

ESCI-61

Introduction to Photovoltaic Technology

Ridha Hamidi, Ph.D.



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?



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



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



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



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 - Students who miss more than 2 sessions will be automatically withdrawn.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



ESCI-61

Introduction to Photovoltaic Technology

Ridha Hamidi, Ph.D.



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**



PV System Design Project



General Approach

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



Discover Which Appliances Cost You The Most



Kill a Watt
Electricity Usage Monitor



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

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
			52.41	459	\$55.09	116	\$13.87
Savings						344	\$41.22



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
			1,175	\$141.04	385	\$46.21
Savings					790	\$94.83



Investment

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

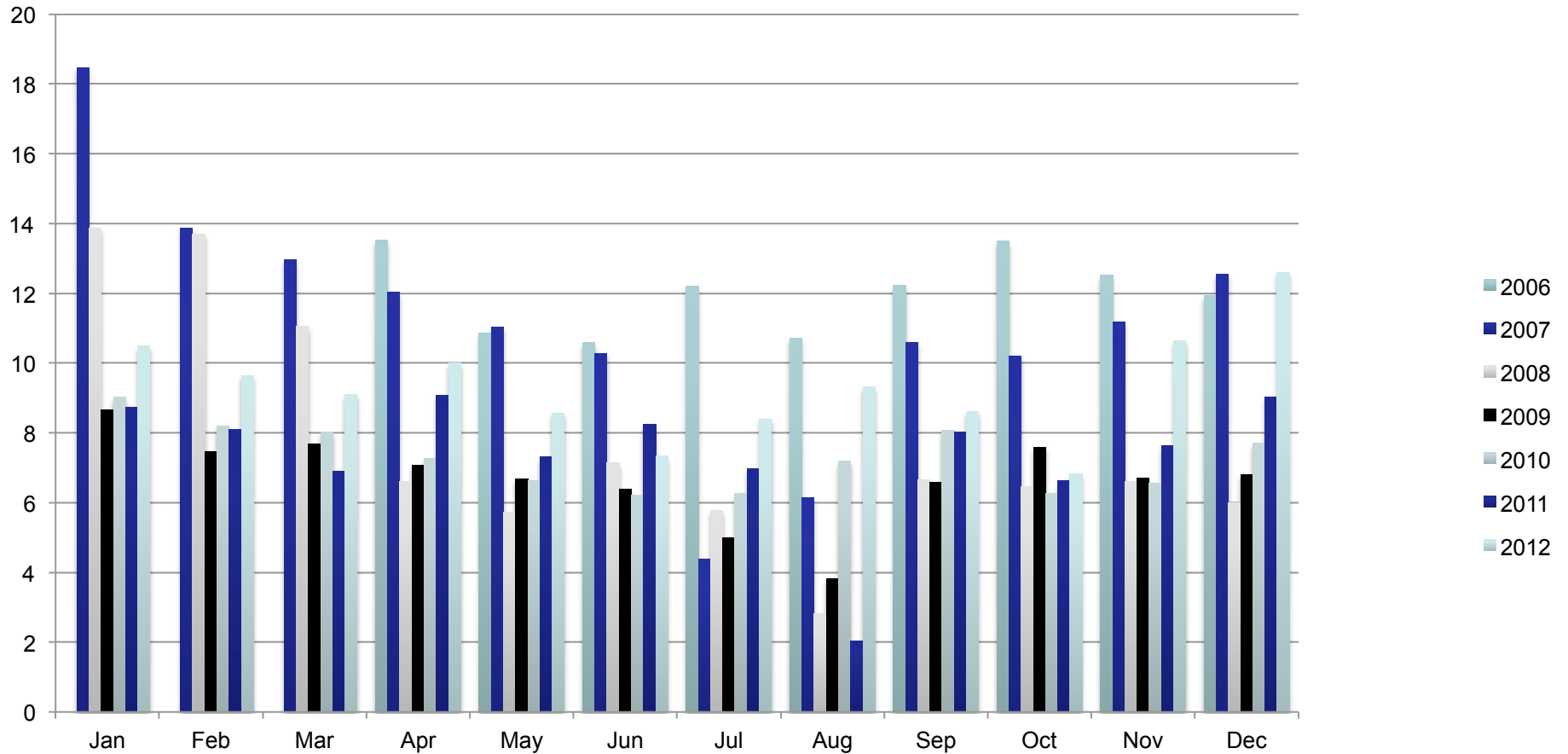


Expected Energy & Cost Savings

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



Electricity Usage (kWh/Day)



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



Average Electricity Usage (kWh/Day)

