and costs evolve over time to determine market price acceptance. We will also explore how value is created in these industries, and how risks are managed. Many of these factors will be demonstrated in simulation exercises using at least two or more LCA software tools. In addition, the use of prior art searching and IP protection for these new and existing products can increase the likelihood of successful product introduction and/or sustainability.

By using targeted readings, case studies, lectures, and guest lectures, we will observe how these dynamics are useful for any technology sector as well as for specific markets including historical context. In addition, we will learn how to use practical analytical tools including cost curves and involve carbon credit analysis to make empirically grounded business decisions. With this grounding, each student and project group will consider the practical product and market factors that should be considered involving energy security, infrastructure, natural resources, climate

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regulation, and profitability. This class is designed to meet the learning needs of students with or without experience in green energy industries, but also provides a valuable introduction to green sustainable product development and/or augmentation for non-specialists.

Course Requirements (I = Individual deliverable; T = Team deliverable):

Due Dates	Assignments	Points
	Class attendance and participation (I)	10
Due Before Class Each Thursday	Homework Assignments (I) – not graded – participation value	10
LCA Simulations (T)	Each project and group should work together for two (2) LCA tool simulations (Umberto and openLCA) Then provide a short summary of the results	20
Project Participation (T)	Each project will likely have 5 students this semester – each student should participate equally – one (1) student should be designated as project leader	N/A required for all
December 1-2 (T)	Final Project Drafts Presented to G Grune	20
December 13 (T)	Final project - paper and presentation (I)	40

Evaluation criteria for this course include:

- **Class attendance and participation (10%):** Class attendance and participation is a crucial part of the learning process in this course. You will learn a great deal from the ideas of others in the class. It is important that you come to class prepared to share your insights with others and to compare your perspective on the day's topic with the perspectives of your peers. You will be evaluated on the quality of your engagement in the discussion, creative and thoughtful insights, and respect for others' contributions. However, more is not better, so be prepared to contribute to a balanced conversation involving all participants.
- **LCA Simulation (10%)*:*** Each student for each team/project will learn the use of Life Cycle Assessment by having access and utilizing at least 2 (two) software tools (currently openLCA and Umberto) for at least one product (preferably one that the team has chosen to work on during the semester). After the LCA simulation is complete project teams will document and submit their learnings in a Team Debrief document. Please submit a ~800-word debrief, in PDF format using 12-point single-spaced text.
- **Final project – paper (20%) and presentation (%) = (60%)**

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The green product industry is currently undergoing profound shifts driven by new technologies, evolving policy priorities, emerging business models, and changing consumer needs and expectations. For your final project, please select one of the technologies below and assess its potential impact on projected profitability for the industry associated with that technology for the next 5-10 years.

You will write a group paper on this topic. Imagine preparing this analysis to share with industry professionals and investors at one or more major "energy futures" conferences in 2024. Your paper should be at least 1,200 words (you will not be penalized if it is longer – with a 300 word or less executive summary) that summarizes three major issues; Energy consumption, Waste Analysis and Profitability. You may also include relevant tables or graphics and provide proper citations. You should use multiple data sources and demonstrate the breadth of your research by considering different perspectives. Highlight any key assumptions or debates that impact your assessment.

In addition, each team will prepare and deliver a 10-minute presentation, followed by 5-minute Q&A in the draft sessions with Guerry during the last week of classes.

Technology Innovations this Semester:

1. "Micro" wind turbines – Daniel Lerner (1-2 projects) – Roof top compressors
2. Hydraulic Power Units – Daniel Lerner (1-2 projects) – Pumps/Steering mechanisms
3. LCAPIX software resurrection – Guerry (1 project) – other LCA software
4. Nutroleum (alternatives to petroleum jelly) – Guerry
5. Nutrasporin (alternatives to Neosporin) – Guerry
6. Chelated Silver Oxide (alternatives to colloidal silver) - Guerry
7. CPS Biofuels – GTBE (jet fuel alternatives) – USP10,344,235 – Marty Trivette
8. CPS Biofuels – Hexane from fermentation with Kolbe– USP8,241,881- David Bradin
9. CPS Biofuels – Heptanone – USP 8,148,579 - David Bradin
10. CPS Biofuels – Biodiesel Kolbe electrolysis – USP 8,481,771 – David Bradin
11. Biofuels (E10 Substitute for gasoline) – David B., Guerry, Marty
12. Tempgate/NFTs/EvGO charging stations (1-3 projects) – Ravi Singh
13. Distribution Transformer Oil Choices – Guerry
14. Modular nuclear/fusion - Chris Nestor – Westinghouse
15. Surfboards – Guerry
16. Acrylamides – Guerry

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17. ***OTHER*** (topic to be approved ahead of time by Guerry)

In your analysis, please consider the following questions:

1. What is the potential impact of this product innovation in the world of green sustainable products and how is it likely to evolve with the global energy transition over the next 5-10 years?
2. What is the value proposition of this product innovation for waste reduction and energy transitions regarding energy efficiency, customization, affordability/profitability, reduced environmental impacts, and the value chain. What are the potential drawbacks, risks, or liabilities?
3. How might economic, political, regulatory, customer, and social trends over 5-10 years (global or regional) be perceived with this product innovation?
4. Using concepts learned in class, what impact might this product innovation have on waste reduction and energy supply/demand in the US or globally?
5. How might industry dynamics be affected by this product innovation?
6. What enablers or barriers exist that might influence the deployment of this product innovation?

PRESENTATION SUMMARY

What existing companies would be attractive investments for the product(s) described? What kinds of new ventures would you expect to emerge in this space? Your paper should be an objective analysis of your target innovation – including both the promise and the challenges of adoption. This is where some of your knowledge regarding Intellectual Property and patents will be of assistance. Please provide an executive summary that also recommends what industry participants and investors might anticipate in the coming decade regarding the product(s) described and how they should respond.

The ultimate goal of this course is to provide the student with the ability to utilize the proper understanding for developing new products that utilize energy transition and sustainable environment tools available to leverage emerging strategies. The use of these tools will allow for successful endeavors in any future engineering management career.

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The goals of this FULL semester course are;

- Provide information and education involving development of new products using sustainable energy and environmental solutions for transforming economies
- Understanding the use of ESG as it relates to New Product Development and relationships to the Energy Star and closely associated programs
- Understanding and use of Life Cycle Assessment (LCA) and Activity Based Costing (ABC) for New Product Development plus the use of carbon credits to complete valuations
- Understanding and use of ISO 14000 for practices in developing new products
- Enable the participants to understand all aspects of product initiation, substantiation, and introduction into an accepting marketplace.
- Defining sustainability and green energy and environment Product ideation, creation, and public policy initiatives
- Prior Art Searching and Conceptualizing Innovation for Products that Meet New and Existing Market Demands
- It will also be shown how green, sustainable, ESG policy-based products can be leveraged for energy and environment transitions when applied in a technology-based organizational setting. This learning allows for the ability to make decisions that will allow for benchmarking the multiple opportunities that an organization must consider before embarking on an energy transition program.

Specific Topics to be covered in detail:

1. Development of new products that allow pivoting from fossil fuels to sustainable green energy policies
2. Products that utilize technologies required to make these pivots

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3. Assessment and proper decision-making regarding implementation of green product choices

4. Understanding how to develop products that meet local regional and global energy transition regulations and compliance

5. Understanding and implementation of regional and global Intellectual property laws and regulations

6. Search, retrieve, analyze and map IP for the products meeting energy transition sector(s)

7. Product licensing and licensing opportunities for products in the sustainable green energy and environment sector

RESOURCES:

There are 3 ***suggested*** **textbooks for this course;**

" Design for Environment: A Guide to Sustainable Product Development, 2nd Edition, Joseph Fiksel – 2009 – ISBN 9780071605564

"Energy Demand and Climate Change", Franklin Hadley Cocks, Wiley, VHC – Duke University, 2019, ISBN 978-3-527-32446-0

"The Singularity is Near" Ray Kurzweil - 2005 – Viking Publishing, Co., ISBN 978-0-670-03384-3

Additional References:

Coley, D. Energy and Climate Change Creating a Sustainable Future 2008 ISBN: 978-0-470-85312-2

Paul, B. Future Energy How the New Oil Industry Will Change People, Politics and Portfolios 2007 ISBN: 978-0-470-09642-0

Kruger, P. Alternative Energy Resources The Quest for Sustainable Energy 2006 ISBN: 978-0-471-77208-8

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Olah, G. A., Goeppert, A., Prakash, G. K. S. Beyond Oil and Gas: The Methanol Economy 2006 ISBN: 978-3-527-31275-7

Synwoldt, C. Mehr als Sonne, Wind und Wasser Energie für eine neue Ära 2008 ISBN: 978-3-527-40829-0

Romm, J. J. Der Wasserstoff-Boom Wunsch und Wirklichkeit beim Wettlauf um den Klimaschutz 2006 ISBN: 978-3-527-31570-

"Introduction to Intellectual Property and IAM", G.L. Grune course notes

"Who Owns the Sun?" by Daniel Berman and John O'Connor, Chelsea Green Publishing Co., White River Junction, Vermont, ISBN 0-930031-86-5, 1996

WEEKLY SYLLABUS TOPICS AND ASSIGNMENTS

Week 1: 1/11/2024

Design of New and Existing Products

Week 1 - Defining DFE

Required Reading: – Discuss Energy and Environment Transitions and what to review
– **Design for Environment: A Guide to Sustainable Product Development, 2nd Edition – first 2 chapters**

Lecture Content:
Different definitions of DFE
The value of creativity in a technology related firm

Initial Review of Projects and Project Considerations:

Discussion:
How does policy driven energy and environmental concerns affect product value?
What risks are involved ?
What constitutes DFE ?

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Week 2; - 1/18/2024

DFE and GSE – As It Applies to Energy Transitions

Week 2 – Understanding DFE and GSE
Complete project assignment discussion (assign teams)

Required Readings:
– Chapters 4-6 **of Design for Environment: A Guide to Sustainable Product Development, 2nd Edition**

Lecture Content:
Relating DFE to policy matters
Understanding the past

Discussion:
How to begin DFE
Determination of projects for DFE/GSE consideration
Initial DFE methodology
Search engines and search tools available to begin project work

Week 3; 1/25/2024 – Guest Lecturer Mr. Daniel Lerner Innovation in the Energy and Environment Transition Space

Week 3 – Merging DFE and GSE Strategies for New Products

Required Readings:

Chapters 7-10 of **Design for Environment: A Guide to Sustainable Product Development, 2nd Edition**

Chapters 1-5 of Who Owns the Sun ?

Assign projects to student participants – after drop/add date is complete -might extend to week 4

Lecture Content:
Selecting the best technical projects and assigning students to each group
The portfolio approach
Tools to utilize

Discussion:

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Discuss all issues and expectations for each project
Exercise on Technology Assessment
Exercise on Valuation

Optional Readings (in order of priority):
"Implementing a Stage Gate Process: A Multi-Company Perspective," by P. O'Conner, J. Prod. Innov. Manag., Volume 11, 1994
"A Few Things Every Manager Ought to Know about Risk," Harvard Management Update, Reprint no. U9703D

Week 4; 2/01/2024 – Guest Lecturers Greg Twiss and Joseph Fiksel

DESIGN CAPABILITIES AND TECHNIQUES

Week 4 - Systematic product design

Required Reading:

Chapters 10-13 Design for Environment: A Guide to Sustainable Product Development, 2nd Edition

Finish Who Owns the Sun?

Discussion:
What limits creativity?
Is "creative organization" an oxymoron?
What is the role of creativity in an existing firm?
How do large firms utilize creativity?

Lecture Content:
Aspects and methods for doing industry analysis
Aspects and methods for doing competitive analysis
Importance of competitive and industry analysis

Discussion:
What is the importance of competitive analysis?
What are the methods that are useful for analyzing competitive products (services) and companies?
What is the role of competitive analysis in the business plan?

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Week 5; 2/08/2022 – Guest Lecturer – Ravi Singh

GREEN SUSTAINABLE AND RENEWABLE BENCHMARKING – Life Cycle Assessment and Activity Based Costing

Week 5 – will present a comprehensive review

Required Reading:

Design for Environment: A Guide to Sustainable Product Development, 2nd Edition

Lecture Content:

What is LCA ?
What is ISO 14000 ?
What is Activity Based Costing ?

Discussion:

What are the basic requirements to develop a usable product ?
How to develop a useful global product ?
Distinguishing pretenders from saleable offers ?

Week 6; 2/15/2024 – Tentative Guest Speaker Chris Nestor

Product Examples

Week 6 – Wind Turbines, Biofuels, Solar Alternatives -Contrast with existing Petroleum Technologies

Required Reading:

Chapters 14-17 Design for Environment: A Guide to Sustainable Product Development, 2nd Edition

Lecture Content:

Defining wind, biofuels, geothermal, hydroelectric (Schneider Electric) and solar technologies
The prior art search
Using prior art to your advantage

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Discussion:

What's been done before – what constitutes prior art ?
Using the past to create the future
What works and what does not work

Week 7; 2/22/2024 – After Break Tentative Guest Speakers Marty Trivette and David Bradin

Product Innovation for DFE

Week 7 – How to Create the Future Product(s)

Required Reading:
Finish **Design for Environment: A Guide to Sustainable Product Development, 2nd Edition**
Begin - **"The Singularity is Near" by Ray Kurzweil**

Lecture Content:
Guest Lecturer – David Bradin/ Marty Trivette – Biofuels
Also invite Greg Twiss

Discussion:
Implementing the Energy Equation and LCA to define the outcome
Using ISO 14000 to achieve the results
Begin Group Product design in earnest

Week 8; 2/29/2024 – Tentative Guest Speaker Nhiem Cao

Week 8 – Group Reviews of Product Design and Development

Required Reading:
Continue "The Singularity is Near" by Ray Kurzweil

Lecture Content:
Defining product innovation
Differences between innovation, imitation, and implementation
Licensing activities contemplated

Discussion:

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What constitutes product innovation ?
Where, how and when do you design the next best DFE product ?
Real-life examples of DFEs that works

Week 9; – 3/07/2024 NO Guest Speakers – Focus on Projects

Work on projects – DFE product design review with each group week after break

Week 10; - 3/14/2024 Spring Break – Focus on Projects

Week 10 – Implementing DFE with Tools Provided

Required Reading:
Continue with **"The Singularity is Near" by Ray Kurzweil**
Lecture Content:
Review of each project with each group
Drafting the DFE product
Explaining how the new product design meets the energy transition requirements
Quantifying the basics

Discussion:
What constitutes a real DFE ?
Quantifying the energy and environment loads ?
Why the new product will be successful or not ?

Week 11; - 3/21/2024 NO Guest Speakers – Focus on Projects

FINALIZE PRODUCT/PROJECT ISSUES

Working with Groups to Finalize New DFE Projects/Products
Week 11 – Ensuring Success – Multi-variable factor analysis

Further Review of the Projects
Provide Roadmaps to Success

Required Reading:

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Continue with **"The Singularity is Near" by Ray Kurzweil**
Lecture Content:
Product design differentiation
Product/Process Comparisons with Older Petro Based Technologies

Discussion:
Is the product/process novel and useful ?
Can this unique approach reach marketplace acceptance and success?
Is it workable, marketable, and protectable ?
Are LCA/DFE/GSE tools utilized to achieve benchmarking needs ?
Provide key features that address all of the above

Week 12; - 3/28/2024 - NO Guest Speakers – Focus on Projects

Week 12 – Mock Final Presentations
Plus other project/product issues
International Perspectives

Required Reading:
Finish **"The Singularity is Near" by Ray Kurzweil**

COMPLETE REVIEW – after Thanks

Week 13; - 4/04/2024 - ESG Presentation – Debi Santini

Week 13 – Review of Group Efforts

Week 14; - 4/11/2024 - Last Class Date – Mock Presentations

Week 14 – Group Presentations

Final Exam date (Tentative); TBD during the class with student input

Green Classroom Certification

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The Green Classroom Certification was created to provide faculty with the opportunity to reduce the environmental impact of their courses and classrooms at Duke University while demonstrating eco-friendly behaviors to students.

You are encouraged to take the Duke Sustainability Pledge and to use the Duke Carbon Calculator to estimate your climate impact.

Appendix – Resources for Students

See below a list of resources that will help you deepen your understanding of the energy industry and its history, priorities, and debates.

Newsletters:

- Axios Generate

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- American Energy Society
- Utility Dive (several sector newsletters)
- VERGE Weekly

Web sites:

- Greentech Media
- ACS Green Chemistry
- ISO - ISO 14000 family — Environmental management
- Life Cycle Assessment (LCA) Software | Umberto (ifu.com)
- **openLCA.org**
- https://studiored.com/
- https://growensemble.com/environmentally-friendly-companies/
- Greenbiz
- https://www.renogy.com
- r/energy
- Climate Central
- Canary Media

Podcasts:

- The Energy Gang
- Interchange (subscription required)
- The Energy Transition Show
- Columbia Energy Exchange
- Long Now: Seminars about Long-Term Thinking

Energy Thought Leaders

- David Roberts – CLIMATE ONE
- Amy Myers Jaffe
- Geoffrey Styles – GSW STRATEGY GROUP

Additional Books:

- Ayres, Robert (2016). *Energy, Complexity, and Wealth Maximization*. Springer Press.
- Bradford, Travis (2018). *The Energy System*. MIT Press.
- Hawken, Paul (2017). *Drawdown: The most comprehensive plan ever proposed to reverse global warming*. Penguin Books.
- Mackay, David (2009). *Sustainable Energy – Without the Hot Air*. Chicago Review Press.
- Rhodes, Richard (2018). *Energy: A human history*. Simon & Schuster.