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**ESCI-61**  
**Introduction to Photovoltaic Technology**

Ridha Hamidi, Ph.D.

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**Introductions**

- Who am I?
  - Background
  - Why am I teaching this class?
- Who are you?
  - Background?
  - Why are you taking this class?
  - What do you expect from it?

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**Class Details**

- ESCI-61, 3 units
- Required course for the *Certificate of Achievement in Energy Management and Climate Policy* and for the *A.A. Degree in Environmental Compliance & Pollution Prevention*
- 12 Meetings in KC239
  - April 10 – June 26, 2013
  - Wednesdays 5:30 - 8:20 PM
- Grading is based on
  - Three Homework Assignments
  - Three Quizzes
  - One Final Project
  - One Final Exam

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## Class Content

- Introduction to PV Systems
- Solar Radiation, Sun-Earth Relationships
- PV Cells, Modules, and Arrays
- PV System Components and Configurations
- PV Site Surveys
- Basics of Electricity for PV Systems
- PV System Design & Sizing
- Mechanical & Electrical Integrations of a PV System
- Field Trips
- Economic Analysis of a PV System, Net metering, Rebate programs

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## Expected Outcome

- Understand photovoltaic technology fundamentals
- Be able to do a site assessment for a residential PV system
- Be able to design and size a grid-tied PV system at residential scale

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## Expectations From Students

- Attend all classes!
  - Students who miss more than 2 sessions will be automatically withdrawn.
- Participate in team assignments in and outside of class time
- Work with a team to design a photovoltaic project.
- Complete homework assignments on time

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# Electricity Sources

- Conventional
  - Fossil Fuels
    - Coal
    - Natural Gas
    - Oil
  - Nuclear
  - Hydroelectric
- Alternative
  - Solar
  - Biomass
    - Biofuels
    - Wood & Derived Fuels
  - Waste
  - Geothermal
  - Wind
  - Wave & Tidal

Color Code : Non Renewable Renewable

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# PV System Design Project

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## General Approach

	Cost	Savings
Generation	\$\$	\$
Conservation/Efficiency	\$	\$\$
Curtailment	☹	\$\$\$

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## Discover Which Appliances Cost You The Most



Kill a Watt  
Electricity Usage Monitor

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## Typical Electricity Usages & Costs

	W	KW	h	PF	W	Qty	Total W	KWh/Year	\$/Year
Refrigerator			24.00					361	\$43.36
Refrigerator (Standby)	0	0.000		1.00	0.00	1	0.00		
Refrigerator (Door Open)	83	0.083		1.00	83.00	1	83.00		
Refrigerator (Working)	199	0.199		0.98	197.96	1	197.96		
Washing Machine	1000		0.5	1.00				183	\$21.90
Dish Washer	420		0.5	1.00				77	\$9.20

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## Standby Usage & Savings

Appliance				Before		After	
	W	Qty	Total W	KWh/Year	\$/Year	KWh/Year	\$/Year
Entertainment Station	32.33	1	32.33	283	\$33.99	28	\$3.40
Router	8.16	1	8.16	71	\$8.58	36	\$4.29
Modem	5.20	1	5.20	46	\$5.47	46	\$5.47
Desktop & Monitor	2.80	1	2.80	25	\$2.94	2	\$0.29
Toaster	1.60	1	1.60	14	\$1.68	0	0
Music Station	1.00	1	1.00	9	\$1.05	0	0
Cell Phone Charger	0.00	2	0.00	0	\$0.00	0	0
Laptop Charger	0.10	2	0.20	2	\$0.21	0	0
Food Processor	0.00	1	0.00	0	\$0.00	0	0
Coffee Maker	0.00	1	0.00	0	\$0.00	0	0
Microwave	0.40	1	0.40	4	\$0.42	4	\$0.42
Printer	0.00	1	0.00	0	\$0.00	0	0
Mower Charger	0.70	1	0.72	6	\$0.76	0	0
Electric Tooth Brush	0.00	1	0.00	0	\$0.00	0	0
<b>Savings</b>			52.41	459	\$55.09	116	\$13.87
						344	\$41.22

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## Savings on Lighting & Drying

Appliance				Before		After	
	W	h/day	KWh/Year	\$/Year	KWh/Year	\$/Year	
Dryer	2000	0.5	365	\$43.80	183	\$21.90	
Living Room	200	5	365	\$43.80	91	\$10.95	
Living Room	75	5	137	\$16.43	34	\$4.11	
Kitchen	180	2	131	\$15.77	33	\$3.94	
Dining Room	160	1	58	\$7.01	15	\$1.75	
Bathroom 1	160	1	58	\$7.01	15	\$1.75	
Hall	75	1	27	\$3.29	7	\$0.82	
Backyard	120	0.5	22	\$2.63	5	\$0.66	
Bathroom 2	60	0.5	11	\$1.31	3	\$0.33	
<b>Savings</b>			1,175	\$141.04	385	\$46.21	
					790	\$94.83	

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## Investment

- 17 x CFL Bulbs : \$14
- 2 x Drying Racks : \$34
- 2 x Power Strips : \$18
- Total : \$66




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## Expected Energy & Cost Savings

- Energy Saving : ~1000-1100 kWh/Year
- Cost Saving : ~\$120-\$130/Year
- 25%-27%

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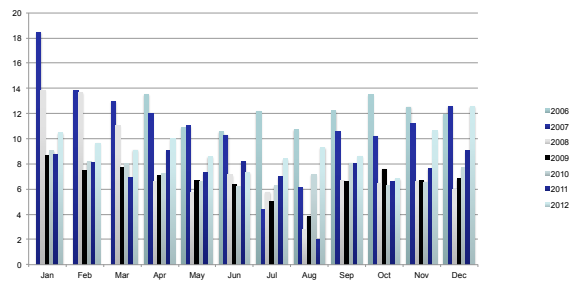
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## Electricity Usage (kWh/Day)




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## Electricity Usage (kWh)

	2006	2007	2008	2009	2010	2011	2012(*)
Average per Year	4,335	4,063	2,810	2,471	2,677	2,678	3,400
Average per Month	361	339	234	206	223	223	283
Average per Day	11.9	11.1	7.7	6.8	7.3	7.3	9.3

(\*) had a water damage, adopted a dog, and moved to a new house

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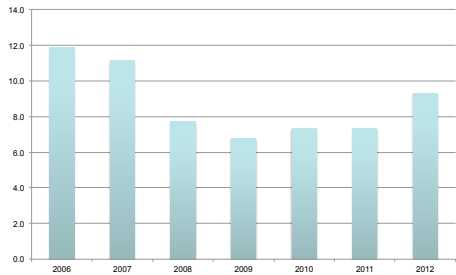
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### Average Electricity Usage (kWh/Day)



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