For the Instructor: Teaching Note on "Green Lights' Economics: Graphic Design Considers a Lighting Upgrade"

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This case is appropriate for second-level undergraduate or MBA finance classes, typically financial management. It is a simple case that could also be employed in a corporate finance course at the beginning of the semester. Sensitivity analysis may by added (see Question 3) to complicate the solution.

"Doing well" (making money) and "doing good" (reducing environmental harm) are the main focus of this case. While installing more efficient lighting will not solve the world's environmental problems, it does reduce energy use, which in turn reduces the carbon dioxide emissions implicated in global warming. The present value cost of global warming is enormous. Multiplying that cost by even a low probability of occurrence still leaves a rather large present value that an instructor may take a crack at calculating through class discussion. Of course, the timing of the damage of global warming is uncertain.

Green Lights is a significant pollution prevention program. It shows how the government can step in to help business do things more efficiently without regulation. While rebates from utility companies are an added sweetener, the savings accrued by reducing energy use would still make upgrades economically viable. Typically, however, many firms want payback in a short period of time, often one year or less. This means that rebates are the difference between going ahead and doing nothing.

Note: The NPPC has copies of the Excel spreadsheets used for calculating the answers to this case; both Macintosh and DOS formats are available. If you would like to receive these spreadsheets on a 3.5-inch disk, contact the NPPC directly.

Answers

1. "Taylor wanted to know how much his savings would be if he only installed the motion sensors (thereby reducing the hours of light usage) compared to the savings he would accomplish by only installing new ballasts and lamps (thereby reducing energy consumed per hour of usage)."

Answer: Table A-1 shows the savings under new ballasts and lamps only (without motion detectors). Column 1 shows the new hours of usage; Column 2 shows the cost of operating lights ($0.09 kWh) under reduced hours (1,125) with old fixture usage (0.336) after taxes (6%) equaling (0.09 * 1,125 * 0.336 * 1.06 = $36.06) for savings in the President's Office. The savings from just installing the motion detectors is shown as the total of Column 2 — $168.69 — maintaining the same fixtures but reducing the hours they are in use.

Column 3 shows the reduction in kWh from installing new fixtures. Using Column 3 and information from Table 1, one can calculate the savings under old hours without using sensors, e.g., 2,250 hours for the President's Office at $0.09 / kWh, with the 6% tax times the reduction in kWh usage of 0.124 equaling savings of $26.62. Summing Column 4 totals $471.91 in savings from reducing kWh without installing sensors, i.e., no reduction in hours. Peak demand savings are only achieved if new fixtures are installed. The savings of $121.92 ($5.00 per peak hour demand reduction of 1.92, which is the sum of Column 3, reduction in kWh, times 12 times 1.06 [tax]) is therefore additional and added to the $471.91, bringing the grand total savings from new fixtures to $593.83.

TABLE A-1: BREAKOUT OF SAVINGS FROM REDUCTION IN LIGHTING HOURS FROM MOTION DETECTION INSTALLATION AND REDUCTION IN WATTAGE FROM FIXTURE CHANGES

	Reduction in Hours	Savings at Old Wattage	Reduction in kWh	Savings at Old Hours	
President's Office	1,125	$ 36.06	0.124	$ 26.62	
Signs	–	–	0.114	95.27	
Loading	1,500	48.08	0.216	46.36	
Kitchen	1.125	18.03	0.108	23.18	
Bathroom 1	500	4.01	0.024	2.29	
Workspace 1	450	14.42	0.124	26.62	
Bathroom 2	–	–	0.045	2.15	
Entrance	–	–	0.108	23.18	
Workspace 2	750	48.08	0.248	53.23	
Other	–	–	0.806	173.01	
Totals:	**5,450**	**$168.69**	**1.92**	**$471.91**	**savings**
				121.92	**peak demand reduction**
				$593.83	**total saved from kW reduction**

2. "Having been a business major in college, Taylor was familiar with net present value (NPV) analysis. He wanted to know the NPV of the installation's cash flows, taking into consideration that any of his savings would be taxed 31% by the federal government and 4.5% by the state. The 50% rebate offered by NP&E would save him $1,250, but the 6% state sales tax would apply to the entire $2,500 cost. For tax purposes, Taylor intended to expense the entire cost of the installation. Looking at 10 years worth of cash flows would be sufficient for the analysis. When Taylor first prepared a business plan for his company, he applied a 20% discount rate to projected cash flows. He recalled from a college finance course that, in some cases, it was appropriate to apply a risk-free discount rate to cash flows if there was no uncertainty attached to their occurrence. Currently the Treasury Bill rate was 6%. Of course, calculating the IRR would also be useful, particularly given his uncertainty about which rate to use; it was also a calculation that the EPA required of its Green Lights participants."

Answer: Pre-tax savings of $682.50 (Table 1) translate into after-tax savings of $440.21 {(1-0.045-0.31)* 682.5}. The $2,500 installation is increased by 6% to account for taxes to $2,650 less the $1,250 rebate, bringing the after-tax cost to $1,400. The tax shield on the $1,400 outlay {(0.31+0.045) * 1,400} of $497 reduces the cash flow cost to $903. Treating the savings of $440.21 as an annuity at both 6% and 20% arrives at the present value savings figures of $3,239.98 (6% discount) and $1,845.57 (20% discount). Subtracting the after-tax cost of $903 from both figures gives NPVs of $2,336.98 (6%) and $942.57 (20%). Payback in years is calculated as 903 / 440.21 = 2.05 — see Table A-2. (The IRR can be calculated with a financial calculator or a spreadsheet program such as Excel or Lotus.)

The savings from the installation are virtually certain and should therefore be discounted at a lower discount rate than projects involving business risk. The only risk that is entailed here is the risk that the firm will go out of business in less than 10 years; even then, the building with fixtures could be sold and some of the sales proceeds attributed to the new fixtures.

TABLE A-2: NPV OF SAVINGS ASSUMING 10-YEAR HORIZON AND NO CHANGE IN USE OR RATES

Pre-Tax Savings	**$ 682.50**	
After-Tax Savings	**440.21**	
Installation Cost w/6% tax	**(2,650.00)**	
Rebate	**1,250.00**	
Cost	**(1,400.00)**	
Tax Shield on Outlay	**497.00**	
After-Tax Cash Outlay	**(903.00)**	
PV of 10-year Savings Annuity	**3,239.98**	**$1,845.57**
Discount Rate	**6.0%**	**20.0%**
NPV	**2,336.98**	**942.57**
Payback (years)	**2.05**	
Internal Rate of Return	**48%**	

3. "Taylor knew that SNP&L would not be keeping rates at 9¢ / kWh forever. Assuming future inflation to be 3.5% per year, he wondered what the installation's NPV would be, beginning with the following year, when he would begin realizing savings from the installation. Concomitant with rate hikes was the assumption that the local economy would be improving and Graphic Design would be getting more work. This would lead to expanded hours of operation, with both workspaces being used up to 5% more each year for the next seven years, by which time their use would be maximized. What would the incremental NPV of Taylor's savings be under this scenario? It would be useful to take a look at NPV under a range of possible rate hikes from 0% to 7% to get a better idea of just how good deal this might be.

Answer: The first year of increased electricity costs occurs in 1995, when rates rise to $0.09315 (1.035 * .09). First the status quo operating cost is calculated (Panel 1 of Table A-3): Workspaces 1 and 2 are both in use for 2,250 hours in 1994, increasing at a rate of 5% in 1995 to 2,363 hours and continuing increases until the year 2000, when they have reached maximum utilization. The kWh use for the two workspaces is 2,268 (in 1994) minus (.336 * 2,250 for Workspace 1 plus .672 * 2,250 for Workspace 2). Other kWh use is held fixed at 8,873 (1994) throughout the scenario as is peak demand of 4.52 (all data from Table 1). The total cost with tax for operations of $1351 is arrived by multiplying total kWh usage (11,141) by cost ($0.09), adding peak demand cost for the year ($5*4.52*12) and boosting the total by the tax rate (6%). The same analysis is performed using the proposal figures of hour usage (1,800 and 1,500, respectively) for Workspaces 1 and 2, other hour usage of 4,247, and peak demand of 2.61. The savings are $682 in 1994 (1351-668).

Note: In Year 7, workspace use flattens out and no longer increases, but savings are still growing because of utility price hikes. The present value of saving across the ten years discounted at 6% is $7,235; at 20%, it is $3,359. Subtracting the cost of $903 arrives at NPVs of $6,332 (at the 6% discount rate) and $2,456 (at 20%) with an IRR of 58%.

Note: By placing the 3.5% electricity hike and the 5% per annum increase in separate cells in the spreadsheet and relating them in the model with dollar signs (locking in the cells), it is possible to look at a number of different scenarios. Data tables and graphs may then be added to the analysis.

4. "What are the financial and environmental implications of selling the old lighting system? By selling it, does Graphic Design perpetuate the use of inefficient equipment?"

Answer: While Taylor gets some ready cash from the sale of the old lighting system, he does perpetuate the use of inefficient lighting by someone else. Those new users (and they might be in another country, because used equipment is routinely exported) save money by going with used equipment, but the present value of their savings evaporates when electricity use differentials are accounted for.

The possibility of selling another party "radioactive" ballasts was also raised in the case. There has been no scientific proof of the existence of more than background radiation being emitted from ballasts or of the harm that can be done by them. It is a controversy similar to harm done by power lines. Scientific proof is inconclusive (i.e., no statistical findings show harm while anecdotal evidence continues to raise questions).

TABLE A-3: NPV OF SAVINGS FROM INSTALLATION ASSUMING WORKSPACE USE GROWTH OF 5% AND 3.5% ANNUAL INCREASE IN ELECTRICITY COSTS

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
kWh cost	$ 0.09	0.09315	0.099785	0.110633	0.126954	0.150781	0.185349	0.235815	0.310524	0.423212	0.596983
				2,605	2,735	2,872	3,015	3,166	3,166	3,166	3,166
Workspace 2	2,250	2,363	2,481	2,605	2,735	2,872	3,015	3,166	3,166	3,166	3,166
Annual kWh Usage											
Workspaces 1 & 2	2,268	2,381	2,500	2,625	2,757	2,895	3,039	3,191	3,191	3,191	3,191
Remaining Lighting	8,873	8,873	8,873	8,873	8,873	8,873	8,873	8,873	8,873	8,873	8,873
Total	11,141	11,254	11,373	11,498	11,630	11,767	11,912	12,064	12,064	12,064	12,064
							$2,628	$3,303	$4,259	$5,700	$7,922
With Green Lights Installation											
			1,985	2,084	2,188	2,297	2,412	2,533	2,533	2,533	2,533
Workspace 2	1,500	1,575	1,654	1,736	1,823	1,914	2,010	2,111	2,111	2,111	2,111
Annual kWh Usage											
Workspaces 1 & 2	1,018	1,068	1,122	1,178	1,237	1,299	1,364	1,432	1,432	1,432	1,432
Remaining Lighting	4,247	4,247	4,247	4,247	4,247	4,247	4,247	4,247	4,247	4,247	4,247
Total	5,265	5,316	5,369	5,425	5,484	5,546	5,611	5,679	5,679	5,679	5,679
								$1,585	$2,035	$2,713	$3,760
Savings	682	708	757	834	949	1,116	1,360	1,718	2,224	2,986	4,162
Tax	242	251	269	296	337	396	483	610	789	1,060	1,478
Net Savings	$440	$457	$488	$538	$612	$720	$877	$1,108	$1,434	$1,926	$2,685

Install Cost w/6% tax	$(2,650)
Rebate	1,250
Cost	(1,400)
Tax Shield on Outlay	497
After-Tax Cash Outlay	(903)

PV Savings 1995–2004	$7,235	$3,359
Discount Rate	6%	20%
NPV	$6,332	$2,456
IRR	58%	

Published by:
The National Pollution Prevention Center
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