ENERGY INFRASTRUCTURE: SOLAR POWER INNOVATION CHALLENGE
COURSE SYLLABUS

Create Innovative Solutions to Society's Complex Challenges

Instructor: Program Lead: New York Academy of Sciences
Course Time & Format: 10 weeks; approximately 2-4 hours weekly
Format: Blended; Online
Age Level: 13 - 17 years old

COURSE DESCRIPTION & OBJECTIVES

Innovation Challenges are an introduction to foundational concepts of design thinking with an emphasis on developing and testing new solutions to society's greatest challenges. The Energy Infrastructure: Solar Power Innovation Challenge requires students to work in self-selected, distributed teams, requiring cross-cultural communication, dynamic problem solving, deep critical thinking related to society, leadership and project management skills.

Students must first identify their project team and then work together with a mentor to apply design thinking processes to approach the real-world health problems of air pollution in an innovation challenge with the Junior Academy. While each student must identify their own role within the team, together they will learn how to identify and map out a real problem and ways to build and test solutions quickly through an iterative, scientific approach. This course requires extensive student collaboration and regular engagement through The Academy's Junior Academy and its online platform, Launchpad.

THE CHALLENGE

Demand for energy continues to grow as countries become more electrified and new technologies, such as artificial intelligence (AI), require increased levels of electricity to function. Depending on fossil fuels for this growing need is neither practical nor sustainable. Renewable sources of energy, including solar panels, are the obvious choices for an increasingly energy-hungry society. However, at least two technological challenges must be overcome in order to rely fully on solar power. First, the current electrical infrastructure in many regions is not capable of handling large amounts of renewable energy. Many power grids are aging and were mainly built to support fossil fuel plants and nuclear plants. Second, solar energy options create varying amounts of electrical output depending on time of day, season, location, and weather conditions. Options exist for storing solar energy when and where it is captured. However, in order

to meet demand, these options must become more efficient, more reliable, more affordable, and scalable. Improvements must also be made so that the stored power can be better distributed from the source to where the energy demand is highest. Additionally, current battery options for energy storage require rare earth minerals - finite resources that have environmental, economic, and political challenges of their own. Innovative solutions are required to improve solar energy storage technology, energy distribution, and infrastructure.

Student Challenge: **To design an innovative and scalable solution to improve electrical infrastructure and/or energy storage technology in order to make solar energy use more reliable, efficient, and economical for meeting the energy demands of technology and society.**

Students will work collaboratively to consider the following when designing their teams' solution:

- What level will you focus your solution on? Individual households or buildings? City infrastructure? Regional power grids? Agriculture? Nomadic communities?
- What geographical or governmental region will you focus your solution on? What are the most urgent energy challenges in this region? How can your solution be scaled to other regions?
- What are the supply, demand, distribution needs, and storage capabilities of electricity for your specific territory or geographical location?
- What might be the cost of your solution? Will it be affordable for your focus audience?
- How might retrofitting be part of your solution?
- How could Artificial Intelligence (AI) be incorporated into your solution? Identifying ideal locations for retrofitting existing infrastructure? Managing energy flow? Managing energy use and storage? Through machine learning? Diagnosing and/or responding to system or grid fluctuations? Something else?
- How can you use available data and research to inform or test your solution?
- How will you prototype your solution?
- Could your solution be expanded to other renewable energy sources such as wind or geothermal?

LEARNING OBJECTIVES

INNOVATION CHALLENGE LEARNING OBJECTIVES *At the end of this course, students will be able to:*

- Develop critical thinking and problem-solving skills through brainstorming techniques to develop ideas and design a solution to a complex problem.
- Develop their own arguments and analyze competing perspectives to a complex problem with supporting evidence.
- Develop a deeper, personal civic identity and clearly identify their role in their community.

- Develop a solution that could play a part in transforming a specific societal need regarding a larger issue that is transferable to a specific community and larger global community.
- Use data and insights of an inquiry to answer a research question using scientific terms in charts, tables, or graphs.
- Utilize a social justice lens when applicable to interpret the data and critically think about which groups are not represented around decision making.
- Effectively communicate ideas, data and insights using various forms of media.
- Effectively collaborate with team members with empathy and mutual respect, and develop an expanded perspective about how people from other countries see the world.
- Effectively communicate challenge specific variables that impact the environment, society, and economy including examples of the effect on local communities.
- Understand how to apply Design Thinking methods to understand what users need, and how to develop solutions to meet those needs.
- Learn how to actively listen, work through any disagreements, and solicit input from people in creative ways to generate new ideas.
- Learn how to test ideas and develop rapid prototypes.
- Identify corresponding careers connected to Innovation Challenge.

COURSE OUTLINE

TIME	TOPIC	ASSIGNMENTS	FORMAT
Week 1	• Getting Started w/Junior Academy • Onboarding	• Join Launchpad Platform • Review Junior Academy Orientation • Attend Virtual Kick Off Week • Complete Course Pre-Survey	Individual
PHASE 1 Challenge Team Formation			
Week 2	Challenge introduction • Background on your Challenge • Finding Mentors & Experts • Reaching out to experts	• Complete Required Weekly Reading • Engage in Launchpad Discussions • Complete activities found in resource library	Collaborative
Week 3	Team Building • Forming Your Team • Holding a Virtual Team Building • Creating a Team Comm's Plan	• Engage in Launchpad Discussions • Hold 1st Team Meeting • Complete Required Weekly Reading • Due Milestone #1: Team Dynamics	Collaborative
PHASE 2 Research, Brainstorm & Plan			

Week 4	Researching • Gathering relevant and diverse materials, articles, books, and sources • Developing research questions and interviewing	• Engage in Launchpad Discussions • Engage/Meet with your Team • Complete Required Weekly Reading	Individual Collaborative
Week 5	Brainstorming • Team Concept Brainstorm • Develop How "Might We" Ideas • Building Team Empathy	• Engage in Launchpad Discussions • Engage/Meet with your Team • Complete Required Weekly Reading	Collaborative
Week 6	Design & Plan • Categorizing & Bundling Ideas • Deciding & creating your concept • Developing a user testing plan	• Engage in Launchpad Discussions • Engage/Meet with your Team • Complete Required Weekly Reading • Due: Milestone #2: Design & Test Plan	Individual Collaborative
PHASE 3 Build, Test & Analyze			
Week 7	Build • Creating a Prototype • Build storyboard & journey map • Identifying your variables • Rapid Prototyping	• Engage in Launchpad Discussions • Engage/Meet with your Team • Complete Required Weekly Reading	Collaborative
Week 8	Test & Analyze • Conducting User Testing • Getting User Feedback • Analyzing your data Results	• Engage in Launchpad Discussions • Engage/Meet with your Team • Complete Required Weekly Reading • Due: Milestone #3 Analyze Results	Collaborative
PHASE 4 Iterate & Develop Final Projects			
Week 9	Iterate • Modifying your concept design based on your results • Refining & re-test your prototype	• Engage in Launchpad Discussions • Engage/Meet with your Team • Complete Required Weekly Reading	Individual Collaborative
Week 10	Develop Final Project • Creating draft of Final Project • Project Feedback & revision • Submitting Final Project • Complete Course Post-Survey	• Due: Executive Summary • Due: Final Team Presentation • Due: Personal Reflection • Complete Course Post-Survey	Individual Collaborative
New York Academy Challenge Final Project Review & Grading			

COURSE ASSIGNMENTS	**% of FINAL GRADE**

Milestone #1: Team Dynamics: This assignment is focused on team building and planning for how students will work together.	10%
Milestone #2: Design & Test Plan: This assignment is focused on the Team's proposed solution, hypothesis and test plan.	10%
Milestone #3: Build, Test & Analyze: This assignment is focused on building, testing and analyzing data related to your solution.	10%
Team Collaboration & Online Engagement throughout course	20%
Final Presentation, Executive Summary & Personal Reflection Final Presentation Rubric	50%
(100%) **Final Grade**	

GRADING POLICY

Late-work policy: Milestones 1-3 are allowed to be submitted late for point deduction. Late submissions of the Final Solution Presentation for this course will not be accepted after the due date unless previously arranged with **the Academy** for extenuating circumstances. It is important to stay up-to-date on assignments since much of the work builds on previous assignments and will impact students' ability to be effective in providing solutions for their teams' projects.

Re-grade policy: If a student thinks there has been a technical error in the grading of an assignment, they should email program administration at the Academy within one week of receiving the graded assignment, otherwise the assignment will not be regraded. Feedback is provided upon request.

REQUIRED READING LIST

Students are expected to read and refer to a wide variety of texts throughout this course; all of which can be found in the Launchpad Resource Library.

Please see a sample of the Resource Library reading list for this challenge:

Week 1

Launchpad Platform, Launchpad

Junior Academy Orientation, Launchpad

Week 2

Energy Infrastructure: Solar Power Challenge Background, Launchpad

Air Pollution, World Health Organization (WHO)

Air Pollution: Everything You Need to Know, NRDC

Week 3

What is Human Centered Design?, Video Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Design Thinking for Problem Solving, Video Design Kit, Innovation, Design, Engineering & Organization (IDEO)

Week 4

Solar Power Plants: Where the sun's rays are converted into electricity (REPSOL)
Solar PV Energy Factsheet (University of Michigan)
Solar Photovoltaic Technology Basics (NREL)
From Sunlight to Power: How Solar Panels Work (video)
How Solar Thermal Power Works (How Stuff Works)
Understanding Solar Heating (Wolf)
Solar Integration: Solar Energy and Storage Basics (US Dept. of Energy)
NREL Energy Storage Research (NREL)
How Long Can Solar Energy Be Stored in My Panels? (Energy Buster)
Energy Storage Technologies and the Challenges to Face (Azo Nano)
The advantages and disadvantages of solar energy (PV Case)
How AI Can Help Clean Energy Meet Growing Electricity Demand (US Department of Energy)
Artificial Intelligence Models Improve Efficiency of Battery Diagnostics (NREL)
Smart Grids (IEA)
Sun, sensors and silicon: How AI is revolutionizing solar farms (World Economic Forum)
What is energy efficiency retrofitting? (GridX)
The Junior Academy Expert Speaker Series: Roy Rada - Live Q&A for The Green Redesign (2022)
How to Fix Renewable Energy's Hidden Infrastructure Problem (Wall Street Journal video)
Retrofits and Renewables Can Help Create a Smarter, More Sustainable Grid (Reuters)
Cutting urban carbon emissions by retrofitting buildings
Interviewing Experts, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Interviewing Individuals, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Interviewing Groups, Design Kit, Innovation, Design, Engineering & Organization (IDEO)

Week 5

How Might We, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Brainstorming Rules, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
How to Facilitate a Brainstorm, Stanford D School, 2020

Week 6

Bunding Ideas, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Doing a Gut Check, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Creating a Concept, Design Kit, Innovation, Design, Engineering & Organization (IDEO)

Week 7

Determine What to Prototype, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Rapid Prototyping, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Prototype to Test, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Identify a Variable, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Storyboards & Journey Maps, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Tinkercad, Autodesk

Week 8

- Get Feedback, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
- Testing with Users, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
- Research Methods, Launchpad

Week 9 - Week 10

- Integrate Feedback & Iterate, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
- How to Create a Presentation, Launchpad
- How to Create Video Presentations, Movavi
- Presentation Guidelines, Launchpad