

# CORE CURRICULUM OUTLINE

## Weekly Modules and Learning Objectives

### Yale Financing and Deploying Clean Energy certificate program



COURSE	#	WEEKLY MODULE	LEARNING OBJECTIVES
<p><b>Clean Energy Policy:</b></p>  <p>How does Policy support or hinder the deployment and financing of clean energy?</p>	1	Why Policy Matters and Energy Policy History	<ul style="list-style-type: none"> <li>Learn about why energy policy matters, which issues energy policies typically cover, and what they often fail to address</li> <li>Review the history of energy and environmental policies in the U.S., as well as the key actors and drivers responsible for shaping current energy policy</li> <li><b>Discuss policy drivers, policy actors, and branches of government</b></li> </ul>
	2	Electric Utility Policy	<ul style="list-style-type: none"> <li>Examine electricity utility policy, including approaches to deregulation and types of electricity markets around the globe</li> <li>Learn the fundamentals of the U.S. electric utilities regulatory framework including key definitions and processes for rate design, infrastructure build-out, and legal processes</li> <li>Understand the role of market actors, regulators, and operators in deciding which new assets come online in the short and long term through economic dispatch</li> <li><b>Submit your first draft clean energy Policy Memo</b></li> </ul>
	3	Envisioning the Energy Future: Integrating Renewables	<ul style="list-style-type: none"> <li>Explore how electric systems and needs are broadly changing and explore the integration of renewables and the pricing dynamics that influence the speed and scale of the clean energy transition</li> <li>Take an economic view of renewables integration, a deep dive into optimal investment strategies for different generation technologies, and the different revenue and cost mechanics driving decision-making</li> <li><b>Explore metrics like LCOE in further depth and approach concepts of efficiency</b></li> </ul>
	4	Approaches to Policy and Regulation	<ul style="list-style-type: none"> <li>Learn about different approaches to policy and regulation, including institutional mechanisms for reporting, target-setting and performance evaluation</li> <li>Explore the strengths and weaknesses of different regulatory tools like subsidies, taxes, or market approaches, and take a deep dive into the U.S. Inflation Reduction Act</li> <li>Explore differences between feed-in tariffs and net metering, and explore net metering debates and the concept of value of solar</li> <li><b>Submit Policy Memo peer reviews to classmates</b></li> </ul>
	5	Carbon Pricing: Leveling the Playing Field	<ul style="list-style-type: none"> <li>Understand how carbon pricing mechanisms work and explore the advantages and disadvantages of cap and trade and carbon tax policies in particular, and learn to compare these policies from an economic perspective</li> <li>Explore the concept of, and debate surrounding, the social cost of carbon</li> <li>Apply about a political science framework for policy analysis to design more durable and effective policies</li> <li><b>Submit analysis of your Policy Memo</b></li> </ul>
	6	Policy Tools: Promoting Innovation	<ul style="list-style-type: none"> <li>Learn about different approaches to drive innovation in the private sector, including common approaches like renewable portfolio standards or RPS, and different procurement approaches to clean energy projects, such as auctions and reverse auctions</li> <li>Think through policy tools to manage uncertainty and explore the correlation between commodity markets and wholesale markets</li> <li><b>Submit revised clean energy Policy Memo</b></li> </ul>

COURSE	#	WEEKLY MODULE	LEARNING OBJECTIVES
<b>Clean Energy Policy:</b> (continued)	7	Clean Energy Policy: From Local to Regional to Global	<ul style="list-style-type: none"> <li>• What will it actually take to transition to renewable energy and which renewable energies should play the greatest role?</li> <li>• Explore the demands and complexities involved in designing policy that shifts the world to renewable energy while ensuring that power is consistently available</li> <li>• <b>Generate support for your policy with an op-ed</b></li> </ul>
	8	Policy for a Sustainable Energy Transition	<ul style="list-style-type: none"> <li>• Explore the broader landscape of global energy policy and understand the relationship between climate policy and clean energy policy</li> <li>• Understand the role of climate policy in shaping clean energy outcomes at the local, regional, and global scale</li> <li>• <b>Evaluate your policy with the Energy Justice Scorecard</b></li> </ul>
<b>Technology Transitions</b>  What are current energy models and what are technological and economic challenges to the clean energy transition?	1	Energy Technology and Society	<ul style="list-style-type: none"> <li>• Review the historical context of energy use and start tracing the patterns of global energy transitions</li> <li>• Learn about energy systems from a macro perspective, five key facts about world energy use today, and the heterogeneous nature of energy systems</li> <li>• <b>Use the Kaya Identity and analyze energy flows through systems</b></li> </ul>
	2	The Current Energy System Part 1	<ul style="list-style-type: none"> <li>• Explore fossil and earth resources, and understand the environmental implications of the use of oil, gas, coal, and biofuel technology</li> <li>• Learn about the role of fossil fuels in our energy system, including its origin and distribution, how long fossil fuels are expected to last, and technological reasons for its widespread use</li> <li>• <b>Apply concepts of energy density</b></li> </ul>
	3	The Current Energy System Part 2	<ul style="list-style-type: none"> <li>• Understand how nuclear and hydro are currently used in producing electricity, and explore their benefits, limitations, and challenges</li> <li>• Learn about the design, installation, and environmental impacts of hydropower, as well as critically examine hydropower and pumped hydro within the current energy landscape and its potential in the future</li> <li>• <b>Apply the hydropower equation</b></li> </ul>
	4	Solar Energy	<ul style="list-style-type: none"> <li>• Understand solar as a resource, and use solar maps to understand factors that influence solar power production</li> <li>• Explore the technical characteristics of photovoltaics, solar thermal heating, and concentrated solar power</li> <li>• Review the critical functions of inverters in solar efficiency</li> <li>• Discuss installations and siting challenges</li> <li>• <b>Use average capacity factors to determine the carbon savings replacing a coal plant with a solar and combined cycle plant</b></li> </ul>
	5	Wind Energy	<ul style="list-style-type: none"> <li>• Understand wind as a resource, airfoil and turbine design, turbine installation on and offshore, modes of failure, and environmental considerations</li> <li>• Explore issues of wind intermittency, statistics, and weather forecasting techniques as well as intermittency in all renewables</li> <li>• <b>Use the wind power equation</b></li> </ul>
	6	Baseload Clean Power	<ul style="list-style-type: none"> <li>• Understand the need for and sources of baseload clean power</li> <li>• Review nuclear power history and present use, understand nuclear technologies such as fusion and fission, and explore the application of nuclear technologies through case study</li> <li>• Explore geothermal technologies, including technology, opportunities, risks and challenges</li> </ul>

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<b>Technology Transitions</b> (continued)	7	Storage & System Decarbonization Part 1	<ul style="list-style-type: none"> <li>Review concepts of grid structure, basics of electricity transmission and distribution</li> <li>Examine the impact of transmission congestion on energy markets and demand planning</li> <li>Discuss energy storage and battery trends and technologies in depth, including lithium-ion, hydrogen fuel cells, flow batteries, green hydrogen, and other unconventional energy storage technologies</li> </ul>
	8	System Decarbonization Part 2	<ul style="list-style-type: none"> <li>Explore social and behavioral inputs to energy systems, and understand life-cycle analysis of energy chains</li> <li>Delve into household energy demand, understand the basics of buildings and thermal balance, and explore technological options, including geothermal for heating and cooling (heat pumps)</li> <li>Examine high-demand energy systems, such as transportation, and emerging trends driving demand, such as AI &amp; data centers</li> </ul>
<b>Renewable Energy Project Finance</b>  How are renewable energy projects structured and developed?	1	Fundamentals of Project Finance Debt and Energy Basics	<ul style="list-style-type: none"> <li>Learn the fundamentals of project finance, including parties and structuring</li> <li>Explore how and how well project finance structures have been used in the past in both non-renewable and renewable energy projects</li> <li><b>Model debt facilities, size debt capacity, and use financial functions in Excel</b></li> </ul>
	2	Navigating Legal Contracts	<ul style="list-style-type: none"> <li>Understand the contractual framework of project finance and layout the relationship between lenders and the special purpose vehicle</li> <li>Explore basics of loan agreements and practice reading common types of contractual provisions in project finance documentation</li> <li><b>Build parts of a loan term sheet</b></li> </ul>
	3	Project Revenues	<ul style="list-style-type: none"> <li>Understand the primary drivers of a project's revenue</li> <li>Explore the ways projects sell electricity to the grid and concepts of risk allocation in power purchase agreements</li> <li>Compare power purchase agreements, asset ownership, and leases</li> <li><b>Build out tools to perform a sensitivity analysis</b></li> </ul>
	4	Project Costs	<ul style="list-style-type: none"> <li>Understand the primary drivers of a project's expenses, including capital expenditures, and operating expenses</li> <li>Understand the role of insurer and credit reporting agencies</li> <li>Explore EPC and O&amp;M contracts</li> <li><b>Build parts of a power purchase agreement term sheet</b></li> </ul>
	5	Project Risks and Variability	<ul style="list-style-type: none"> <li>Understand the variability and risks associated with renewable energy projects</li> <li>Explore forecasting techniques for wind and solar, including probabilistic approaches</li> <li><b>Incorporate variability into a dynamic financial model</b></li> </ul>
	6	Financial Modeling	<ul style="list-style-type: none"> <li>Translate financial inputs or cashflows (revenues, costs, and risk) into outputs (balance sheet, income statement)</li> <li>Model seasonality reserves and debt service reserves, both in construction and operation</li> <li><b>Add a balance sheet to your cumulative solar model</b></li> </ul>
	7	Tax	<ul style="list-style-type: none"> <li>Understand the tax implications of accelerated depreciation and the mechanics of different tax credits</li> <li>Explore tax equity structures and tax modeling</li> <li><b>Build a model factoring in the impacts of both depreciation and tax credits available for a wind energy project</b></li> </ul>

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<b>Renewable Energy Project Finance</b> (continued)	8	Emerging Markets	<ul style="list-style-type: none"> <li>• Understand how project finance in emerging markets may be subject to different risks</li> <li>• Learn about the techniques and tools used to manage country risks for lenders</li> <li>• Learn about risk management within PPAs</li> </ul>
	<b>Innovation</b>  How can we effectively balance the value, challenges, and trade-offs involved in clean energy deployment?		
	1	Framing the Problem	<ul style="list-style-type: none"> <li>• Understand energy demand forecasting.</li> <li>• Assess the trade-offs in financing and deploying clean energy.</li> <li>• Explore energy demands' impact on clean energy planning and investment.</li> </ul>
	2	Greening the Grid in a World of Increasing Demand	<ul style="list-style-type: none"> <li>• Examine the effects of demand growth on the grid.</li> <li>• Understand how grid architecture and regulation shape how clean energy is deployed.</li> <li>• Analyze the role of utilities in managing demand growth.</li> </ul>
	3	Consumer Impacts of Rising Energy Demand	<ul style="list-style-type: none"> <li>• Analyze the impact of rising energy demand on consumer pricing.</li> <li>• Assess subnational stakeholders' responses to demand fluctuations, including at the household and state or local government.</li> </ul>
	4	Financing Energy Deployment	<ul style="list-style-type: none"> <li>• Explore new financing tools and shifting landscapes.</li> <li>• Understand tax credits and layered financing.</li> <li>• Analyze future trends in clean energy financing.</li> </ul>
	5	Financing Innovation and Technology Scale-Up	<ul style="list-style-type: none"> <li>• Explore differences between financing for clean energy deployment and innovation.</li> <li>• Understand Advanced Market Commitments (AMCs) and explore their utility for advancing different technologies.</li> <li>• Examine Public-Private Partnerships for funding innovation.</li> <li>• Explore how demand growth impacts innovation financing.</li> </ul>
	6	Demand Growth & Clean Energy Supply Chains	<ul style="list-style-type: none"> <li>• Examine the clean energy supply chain.</li> <li>• Study supply chain effects on clean energy and national security.</li> <li>• Analyze comparative advantage in the clean energy sector.</li> </ul>
	7	Deployment Case Study	<ul style="list-style-type: none"> <li>• Explore practical case study on technology deployment.</li> <li>• Analyze real-world energy challenges through policy, technology, and financing lenses.</li> <li>• Examine real-world deployment scenarios and solutions.</li> </ul>
	8	Ethics, Equity, and Long-term Impacts	<ul style="list-style-type: none"> <li>• Explore ethical considerations in clean energy deployment, including how policy, technology, and finance choices affect affordability and access.</li> <li>• Analyze distributional impacts and trade-offs.</li> <li>• Explore long-term impacts of clean energy policies and practices.</li> </ul>