# The Interdisciplinary Energy Graduate Study Program

## Introduction to the Graduate Program in Energy Studies

The need for clean energy sources has always been a major challenge for humanity – these days more than ever. The production of energy from fossil fuels (coal, oil, and gas) harms nature and pollutes our planet. Therefore, there is a real necessity to develop alternative energy sources that are clean, renewable, and sustainable. Clearly, there is no single magic solution to the global energy problem. Therefore, we must develop a range of solutions that will be implemented in different combinations in different parts of the world.

To address this critical issue, the Technion has established an interdisciplinary energy research program that addresses a wide range of fields, including alternative fuels, energy storage and conversion, renewable energy sources, and energy conservation and management.

The goal of the Technion's Graduate Program in Energy Studies is to build a knowledge base for outstanding and highly motivated students who aspire to work in the energy field, for the benefit of the State of Israel and its population. The program's vision is to cultivate the scientific and engineering workforce that will lead the energy sector in Israel and around the world – in academia, industry, and key decision-making positions.

Future energy engineers and scientists will require a broad understanding of diverse topics from classical engineering and science disciplines, as well as from the fields of entrepreneurship, economics, and policy. Consequently, the proposed curriculum will train engineers and researchers who possess a comprehensive, systemic perspective on all relevant aspects of energy-related activities.

### Program Structure

As a general rule, all Technion graduate school regulations apply to the interdisciplinary committee and the students enrolled in the Graduate Program in Energy Studies.

# MSc Studies

## Acceptance Criteria

Candidates must hold a bachelor's degree in engineering or exact sciences from a recognized academic institution, with a weighted GPA of 82 or higher, subject to approval by the program's admissions committee.

Exceptional cases will be considered individually.

A candidate with extensive relevant experience (approximately five years) and a weighted GPA of 80 or higher may submit a detailed and reasoned application, along with a CV and two recommendations from their workplace. If the graduate studies committee determines that the candidate's experience and professional achievements are sufficient, they may be admitted to the research track at the committee's discretion.

## Study Tracks

The program offers four master's degree tracks:

**Two research-based MSc tracks:**

1. **Master of Science in Energy Engineering (with thesis)** – for Engineering graduates:
    - 18 credits in advanced courses
    - An extended English course (2 credits)
    - Research thesis (20 credits)
    - Additional prerequisite courses may be required
2. **Master of Science in Energy (with thesis)** – for science graduates:
    - 30 credits in advanced courses
    - An extended English course (2 credits)
    - Research thesis (20 credits)
    - Additional prerequisite courses may be required

**Two non-thesis ME tracks:**

3. **ME in Energy Engineering** – for Engineering graduates:
    - 32 credits in advanced courses
    - An extended English course (2 credits)
    - Final project (6 credits)
    - Additional prerequisite courses may be required

4. **Master of Energy** – for science graduates:
    - 44 credits in advanced courses
    - An extended English course (2 credits)
    - Final project (6 credits)
    - Additional prerequisite courses may be required

## MSc Study Requirements

1. Two core courses specific to the Energy Program (6 credits) – **List 1**.
2. Three elective courses from the designated list for the Energy Program (at least 6 credits) – **List 2**.
3. Extended English course (2 credits).
4. Remaining required credits can be completed with elective common/advanced courses in the different Faculties, subject to the published curriculum and in consultation with the temporary/permanent advisor – **List 3**.
5. For students requiring prerequisite courses: Up to 10 undergraduate-level credits may be included in the 32 academic credits required for completing the degree.
6. Students must attend at least 75% of the seminar sessions and other mandatory events (such as the annual Research Day) held on campus under the aegis of the Technion Energy Program.

As a general rule, all Graduate School regulations apply to the interdisciplinary committee and the students enrolled in the program.

Further details about the curriculum can be obtained from the office of the multidisciplinary committee. Additional general requirements – both academic and administrative – are according to the Graduate School's regulations.

## Course Lists

### List 1: Mandatory courses

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|---|---|---|
| **51060004** | **Intro to Clean Energy 1 Sources** | **3.0** |
| **51060005** | **Intro to Clean Energy 2 Devices** | **3.0** |

## List 2: Elective courses specific to the Energy Program (at least three from this list)

| | | |
|---|---|---|
| 51060003 | Hydrogen Technologies | 2.0 |
| 51060006 | Introduction to Wind Energy Harvesting | 2.0 |
| 51080003 | Economy and Management of Energy Systems | 2.0 |
| 518005 | Solar and Photovoltaic Energy | 2.0 |
| 518006 | Bio-Mass Energy | 2.0 |
| 518007 | Advanced Energy Transportation | 2.0 |
| TBD | Energy systems engineering | 2.5 |
| TBD | Entrepreneurship in energy | 2.0 |
| TBD | Modern nuclear energy | 2.0 |

## List 3: General elective courses

**Energy Program**

| | | |
|---|---|---|
| 518004 | Advanced Heterogeneous Catalysis | 2.0 |
| 518008 | Energy Innovation | 2.0 |
| 518009 | Selected Topics in Energy 1 | 2.0 |
| 518010 | Selected Topics in Energy 2 | 2.0 |

**Architecture and Town Planning**

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|---|---|---|
| 206561 | Lighting in Architecture | 3.0 |
| 206563 | Seminar in Planning Passive Solar Struct | 3.0 |
| 206570 | Seminar in Evaluation of Sustainable | 3.0 |
| 206571 | Computer Models for Sustainable | 3.0 |
| 207041 | Ecological Principles in City and Region | 3.0 |
| 207408 | Environmental Impact Statements | 3.0 |
| 207830 | Green Infrastructures | 2.5 |
| 207902 | Advanced Topics in Urban and Reg Plan 3 | 3.0 |
| 207955 | Environmental Science for Planners | 3.0 |
| 209050 | Urban Economics | 3.0 |

**Biology**

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|---|---|---|
| 134121 | Microbiology and Virology | 3.0 |
| 134153 | Ecology | 3.0 |

**Civil and Environmental Engineering**

| | | |
|---|---|---|
| 16203 | Water Resources Systems Engineering 1 | 2.5 |

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|---|---|---|
| 16206 | Environmental Fluid Mechanics | 3.0 |
| 16210 | Water Waves | 2.5 |
| 16223 | Groundwater: Flow | 4.5 |
| 16302 | Air Pollution | 2.5 |
| 16303 | Air Pollution Laboratory | 2.0 |
| 16304 | Advanced Topics in Atmospheric Physics | 2.5 |
| 16328 | Membrane Separation in Wastewater Treatm | 3.0 |
| 16336 | Technologies For Airresources Management | 2.0 |
| 16337 | Environmental Electrochemistry | 3.0 |
| 16338 | Solid Wastes Treatment | 3.0 |
| 16339 | Fate of Pollutants in The Environment | 3.5 |
| 16501 | Elements of Climatology of Buildings | |
| 16513 | Sustainability in Construction | 3.0 |
| 17001 | Ecological Systems | 3.0 |
| 17012 | Physics of Porous Medium | 2.5 |
| 18142 | Sustainable Built Environmental Design | 2.0 |
| 18501 | Life Cycle Assessment in Eng. Systems | 2.5 |
| 19007 | Selected Topics in Statistics | 3.0 |
| 19062 | Models and Simulations of Natural System | 3.0 |
| 19309 | Advanced Water Treatment | 3.0 |
| 19319 | Environmental Microbiology | 3.0 |
| 19323 | Meteorology of Air Pollution | 2.0 |
| 19330 | Chemistry of Environmental Processes | |
| 19335 | Atmospheric Aerosols | 2.0 |
| 19523 | Energy in Buildings | 2.0 |

**Chemical Engineering**

| | | |
|---|---|---|
| 56120 | Electron Microscopy of Soft Matter | 2.0 |
| 56146 | Selected Engineering Subjects | 2.0 |
| 56149 | Optimization and Numerical Analysis Meth | 2.5 |
| 56166 | Interfacial Phenomena | 2.0 |
| 56378 | Statistical Chemical Engineering Thermodynamics | 2.0 |
| 56379 | Membrane Processes Laboratory | 2.0 |
| 56390 | Molecular Materials | 2.0 |
| 56396 | Colloidal Particles | 2.5 |

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|---|---|---|
| 56397 | Membranes Principles and Materials | 2.5 |
| 56398 | Catalysis on Surfaces | 2.0 |
| 56399 | Engineering For Energy and Environment | 2.0 |
| 56402 | Molecular and Chemical Kinetic Modeling | 3.0 |
| 56403 | Ionic Systems | 2.0 |
| 56404 | Polymer Engineering Laboratory | 2.0 |
| 56407 | Chemical Process Intensification | 3.0 |
| 58126 | Fuel Cells | 2.0 |
| 58127 | Transport Phenomena – Fluid Flow | 2.5 |
| 58143 | Transport Phenomena Heat and Mass | 2.5 |
| 58144 | Advanced Chemical Engineering Thermodyn | 2.5 |
| 58145 | Advanced Reactor Design | 2.5 |
| 58172 | Polymer Thermodynamics | 2.0 |
| 58173 | Physical Methods for Polymer Characteriz | 2.0 |
| 58177 | Mathematical Methods in Chemical Eng. | 3.5 |
| 58181 | Structure Determination by Scattering | 2.0 |
| 58185 | Solid State in Chemical Engineering Grad | 2.5 |
| 58186 | Statistical Termodynamics in Chem. Eng. | 2.5 |
| 58187 | Self-Assembly in Polymer Systems | 2.0 |

**Aerospace Engineering**

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|---|---|---|
| 85406 | Rocket Propulsion | 2.5 |
| 85407 | Jet Engines | 2.5 |
| 86172 | Numerical Methods in Aero Eng. | 3.0 |
| 86284 | Wind turbines and energy production | 3.0 |
| 86320 | Heat Transfer | 3.0 |
| 86401 | Propulsion Systems for Propeller-driven | 3.0 |
| 86414 | The Ramjet Engine | 3.0 |
| 86470 | Introduction to Supersonic Combustion | 3.0 |
| 86478 | Combustion Processes | 3.0 |
| 86480 | Turbomachinery | 3.0 |
| 86484 | Advanced Measurement Techniques | 3.0 |
| 88413 | Dynamics and Combustion of Fuel Spray Systems | 2.0 |
| 88421 | Rocket and Jet Propulsion 1 | 3.0 |

**Biotechnology and Food Engineering**

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|---|---|---|
| 66332 | Biosensors & Nanobiohybrids | 2.5 |
| 66518 | Biocatalysis | 2.0 |

**Electrical and Computer Engineering**

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|---|---|---|
| 44105 | Theory of Electronic Circuits | 4.0 |
| 44137 | Electronic Circuits | 5.0 |
| 44139 | Dc-dc Converters | 3.0 |
| 44140 | Electromagnetic Fields | 3.5 |
| 44191 | Control Systems 1 | 4.0 |
| 46012 | Int. to Flexible Organic Electronics | 3.0 |
| 46042 | Int. to Power Systems Smart Grids | 3.5 |
| 46044 | Renewable Energy Systems | 3.0 |
| 46045 | Design of Switched-mode Power Conver | 3.0 |
| 46055 | Nano-photonics | 3.0 |
| 46195 | Machine Learning | 3.5 |
| 46196 | Nonlinear Control Systems | 3.0 |
| 46197 | Computational Methods in Optimization | 3.0 |
| 46211 | Deep Learning | 3.0 |
| 48852 | Advanced Energy Conversion Laboratory | 2.0 |
| 48989 | Power System Dynamics | 2.0 |

**Mechanical Engineering**

| | | |
|---|---|---|
| 36007 | Vibrations of Structures | 3.0 |
| 36032 | Analytical Fluid Mechanics | 3.0 |
| 36035 | Introduction to Combustion Engineering | 3.0 |
| 36068 | Thermal Hydraulic Design of Nuclear Reac | 3.0 |
| 36076 | Electrokinetics in Nano Micro-fluidics | 3.0 |
| 36079 | Control of Vehicle Emissions | 2.5 |
| 36080 | Advanced Automotive Propulsion Systems | 2.5 |
| 36082 | Internal Combustion Engine Fundamentals | 3.0 |
| 38715 | Advanced Thermodynamics 1 | 2.5 |
| 38727 | Numerical Methods in Mech. Engineering 1 | 3.0 |

**Chemistry**

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|---|---|---|
| 126302 | Advanced Environmental Lab. Monitoring | 2.0 |

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|---|---|---|
| 126303 | Adv. Lab. of Organometallic Chemistry | 3.0 |
| 127002 | Heterogeneus Catalysis | 2.5 |
| 127009 | Selected Topics in Biomimetic and Supram | 3.0 |
| 127100 | Patents in The Field of Chemistry | 2.0 |
| 127107 | Chemistry of Porphyrins and Metalloporph | 2.0 |
| 127109 | Enviromental Chemistry | 2.5 |
| 127403 | Physical Chemistry of Surfaces | 3.0 |
| 127418 | Chemistry of Semiconductors | 2.0 |
| 127427 | Solid State for Chemists (extended) | 3.5 |
| 127428 | Solid State for Chemists (concised) | 2.5 |
| 127433 | Experimental Methods in Surface Sciences | 2.0 |
| 127436 | Thermodynamics of Small Systems | 2.0 |
| 127437 | Photocatalysis | 2.0 |
| 127441 | Biological Photochemistry | 2.5 |
| 127450 | Biophotochemistry and Quantum Properties | 2.0 |
| 127453 | Electrochemistry | 3.0 |
| 127454 | Practical Simulation in Chemical Physics | 3.0 |
| 127455 | Molecular Orbitals in Organic Chemistry | 3.5 |
| 127457 | Electrifying Nature | 2.5 |
| 127712 | Organic Photochemistry | 2.0 |
| 127731 | Carbohydrate Chemistry and Biochemistry | 2.5 |
| 127735 | Selected Topics in Homogeneous Catalysis | 2.0 |

**Materials Science and Engineering**

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|---|---|---|
| 316240 | Elements of Crystallography | 2.0 |
| 318101 | Porous Polymers | 2.0 |
| 318124 | Advanced Topics in Materials Engineering | 2.0 |
| 318130 | Quantum Modeling of Materials | 2.0 |
| 318221 | Structure & Composition of Solid Surface | 2.0 |
| 318244 | Materials For Sensors | 2.0 |
| 318320 | Thermodynamics and Kinetics of Interface | 2.0 |
| 318337 | Diffusion and Mass Transfer in Solids | 2.0 |
| 318520 | Organic Electronics | 2.0 |
| 318529 | Analytical Scanning Electron Microscopy | 2.0 |
| 318532 | Charge and Heat Transport in Materials | 2.0 |

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|---|---|---|
| 318541 | Scanning Probe Microscopy Fundamental | 2.0 |
| 318600 | Dielectric Mat.: Structure Properties | 2.0 |
| 318601 | Ferroelectric Materials | 2.0 |
| 318820 | High Energy Density Electrochemical | 2.0 |
| 318822 | Science of Ceramic Materials | 2.0 |

**Computer Science**

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|---|---|---|
| 236011 | Topics in Dynamic Graph Algorithms | 3.0 |
| 236018 | Sequential Decision Making and Reinforce | |
| 236203 | Advanced Topics in Collabortive Artifici | 3.0 |
| 236377 | Distributed Graph Algorithms | 3.0 |
| 236501 | Introduction to Artificial Intelligence | 3.0 |
| 236620 | Advanced Topics in Algorithms L | 2.0 |
| 236756 | Introduction to Machine Learning | 3.0 |
| 236779 | Foundations of Algorithms for Massive | 2.0 |

**Data and Decision Sciences**

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|---|---|---|
| 96411 | Machine Learning 1 | 3.5 |
| 96553 | Environmental Economics | 2.5 |
| 96568 | Cost - Benefit Analysis | 2.5 |
| 97280 | Algorithms in Uncertain Scenarios | 3.0 |

**Physics**

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|---|---|---|
| 116003 | Laser Physics | 3.5 |
| 116004 | Nuclear Physics and Elementry Particles | 3.5 |
| 116110 | Physics of the Atmosphere | 2.0 |
| 116217 | Solid State Physics | 3.5 |
| 117010 | Experim.methods in Solid State Physics | 2.0 |
| 117016 | Plasma Physics | 3.5 |
| 117018 | Semiconductor Physics | 2.5 |
| 118028 | Transport of Mater and Charge in Solids | 2.0 |
| 118089 | Electronic processes in semiconductors | 3.0 |
| 118090 | High Energy Astrophysics | 2.5 |
| 118148 | Quantum Nanophotonics | 3.0 |

**Polymer Engineering**

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|---|---|---|
| 858121 | Polymer Rheology | 2.0 |

**Nanoscience and Nanotechnology**

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|---|---|---|
| 648004 | Nanoscale Transport Phenomena | 3.0 |

Additional relevant courses may be available, subject to course availability in the requested semester and approval from the advisor and academic coordinator.

## PhD studies

The Doctor of Philosophy (PhD) program is designed for students with a master's degree in engineering or exact sciences who have demonstrated outstanding academic and research achievements. Each candidate's qualifications will be reviewed individually.

### Acceptance Criteria

In addition to meeting the general requirements of the Technion Graduate School, applicants must demonstrate the ability to conduct independent research. The interdisciplinary committee will review each candidate's application and reach decisions regarding their acceptance and specific conditions.

Applicants must secure a research supervisor prior to submitting their application. In special cases, such as international candidates, the interdisciplinary committee coordinator can assist in finding a supervisor.

### PhD Study Requirements

Doctoral students must:

- Fulfill any special conditions set by the interdisciplinary committee (if applicable).
- Complete at least 8 advanced course credits.
- Submit a research proposal and defend it before the evaluation committee.
- Deliver a seminar presentation, which will be publicly announced in the Technion's bulletin.
- Submit an essay on the proposed research and defend it before the evaluation committee.

### Direct PhD

Outstanding students who have begun a master's program with a thesis and who excel in both their classes and research may transfer to the direct PhD track, subject to the recommendation of the interdisciplinary committee. These students must complete at least 8 advanced course credits in addition to their master's requirements.

### Special PhD Program

This track is designed for exceptional students ("*summa cum laude*") who wish to pursue a PhD immediately after completing their bachelor's degree. Additional admission criteria and study procedures are detailed in the Graduate School catalog (Sections 32.05 and 34.02 of the regulations).