

## Renewable Energy, Technology, and Resource Economics

ENGR 3000 (4 credits / 60 hours)

### Iceland: Renewable Energy, Technology, and Resource Economics

*This syllabus is representative of a typical semester. Because courses develop and change over time to take advantage of unique learning opportunities, actual course content varies from semester to semester.*

#### Description

Iceland is a global model in renewable energy with 99.4% of its energy derived from renewable energy sources. In this integrated, interdisciplinary seminar, we strive to understand why and how Iceland is as successful as it is in leading the renewable economy. This seminar takes an interdisciplinary approach to the study and analysis of renewable energy, technology and resource economics in Iceland. Through the interplay of context, readings, interactions and reflections, our program of study will enable us to develop (i) technical understanding of energy systems; (ii) critical understanding of how energy systems and energy relate to Iceland's social and ecological conditions; (iii) and recognition of the ways Iceland's renewable energy and technology can be mobilized in other global contexts.

#### Learning Outcomes

The *Renewable Energy, Technology, and Resource Economics* course comprises 60 hours of instruction (4 credits). Upon completion of the course, students will be able to:

- Demonstrate understanding of the mechanics of a variety of renewable energy technologies;
- Differentiate among types and scales of energy utilization technologies;
- Relate energy production and consumption to resource use and management;
- Analyze and compare different energy systems and account for the social, economic and ecological costs and benefits of different renewable energies;
- Demonstrate knowledge and ability to work with class concepts of resource economics renewable energy, and technology.

#### Language of Instruction

This course is taught in English, but students will be exposed to vocabulary related to course content as well as the nuances of renewable energy, technology, and resource economics through in-country expert lecturers and field visits to a wide range of venues and regional locales.

#### Course Material and Texts

All of your learning materials will be available on Moodle and/or the SIT online resources library. The list of readings in this syllabus are not complete and new materials will be added to our Moodle site throughout the course.

## Course Schedule

Students will be provided a detailed course schedule during orientation on the program. Please be aware that topics and excursions may vary to take advantage of any emerging events, to accommodate changes in our lecturers' availability, and to respect any changes that would affect student safety. Students will be notified if this occurs.

### Module 1: Foundations and Theories

Module 1 is the foundational module for the program, introducing the physics of energy and major renewable technologies in use in the world today (some of which we find in Iceland). The module is designed to be accessible to those with or without engineering backgrounds.

Topics include:

- Energy Concepts and Hydropower
- Thermal Energy, Geothermal Power
- Geothermal Heat Pump Systems, Combustion
- Solar Energy
- Wind Energy
- Wave and Tidal Power

*Recommended readings:*

Randolph, J., & Masters, G. M. (2018). *Energy for Sustainability: Foundations for Technology, Planning, and Policy*. Island Press.

Fridleifsson, I. B. (2001). Geothermal energy for the benefit of the people. *Renewable and sustainable energy reviews*, 5(3), 299-312.

### Module 2: Climate Change, Energy Technology, Policy & Economics

Module 2 will be held in Akureyri, where students will have classes, discussions, site visits and field research experiences that examine the social and environmental impacts of energy projects, resource economics, policies, and sustainability concepts. Students will also meet with experts in the field of climate science, renewable energy and leaders of industry, research, and development, and learn about Iceland's progress in exploring alternative fuels. Students will look broadly at the environmental/resource economics of providing energy for society, including standard (neoclassical) approaches and alternative views, as well as approaches to sustainability. Policy options for a sustainable future are considered.

Topics include:

- Akureyri – The Green Capitol of the North/Biomass and Biofuels
- Energy Systems and Storage (Site Visits: Laxárvirkjun (Hydropower) and Þeistreykjávirvirkjun (Geothermal))
- The Cultural forms of Geothermal: Site Visit to GEOSea
- Climate Change and a Changing Arctic
- Carbon-neutralizing in practice (site visits to composting plant, methane plant, travel on methane fuel bus, Akureyri hydropower stations)
- Foundations of resource economics and environmental economics;
- Environmental externalities of hydropower and geothermal development

*Recommended readings:*

Bulkeley, H. (2010). Cities and the governing of climate change. *Annual review of environment and resources*, 35, 229-253.

- Islar, M., & Busch, H. (2016). "We are not in this to save the polar bears!"—the link between community renewable energy development and ecological citizenship. *Innovation: The European Journal of Social Science Research*, 29(3), 303-319.
- Guðmundsdóttir, H., Carton, W., Busch, H., & Ramasar, V. (2018). Modernist dreams and green sagas: The neoliberal politics of Iceland's renewable energy economy. *Environment and Planning E: Nature and Space*, 1(4), 579-601.
- Kristjansdóttir, R. and H. Busch. (2019). Towards a Neutral North – The Urban Low Carbon Transitions of Akureyri, Iceland. *Sustainability*, 11, 1-15.
- Read/Review: <https://www.globalcovenantofmayors.org/cities/akureyri/>

### **Module 3: Integrations – Energy, Environment and Society**

Module 3 will integrate key site visits to Myvatn (Krafla power plant), Laugarfell (Karahnjúkar Dam), Reydarfjörður (Alcoa Aluminum plant) and Vatnajökull glacier into the study of the social and environmental dimensions of energy production in Iceland. This module emphasizes an integrated approach to the study of energy, where students will engage in field-based *in situ* discussions, labs and reflections about how energy systems and energy production capacity vary across Iceland according to context and geography.

Topics include:

- Sustainability concepts and definitions;
- Dynamic renewable energy conditions and technological adaptation (site visit to Krafla)
- The limits of renewable energy systems and technologies (site visit to Vatnajökull)
- The social-environmental costs and benefits of energy resources (site visits to Karahnjúkar Dam and Alcoa Aluminum plant)

*Recommended Readings:*

- Bosshard, P. (2003). Kárahnjúkar: A Project on Thin Ice. Berkeley, CA: *International Rivers Network*.
- Carton, W., & Andersson, E. (2017). Where forest carbon meets its maker: Forestry-based offsetting as the subsumption of nature. *Society & Natural Resources*, 30(7), 829-843.
- Hodson, M., & Marvin, S. (2012). Mediating low-carbon urban transitions? Forms of organization, knowledge and action. *European Planning Studies*, 20(3), 421-439.
- Kronsell, A. (2013). Legitimacy for climate policies: politics and participation in the Green City of Freiburg. *Local Environment*, 18(8), 965-982.
- Martiskainen, M. (2017). The role of community leadership in the development of grassroots innovations. *Environmental Innovation and Societal Transitions*, 22, 78-89.

### **Module 4: Looking Ahead and Carbon Futures**

In this final Module of the program, we will examine recent innovations and future directions of Iceland's carbon economy, focusing in particular on CarbFix and the Burfell wind energy plans. These forward-facing projects will help students situate their own final research projects in Iceland's trajectory of energy development and innovation. Combined with discussions, lectures and paper discussions, students will be focusing on their research analysis, writing, and critical reflection during this final module. Part of our work here in Iceland is to understand what is unique to the Icelandic context, and how we might be able to transport what we have seen, studied and analyzed to a broader, global context. Group discussions will work to clarify these kinds of insights and discussion points, which will materialize in final projects in their discussions.

Topics include:

- Carbon sequestration and scaling up CarbFix (discussion with researchers);
- Hellesheidi and the future of Energy Parks (visit to Hellesheidi);
- Burfell wind farms and the future of wind in Iceland (visit to Burfell wind farms)
- Greenhouse production and the growth of food production in Iceland (visit to Fridheimer Farm)

*Recommended Readings:*

Doukas, H., Nikas, A., González-Eguino, M., Arto, I., & Anger-Kraavi, A. (2018). From integrated to integrative: Delivering on the Paris Agreement. *Sustainability*, 10(7), 2299.

Ostrom, E., Janssen, M. A., & Anderies, J. M. (2007). Going beyond panaceas. *Proceedings of the National Academy of Sciences*, 104(39), 15176-15178.

Turnheim, B., Berkhout, F., Geels, F., Hof, A., McMeekin, A., Nykvist, B., & van Vuuren, D. (2015). Evaluating sustainability transitions pathways: Bridging analytical approaches to address governance challenges. *Global Environmental Change*, 35, 239-253.

### **Evaluation and Grading Criteria**

Evaluation is based not only on assessment of comprehension of the course concepts listed above, but also on student engagement and initiative in course exercises and activities. Grade is determined by:

#### Description of Assignments:

##### Class Assignments (30%)

Throughout Module 1, students will complete daily problem sets and other exercises based on readings, class material, and excursions. Students are encouraged to work together, but each person must submit his or her own assignment.

##### Module 1 Exam (25%)

An in-class exam at the end of Module I will cover key concepts and skills from that portion of the class.

##### Group Project (25%)

While students are in Akureyri, they will have the opportunity to participate in a group-based carbon “hack-a-thon” using real-world data from Akureyri’s carbon footprint database. Students will work in teams of three to four other students to research key sectors of the carbon economy, and work together to develop effective and doable strategies to decrease Akureyri’s carbon footprint. Sectors might include: transportation, tourism, carbon capture, waste, and food and fisheries.

##### Reading Facilitation (10%)

Once during the program, students (in groups of 2-4 students) will be responsible for leading a one-hour group discussion that relates the assigned readings with program activities, which might include site visits, lectures, and discussions with professionals. Students will be responsible for providing a short summary of the readings and critical discussion questions.

##### Field/Lab Notebooks (10%)

Students will keep field/lab notebooks throughout the program. Calculations, sketches and notes will be advised, and lab notebooks will be periodically evaluated throughout the program.

### Assessment:

Class Assignments (30%)

Module 1 Exam (25%)

Group Project (25%)

Reading Facilitation (10%)

Lab Notebooks (10%)

### Grading Scale

94-100%	A	Excellent
90-93%	A-	
87-89%	B+	
84-86%	B	Above Average
80-83%	B-	
77-79%	C+	
74-76%	C	Average
70-73%	C-	
67-69%	D+	
64-66%	D	Below Average
below 64	F	Fail

### **Student Expectations and Policies**

- Show up prepared. Be on time; have your readings completed and points in mind for discussion or clarification. This raises the level of class discussion for everyone.
- Have assignments completed on schedule, printed, and done accordingly to the specified requirements. This will help ensure that your assignments are returned in a timely manner.
- Ask questions in class. Engage the lecturer. These are often very busy professionals who are doing us an honor by coming to speak.
- Comply with academic integrity policies as specified in the [SIT Study Abroad Student Handbook](#).
- Respect differences of opinion (classmates, lecturers, local constituents engaged with on the visits). You are not expected to agree with everything you hear, but you are expected to listen across difference and consider other perspectives with respect.

### **Academic Policies**

SIT prides itself on providing students with an experientially based program; we hold ourselves, and our students, to the highest of academic standards. Students are asked to refer to the **SIT Study Abroad Handbook** for policies on academic integrity, ethics, academic warning and probation, diversity and disability, sexual harassment and the academic appeals process.

### **Disability Services**

Students with disabilities are encouraged to contact Disability Services at [disabilityservices@sit.edu](mailto:disabilityservices@sit.edu) for information and support in facilitating an accessible educational experience. Additional information regarding SIT Disability Services, including a link to the online request form, can be found on the Disability Services website at <http://studyabroad.sit.edu/disabilityservices>.