

# TIM 155: Water and Energy Management

**Summer 2015; Tuesday/Thursday 9:00 – 12:30 pm; Jack Baskin Engineering Building 371**

*Administrative note: Session 2 Drop Deadline - Aug 1; Withdraw Deadline August 12*

Instructor: Brent M. Haddad, Ph.D. [bhaddad@ucsc.edu](mailto:bhaddad@ucsc.edu) Office hours: Tuesdays and Thursdays 12:30-2:00 pm Engineering 2, Room 567, and by appointment.

**Introduction.** Well-managed energy and water systems are vital to the economy, public health, and environmental protection. This class introduces energy and water management challenges and explores techniques for understanding them better and generating recommendations. Management challenges include operating at affordable cost, minimizing environmental impacts, meeting growing/shifting demand patterns, upgrading aging infrastructure, and maintaining a skilled workforce.

**What you will learn.** The course presents current water and energy production and consumption trends, resource system overviews, and current and emerging resource-management challenges. The course introduces energy and water modeling techniques that can help decision-makers understand their management choices. Techniques include the NREL SAM renewable energy model, the Theis method groundwater modeling, and water and energy ratemaking models.

**Grading.** 80% Homework. There will be 4 homework sets worth 20% each. Homework is due in class on Tuesdays.

20% Final Exam. The final exam covers the entire quarter – lectures, readings, in-class projects and homework. The exam will be part recall and part analysis. The final takes place in class on Thursday, August 25.

## Readings

The following readings will be used in the course. The abbreviation in bold is used below.

**(GEA)** GEA, 2012: *Global Energy Assessment - Toward a Sustainable Future*. International Institute for Applied Systems Analysis, Vienna, Austria and Cambridge University Press, Cambridge, UK and New York, NY, USA.

**(USDOE)** U.S. Department of Energy, 2014. *The Water-Energy Nexus: Challenges and Opportunities*. Washington, D.C.: Department of Energy.

**(USEIA)** U.S. Energy Information Administration, 2015. *Annual Energy Outlook*. DOE/EIA0383(2015).

Additional articles are also assigned.

## Week 1: Introduction to Energy and Water (7/26&28)

Reading:

**USDOE**, Executive Summary.

**USEPA**, 2015. *How we use water in these United States*. 10 pp. Website downloaded 10-1-15.

**USEIA**, pp 1-27

**GEA, Ch. 1, Ch. 12.2**

In class projects:

Exploring links between economic activity and power and water consumption  
**USDOE** Figures ES3 and ES4 – understanding them in detail  
Understanding USEIA Tables A1 and A2 (starting on pdf p. 51)  
Understanding GEA figures 1.5, 1.16, and 1.28.

## **Week 2 (8/2&4)**

### **Part 1: Sources and uses of water**

Reading:

United Nations, 2016. World Water Development Report 2016: Water and Jobs. Paris: UNESCO. Chs 15-18.

### **Part 2: Climate change, energy, and water**

Reading:

**USDOE**, Chapter 3  
**GEA**, Ch. 13 (“appreciate” the entire chapter, select one of the selections, not including 13.8, to read in detail)  
The Paris Agreement of 2015

In class projects:

Review **GEA** figures 13.2, 13.7, 13.8, 15.4 and 15.6  
The Paris Agreement – what does it mean?

## **Week 3: Renewable Energy (8/9&11)**

Reading:

Lovins, A. 1976. Energy Strategy: the Road Not Taken? *Foreign Policy* (October).  
**GEA**, Ch. 11 (Executive Summary, Sections 11.1, 11.10, 11.11.5, and one of sections 11.2 through 11.9)  
California State Assembly Bill 920

Recommended: <https://www.youtube.com/watch?v=0qtlzkU5wEM>  
<https://sam.nrel.gov/node/69635>

Visit and browse:

the Greentech Media site: [www.greentechmedia.com](http://www.greentechmedia.com)  
the Cleantechnica site: <http://cleantechnica.com/>

In class project:

NREL SAM model (National Renewable Energy Laboratory System Analysis Model)

## **Week 4 (8/16&18)**

### **Part 1: Water Finance and Ratemaking**

Reading:

Portfolio of readings on City of Santa Cruz ratemaking study

In class project:

Water Utility Ratemaking Model

**Part 2: Water availability case study: groundwater**

Reading:

Lee, K., Fetter, C.W., McCray, J.E., 2003. Hydrogeology Laboratory Manual. Pearson Education. Ch. 3: Radial Flow to Wells.

In class project:

Modeling groundwater well dynamics

**Week 5: Water and energy in combination (8/23&25)**

Reading:

US Department of Energy (USDOE). 2006. "Energy Demands on Water Resources." Report to Congress on the interdependency of energy and water."

**USDOE**, Ch. 2: Interconnected Water and Energy Systems

In class projects:

**USDOE** Appendix A – the "Sankey Diagram"

**Final Exam:** Thursday, August 25, in class.