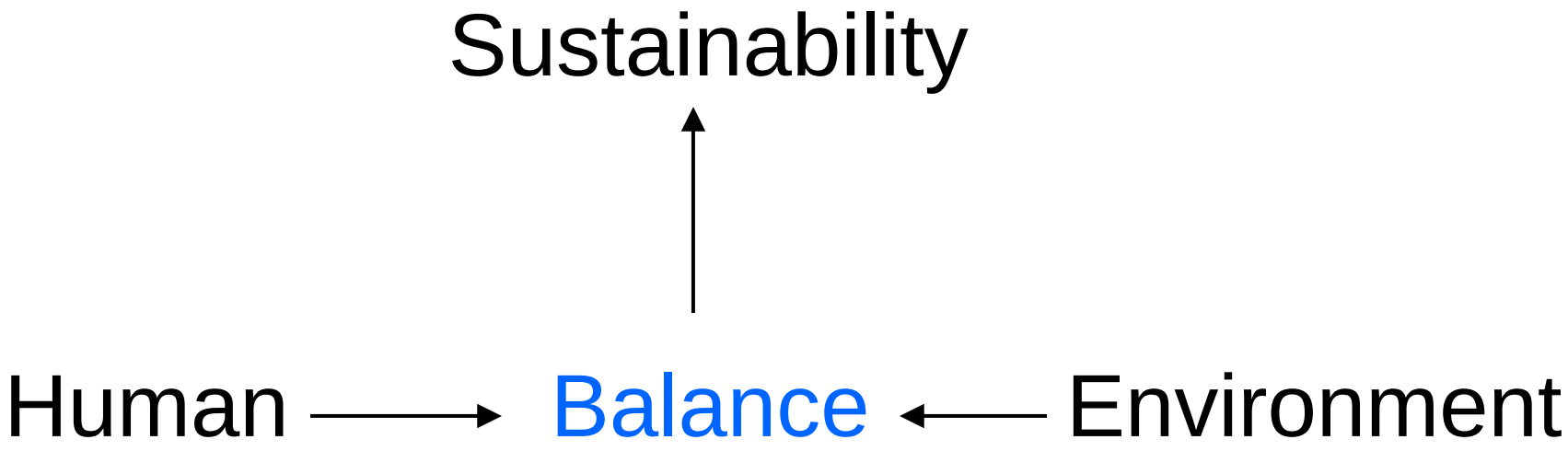
Life Cycle Cost Analysis

Presented by:
Jamie Fox, PE, LEED AP
The Engineering Enterprise

Design Considerations



Design Considerations

Example:

The 5-year investment in a CFL bulb to replace a high use incandescent will provide a **500% return (ROI),** and will outperform the stock market over 5 years, guaranteed.

Yet, only 1 in 10 California sockets have a CFL bulb.

http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/cfls_july_lessons.pdf

*** Top Hedge Fund Manger: ***

Jim Simmons: **80% ROI in 2008**

Annual Salary: → **2.5 billion dollars!!**

http://www.iimagazine.com/Alpha/Article.aspx?ArticleID=2165639

Life Cycle Cost Analysis

Life, liberty, and the pursuit of happiness

Presented by:

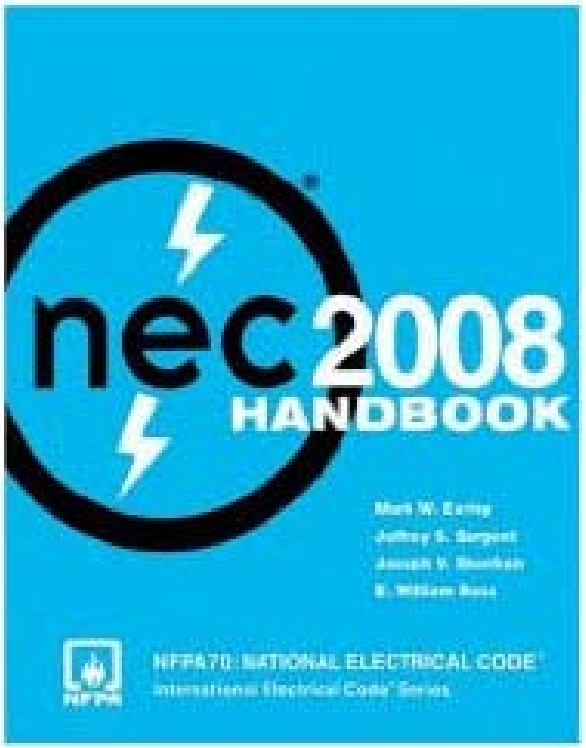
Jamie Fox, PE, LEED AP

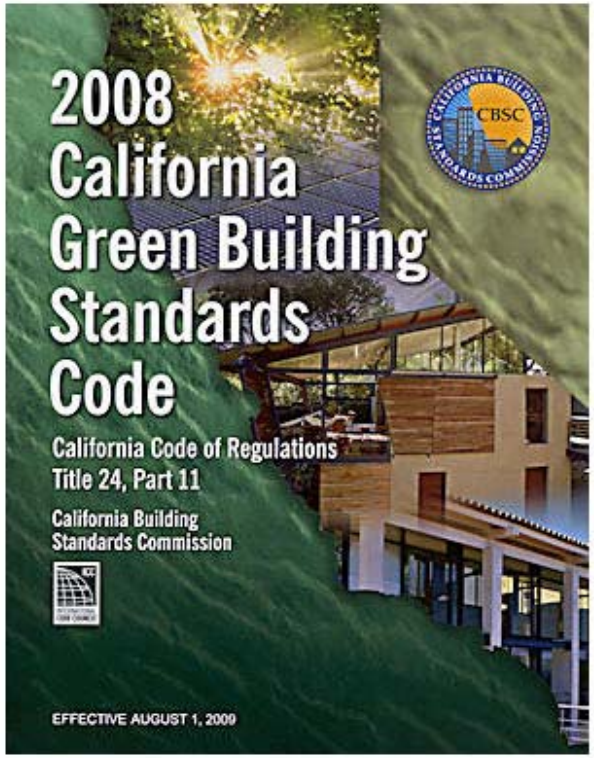
The Engineering Enterprise

The Age of Invention

1909

The Age of Intervention





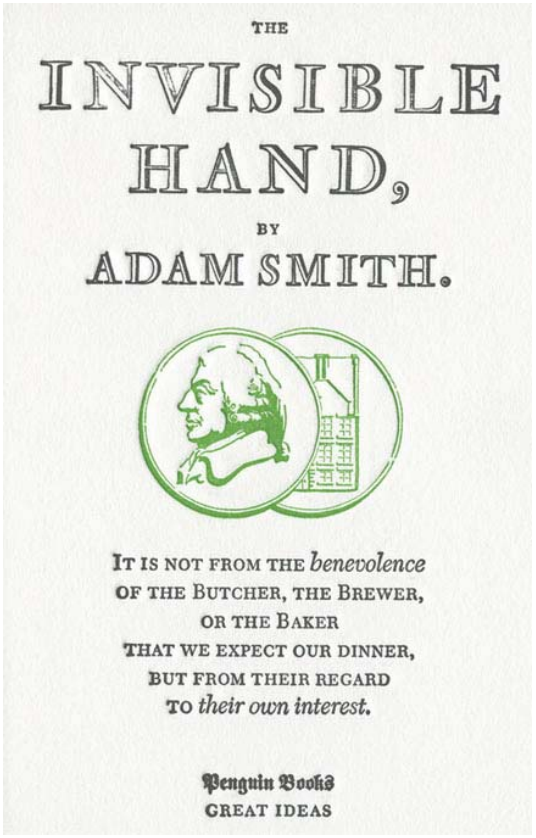
Occupant Safety

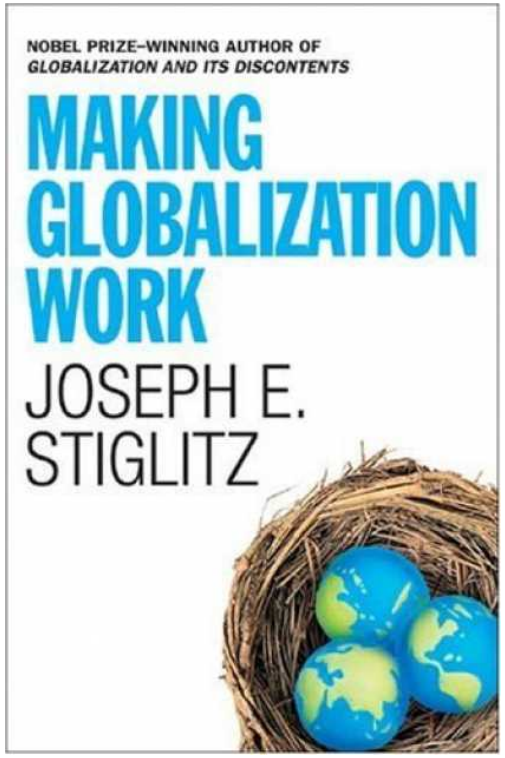
Worker Safety

Sustainability

2009

Free Markets & Regulation





Free Market:

Consumer is allowed to choose freely what to buy and each producer is allowed to choose freely what to sell.

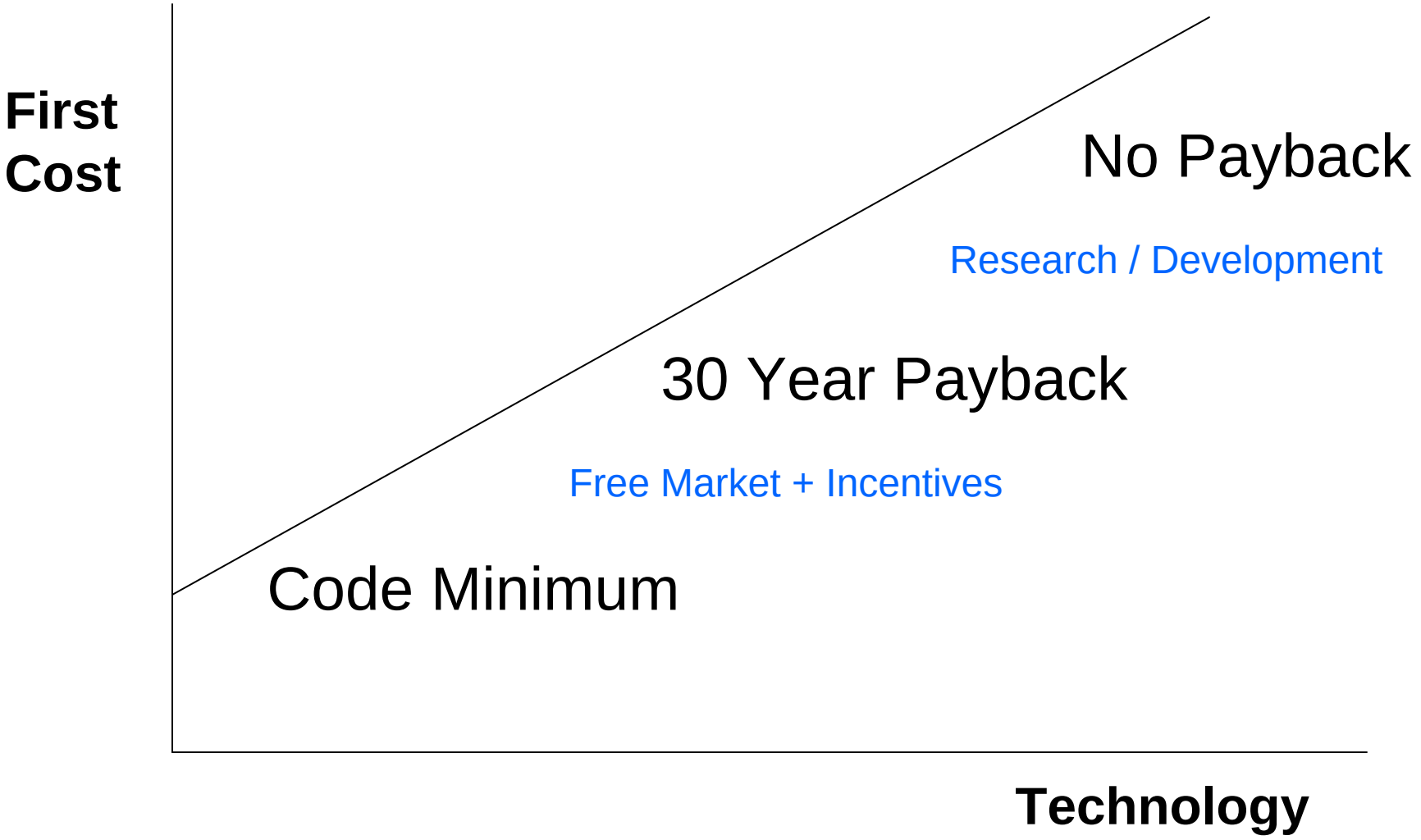
1776

Regulation:

Find the right balance between the market, government, and non-profit organizations.

2006

First Costs for Technology

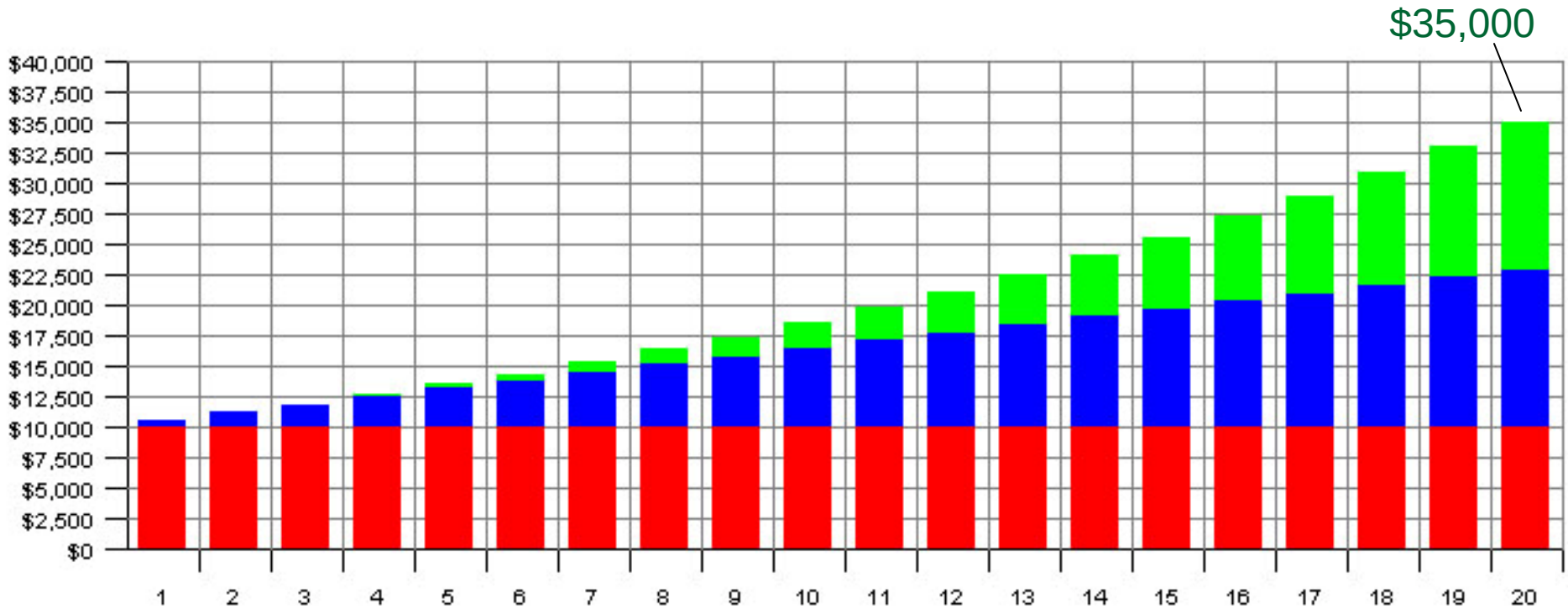


2009 California Budget Crisis

- **The “Governator”:**
  - **“From each crisis we learn”**
  - **“The taxpayers must receive a return (on investment)”**

9/26/08 Commonwealth Club

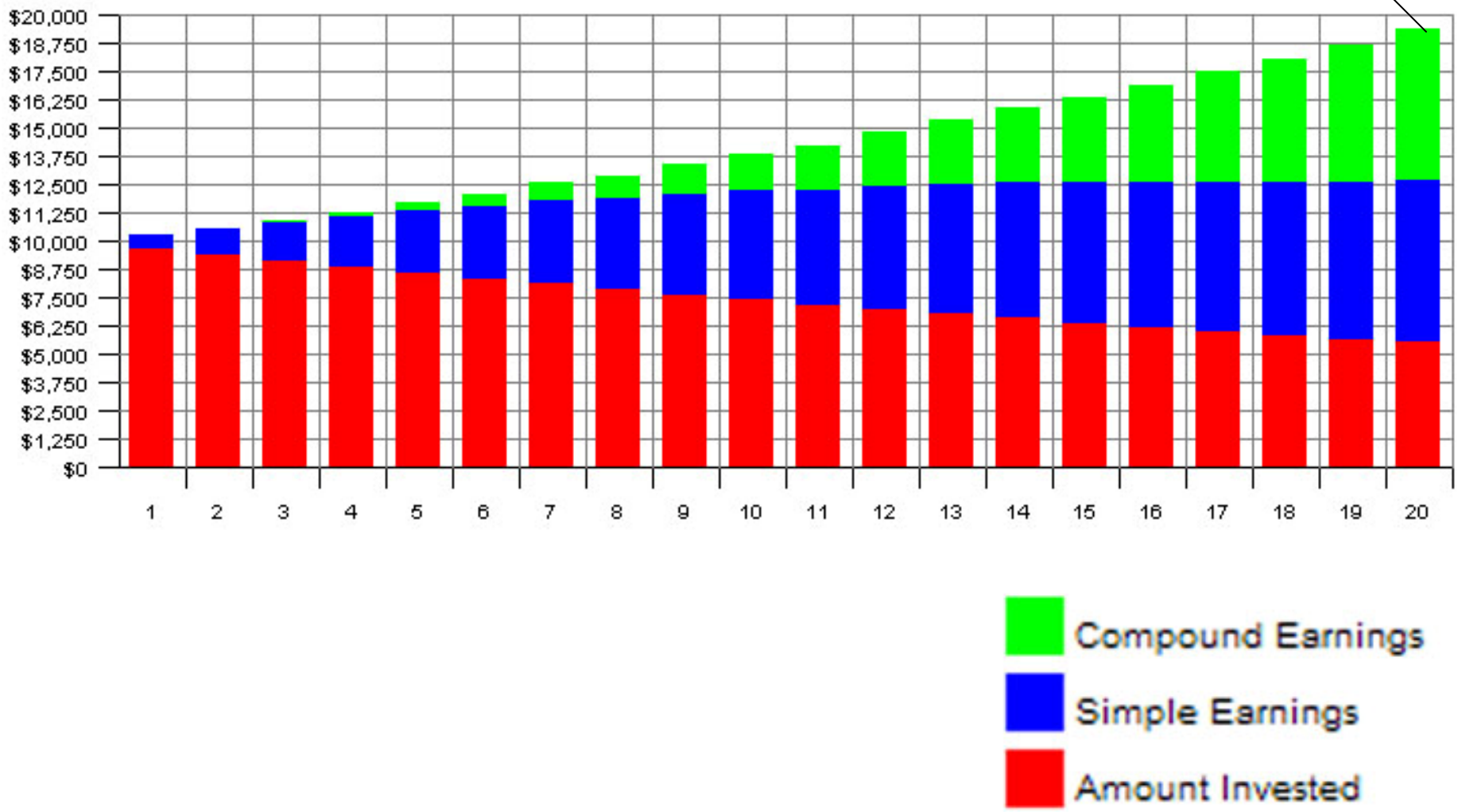
Return on Investment (with transparency)



"Finally, something everyone can agree on" - JF

Return on Investment

$20,000
(Adjusted for Inflation)



Return on Investment

Time Value of Money:

$10,000 = Investment

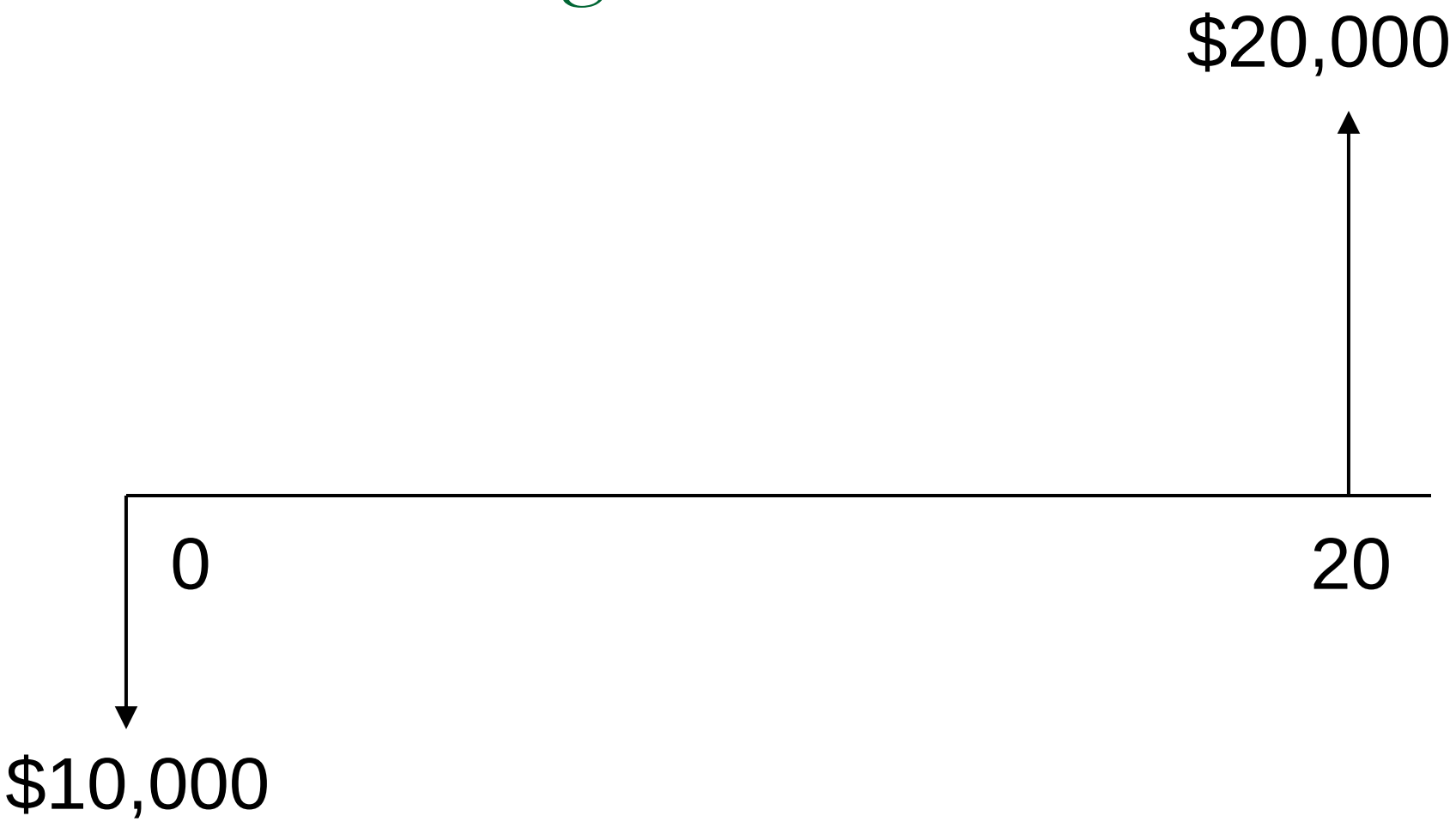
+ 6.5% = Discount Rate

- 3% = Inflation

20 = Years

$20,000 = **2.0 Growth Factor**

Cash Flow Diagram



Present Worth of Future Amount

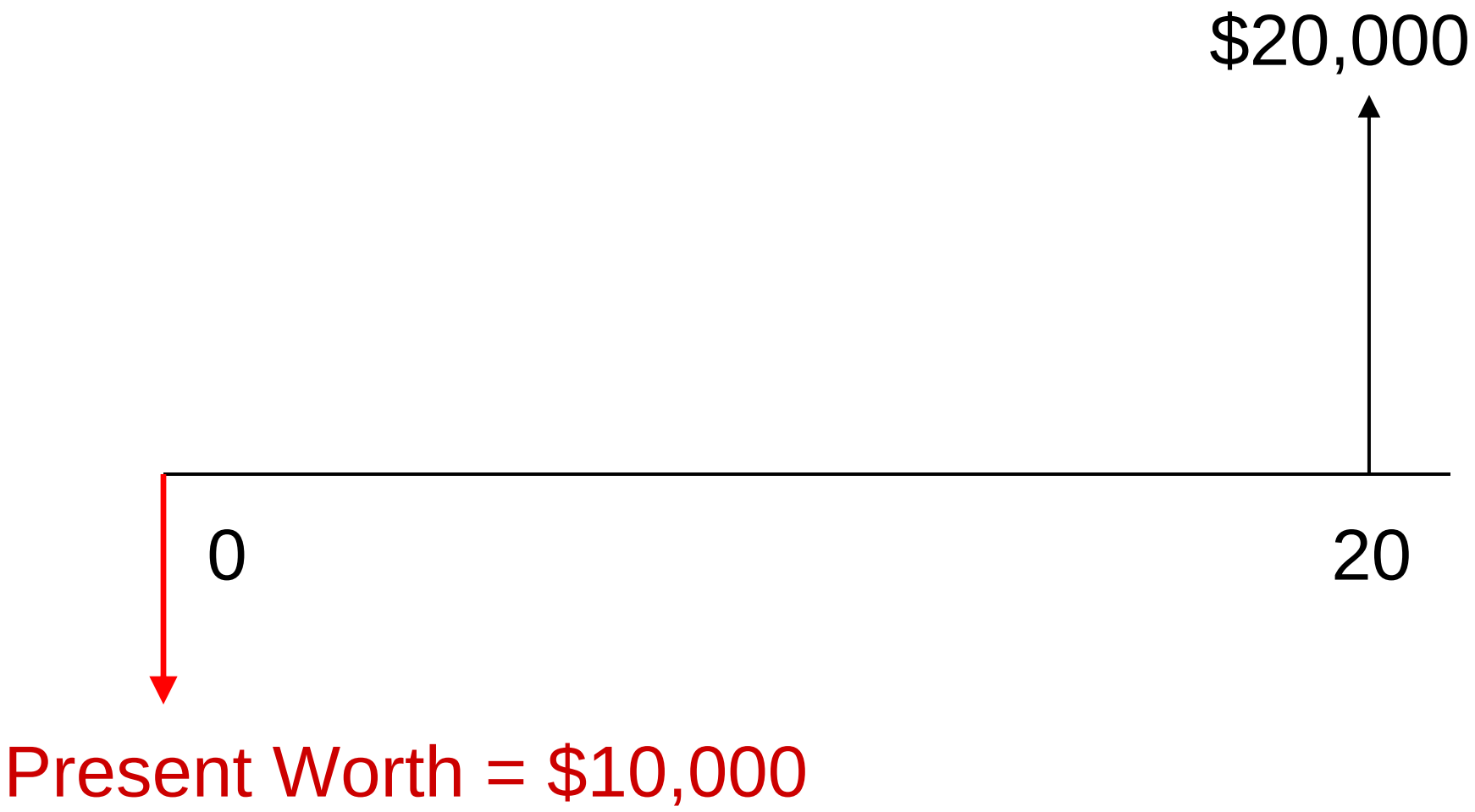
Present Worth of Future Amount

$$= \frac{\text{Future Amount}}{(1 + \text{Discount Rate} - \text{Inflation})^{\#\text{ofYears}}}$$

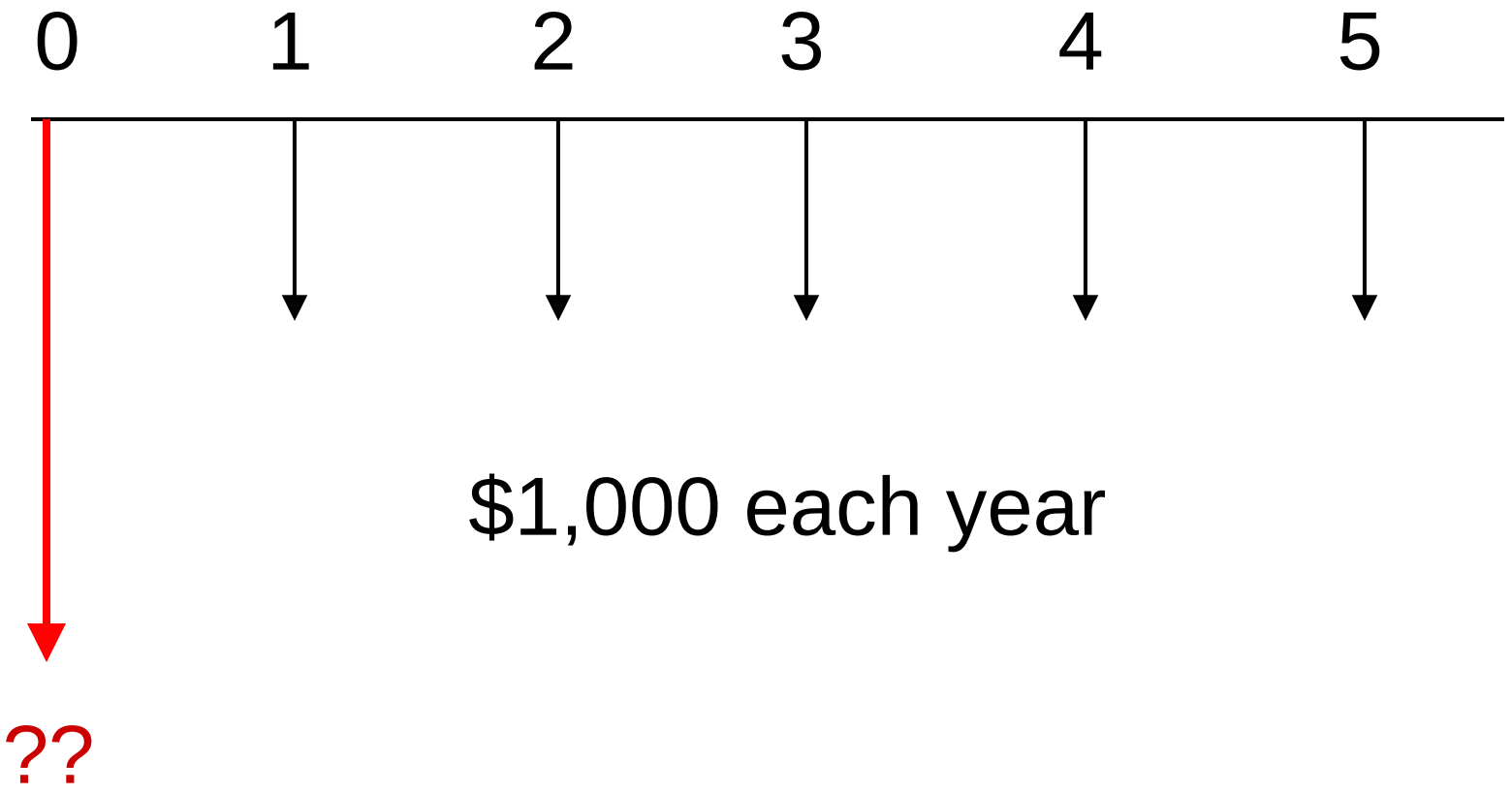
$$= \frac{\$20{,}000}{(1 + 0.065 - 0.03)^{20}}$$

$$= \$10{,}000$$

Present Worth of Future Amount



Present Worth of Annual Amount



Present Worth of Annual Amount

$$= \text{Annual Cost} * \left(\frac{(R)(R)^{\#\text{ofYears}} - 1}{(R-1)} - 1 \right)$$

$$\text{where } R = \frac{(1+\text{Inflation})}{(1+\text{ Discount Rate})}$$

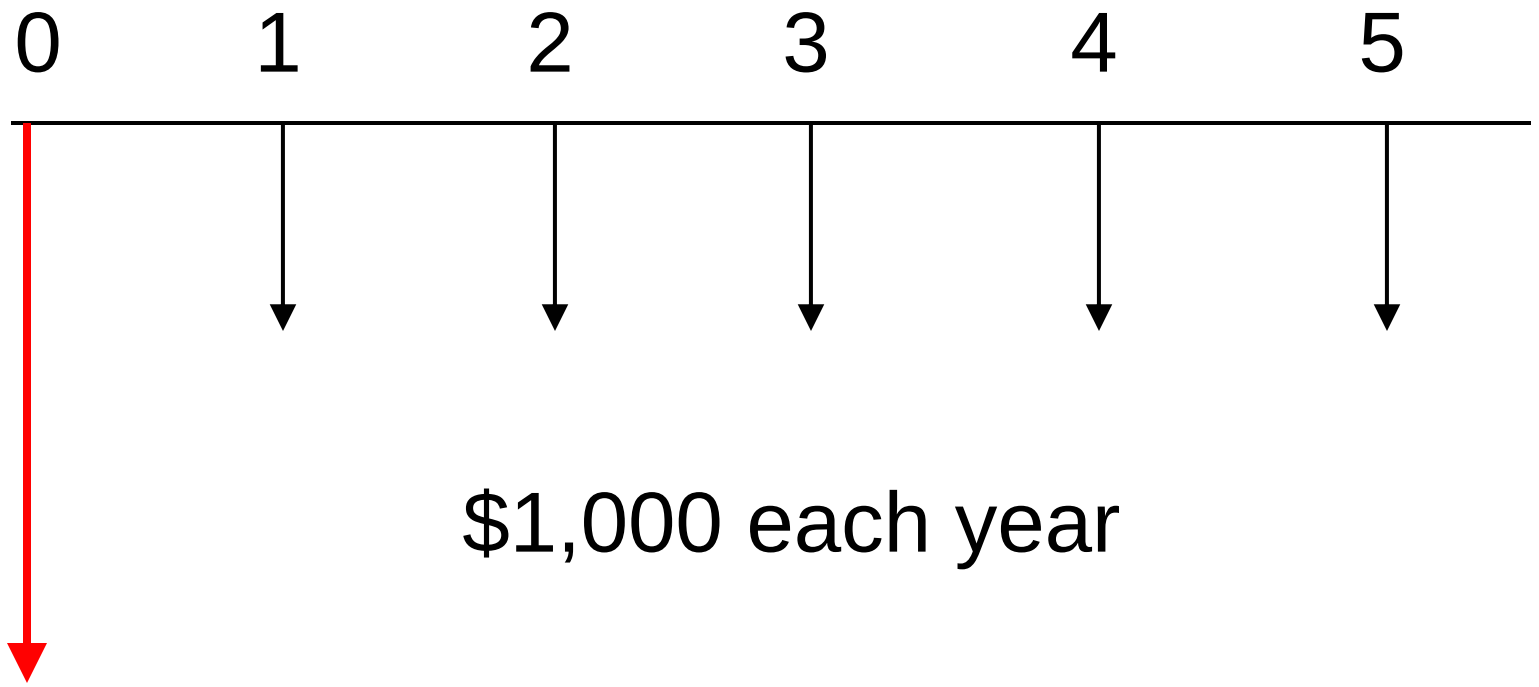
Present Worth of Annual Amount

$$= \$1{,}000 * \left(\frac{(.967)(.967)^5 - 1}{(.967 - 1)} - 1 \right)$$

$$= \$4{,}500$$

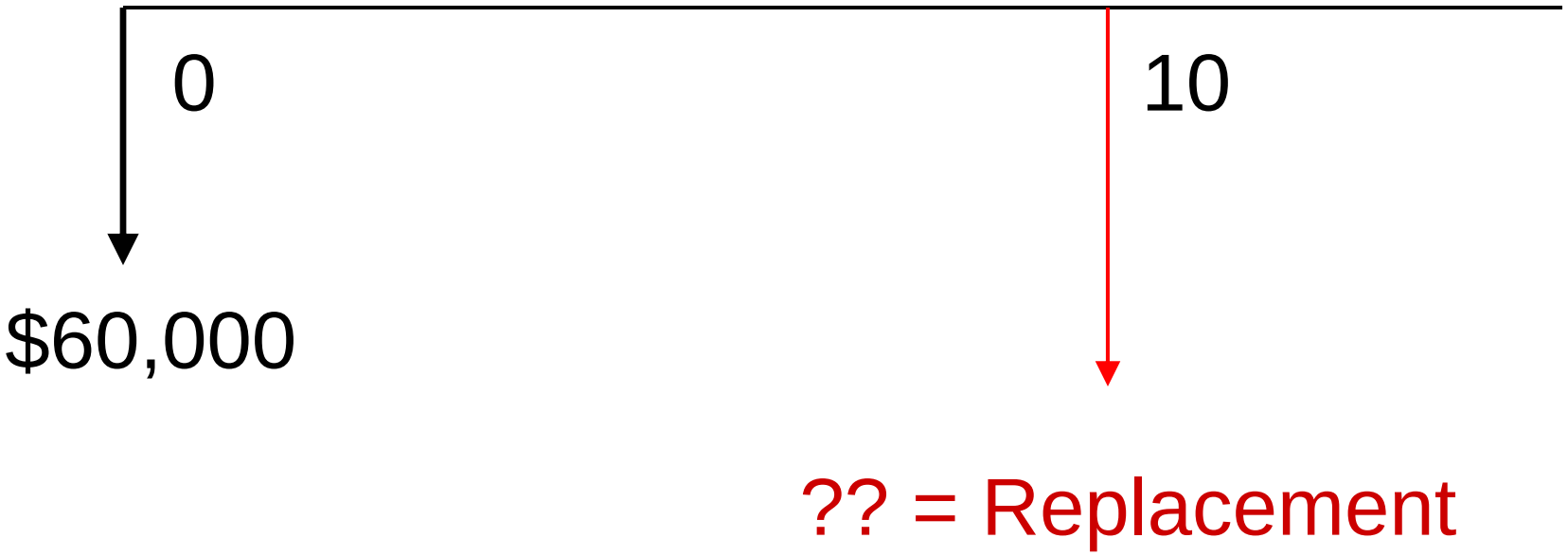
$$R = \frac{1.03}{1.065} = (.967)$$

Present Worth of Annual Amount



$4500 = Present Worth

Future Replacement Cost



Future Replacement Cost

$$= \text{Today's Cost} * (1 - \text{Inflation} + \text{Escalation})^{\#\text{ofYears}}$$

$$= \$60{,}000 * (1 - 0.03 + 0.06)^{10}$$

$$= \$80{,}000$$

Differential Escalation:

Over time, a product's escalation generally equals inflation, but items that are "energy intensive" often escalate faster than the rate of inflation.

Future Replacement Cost

Summary of Variables

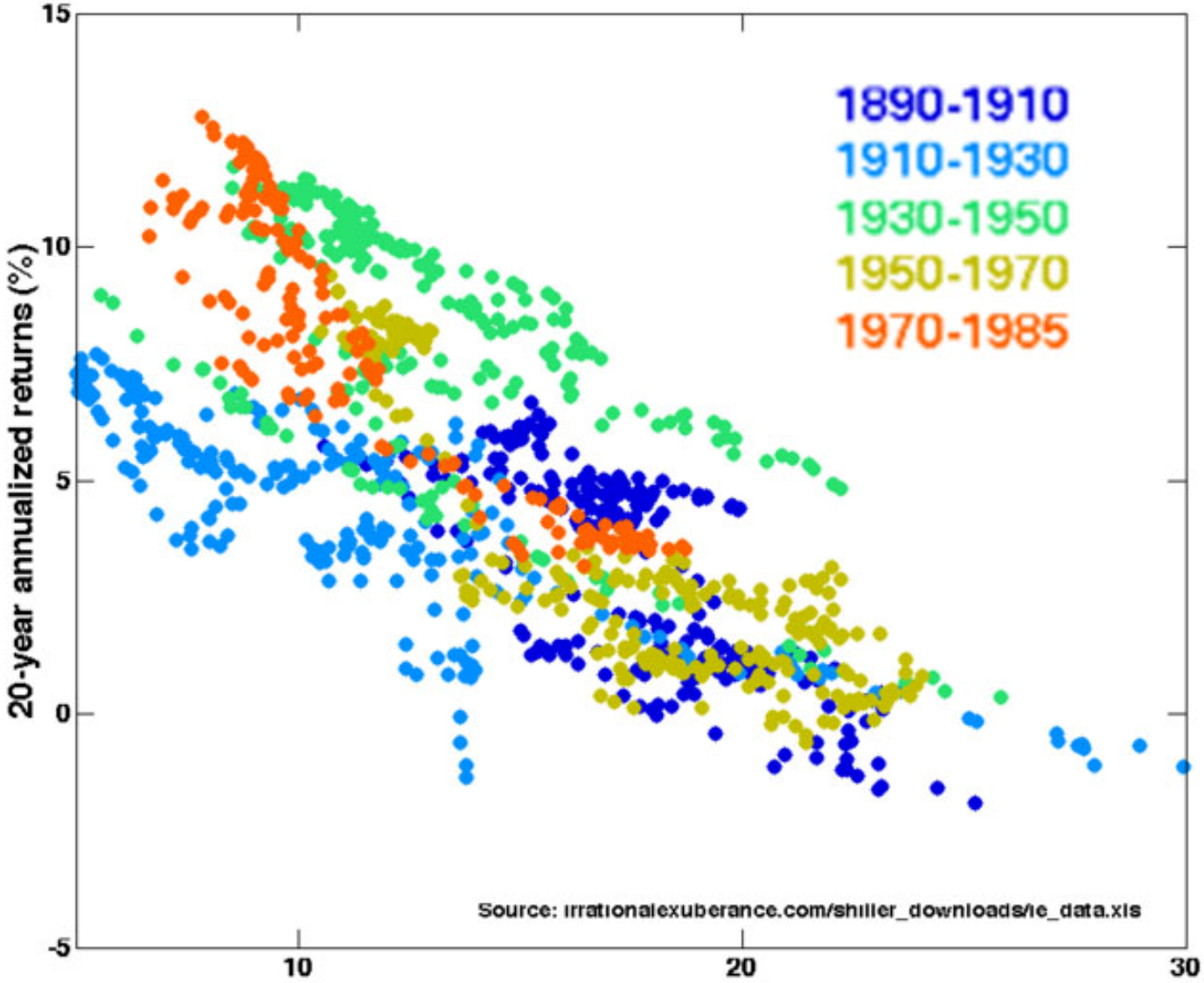
	Typical Values:	Example:
Discount Rate	(3 to 15%)	(6.5%)
Inflation Rate	(0 to 5%)	(3%)
Diff. Escalation Rate	(0 to 10%)	(1%)
Time	(1 to 40 yrs)	(30 yr)
First Costs	($ today)	
Replacement Costs	($ today + diff esc.)	
Annual Costs	($ per year + diff esc.)	

- Calculate Net Present Worth

What discount rate should I use?

10%

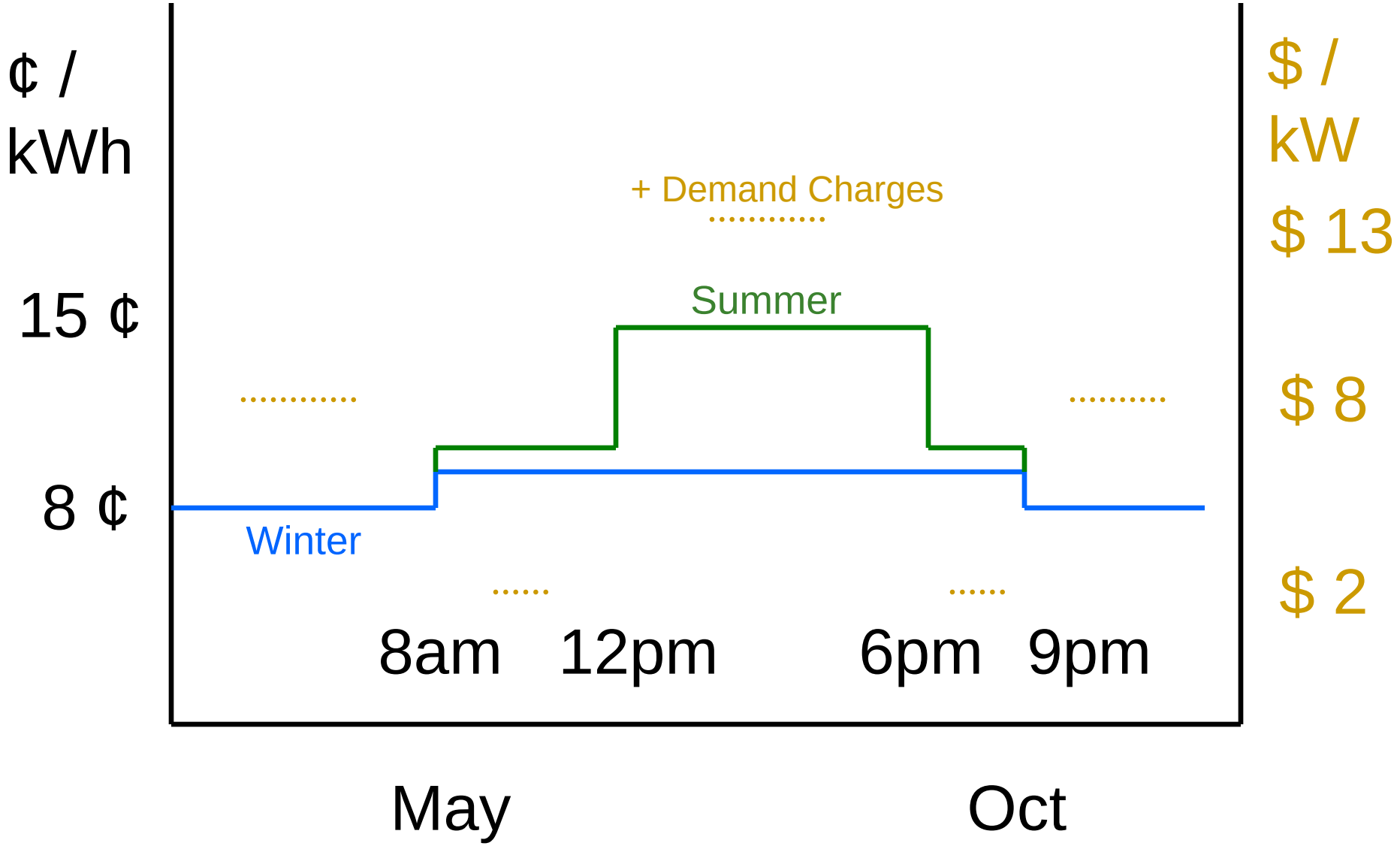
0%



10 P/E

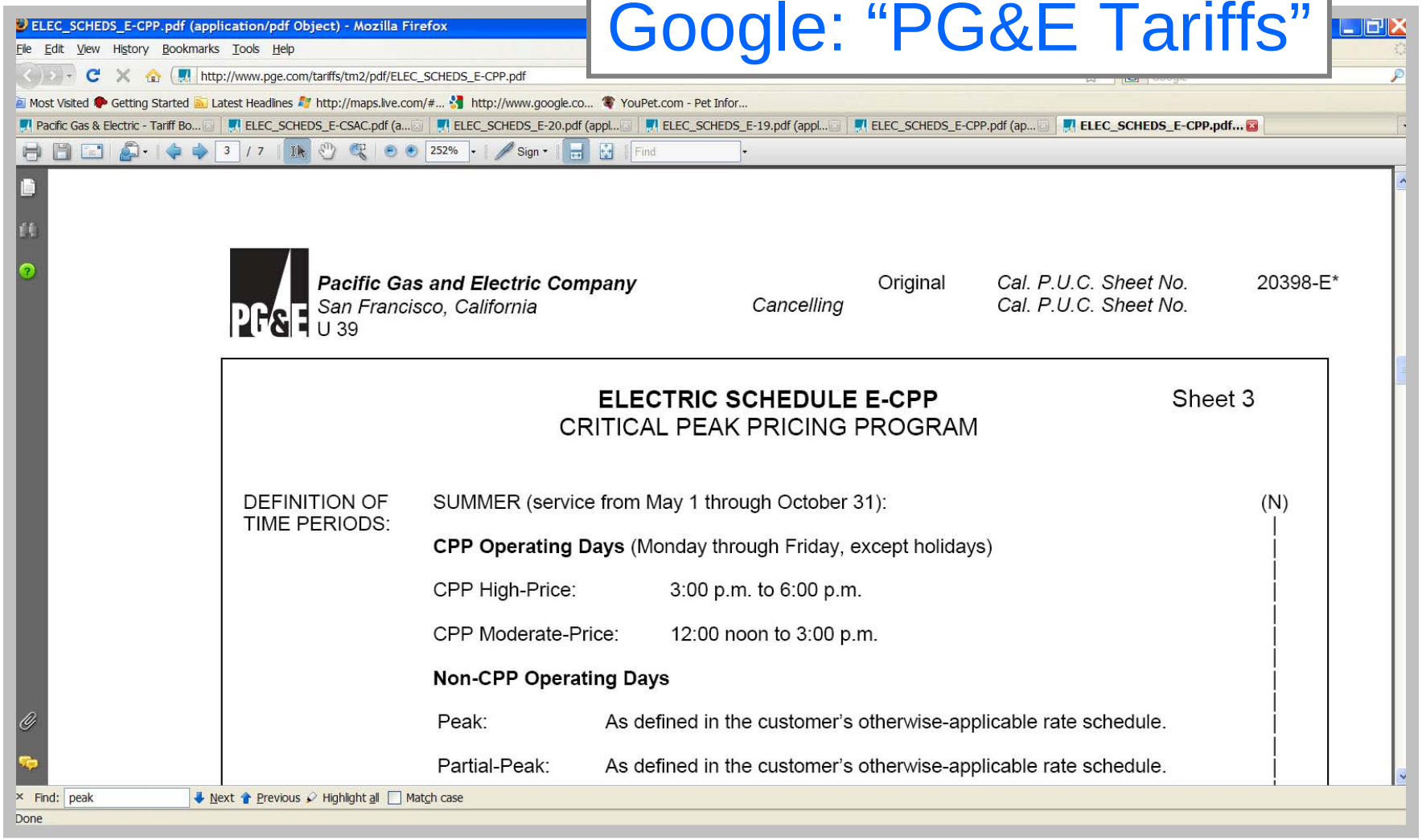
25 P/E

What energy rate should I use?



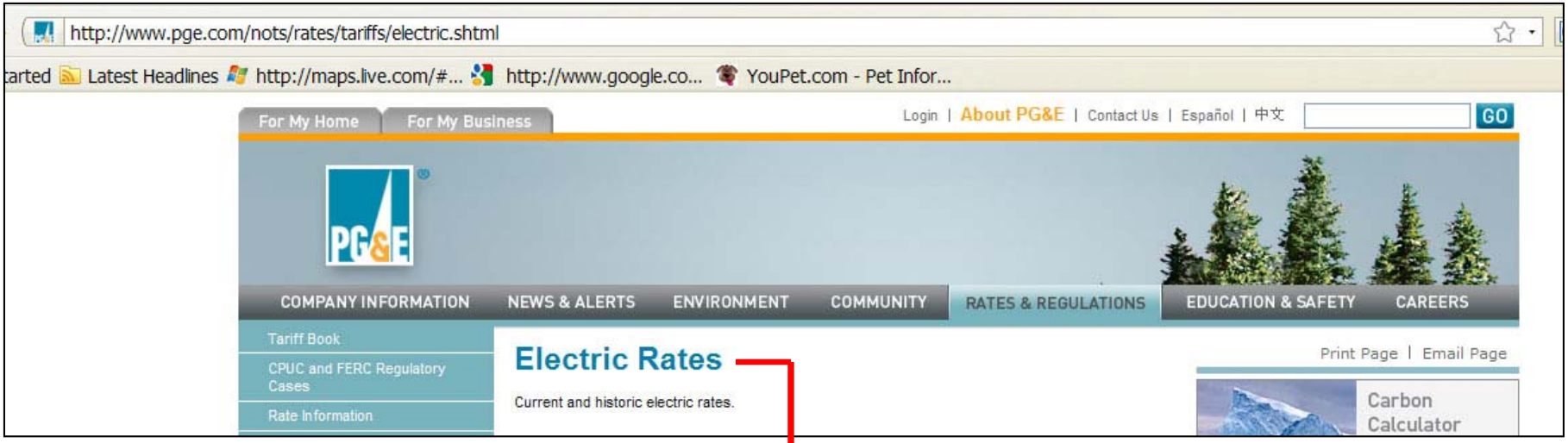
Energy Rates

Google: “PG&E Tariffs”



http://www.pge.com/tariffs/ERS.SHTML#ERS

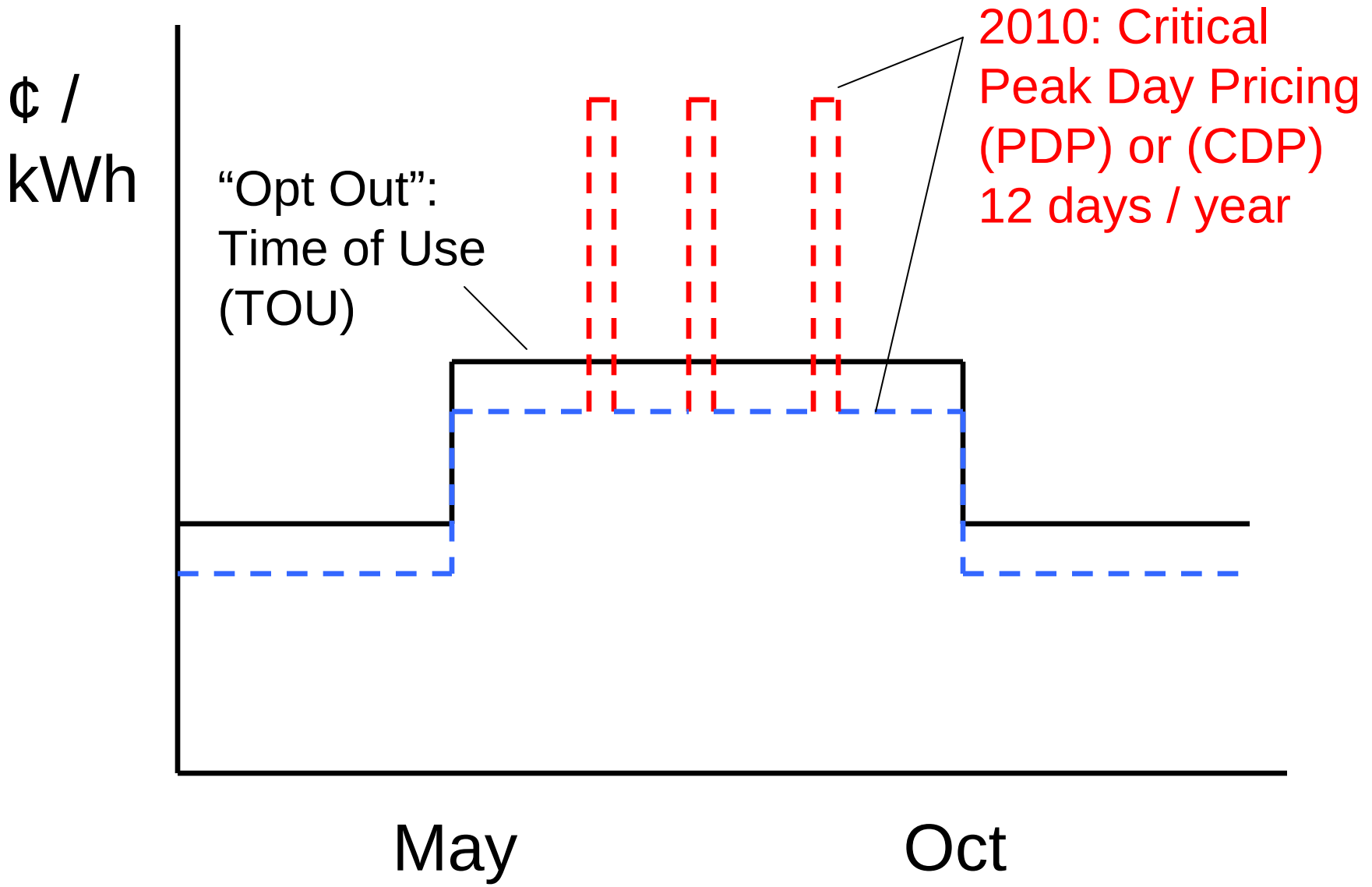
Energy Rates - PG&E Summary Table



Rate Schedule	Customer Charge/ Meter Charge	Season	Time-of-Use Period	Demand Charges ($/kW)	Energy Charges ($/kWh)		Average Rate Limiter[2/] ($/kWh)	Power Factor Adjustment ($/kWh/%)		"Average" Total Rate[1/] ($/kWh)
E20 Secondary Firm	$24.64066 per day	Summer	Max Peak	$13.11	$0.14860		$0.23416	$0.00005		$0.13330
			Part-Peak	$2.88	$0.10173					
			Off-Peak	-	$0.08233					
			Maximum	$7.94	-					
		Winter	Part-Peak	$1.04	$0.09044		-	$0.00005		
			Off-Peak	-	$0.07934					
			Maximum	$7.94	-					

"Average Total Rate"

Energy Rates – The Future



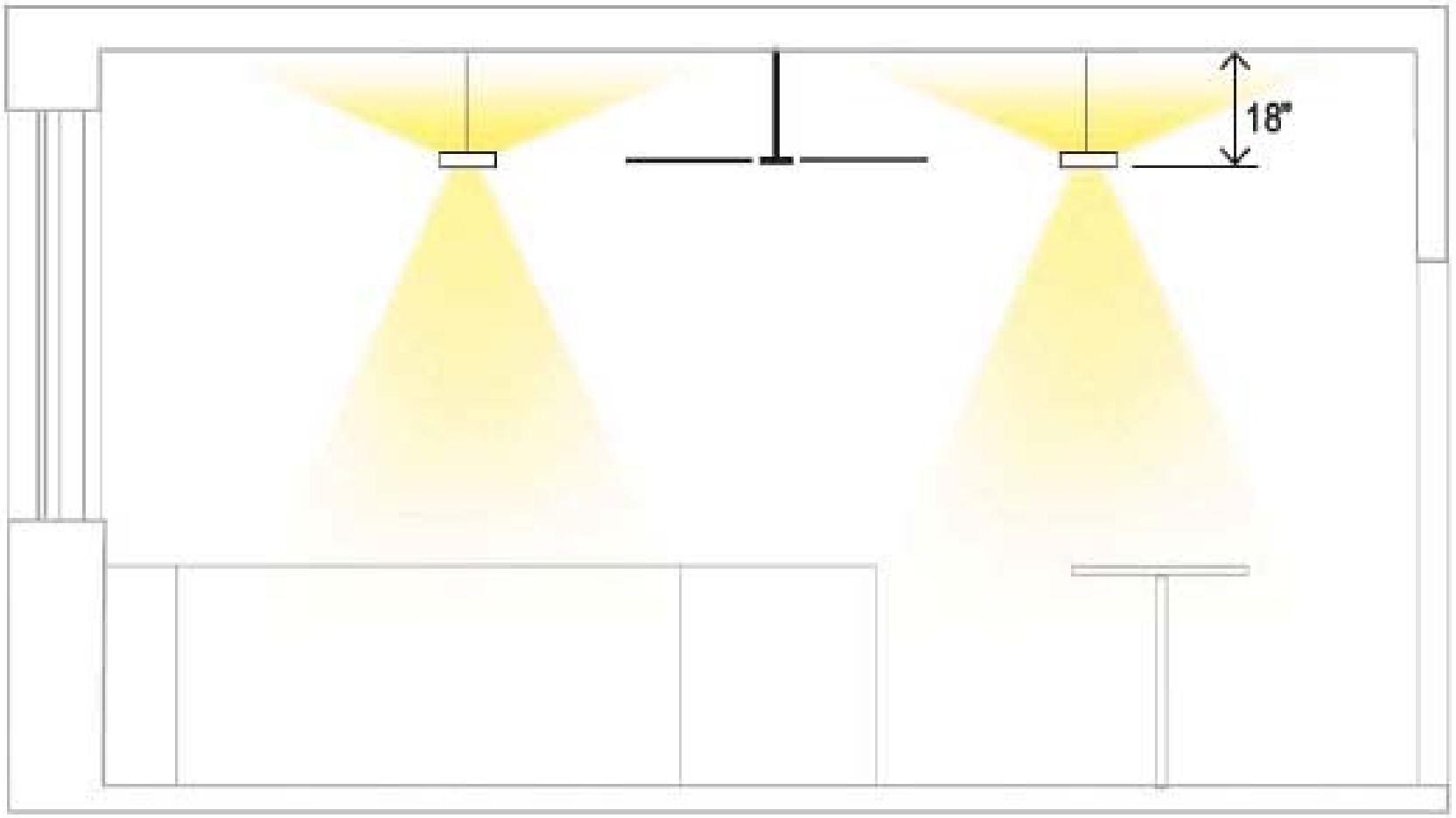
San Francisco International Airport

Charles de Gaulle Airport - Paris, France

Private Office Daylight Control?

Stanford Law School, Polshek Parternship Architects

Private Office Daylight Control?



SECTION (SCALE: 1/4" = 1'-0")

Private Office Daylight Control?

- **Option #1**

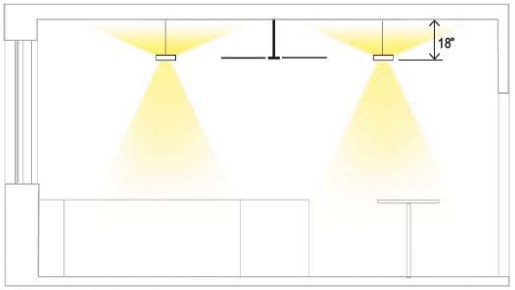
  Manual Dual Level Control

  - Ballast Replacement
    - 40,000 hours

- **Option #2**

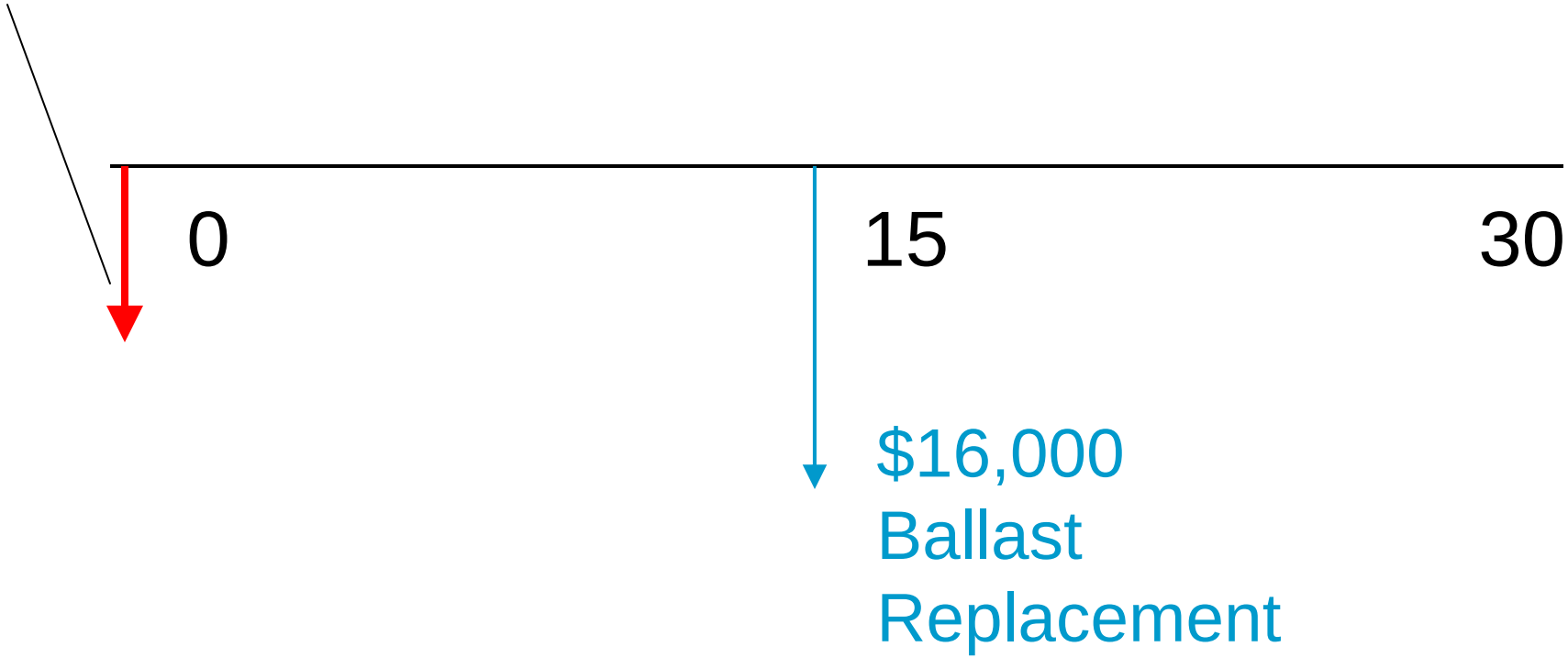
  Automatic Daylight Dimming Control

  - First cost
    - $4.0/sf office space (does not include Utility rebates)
    - $1.0/sf savings for HVAC & Conf Rm. Integration
  - Energy saved
    - 0.5 w/sf during day, 12.5 cents/kwh
  - Ballasts Replacement
    - 40,000 hours
  - 30% below T24 target

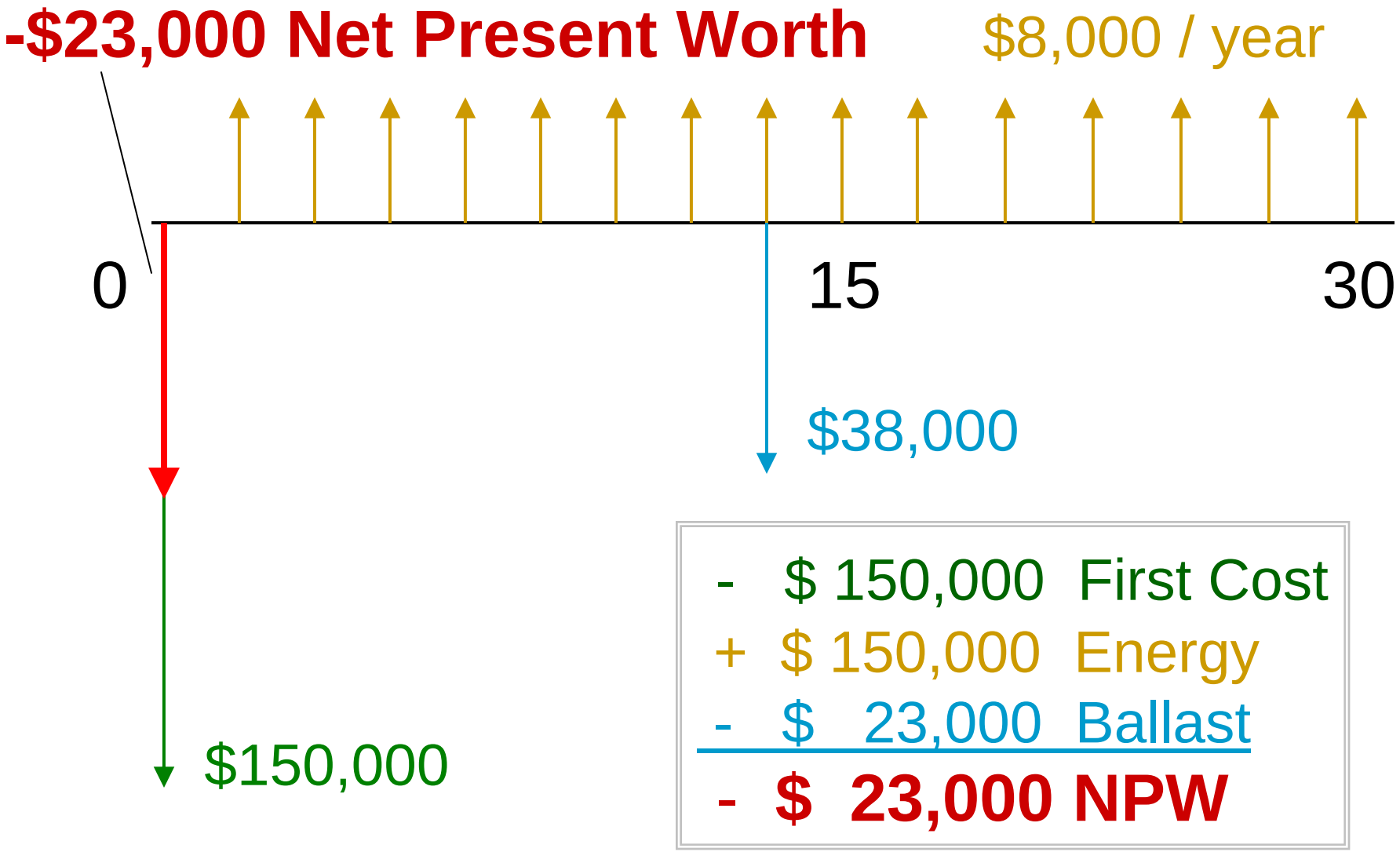


Manual Dual Level Control

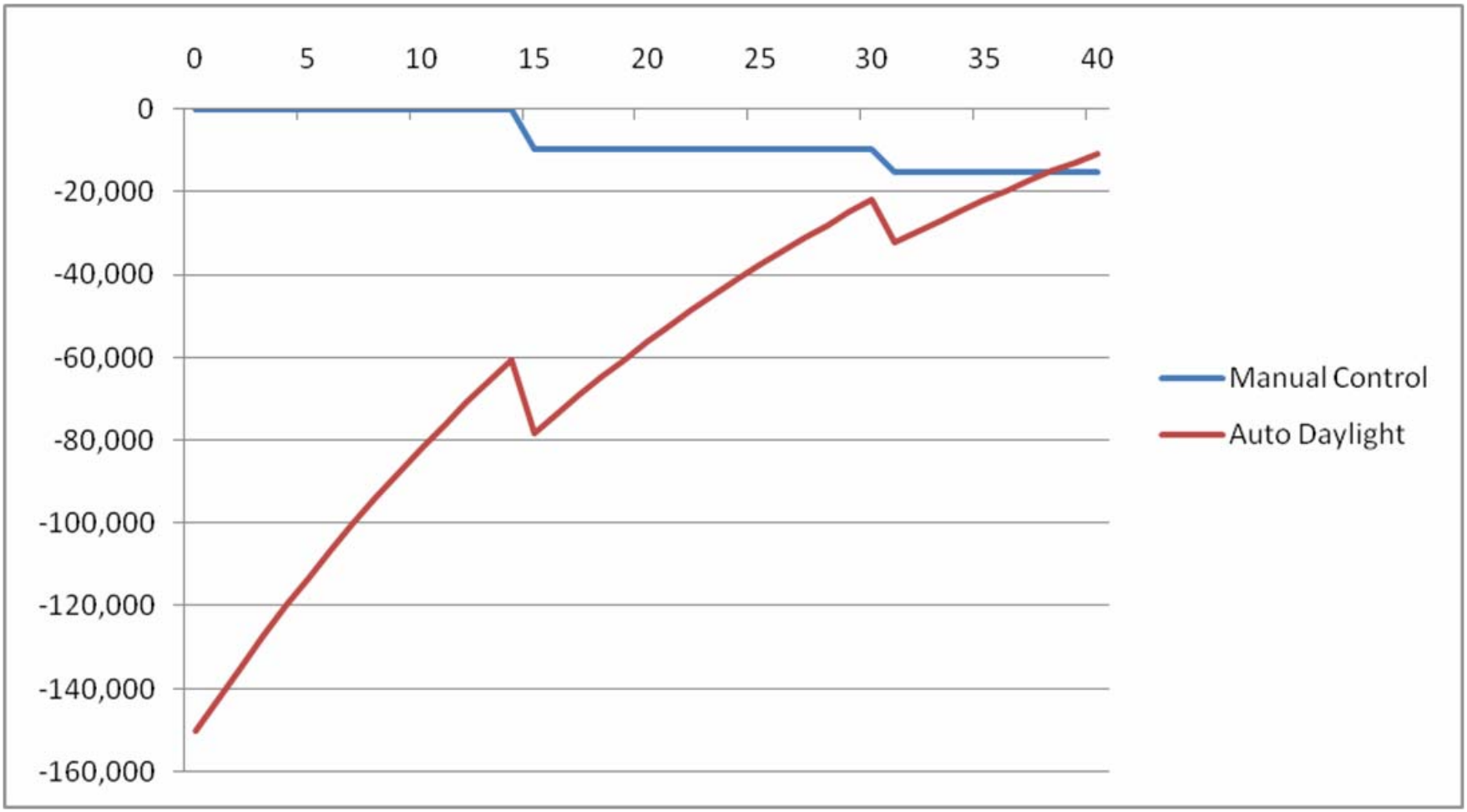
-$9,500 Net Present Worth



Automatic Daylight Dimming



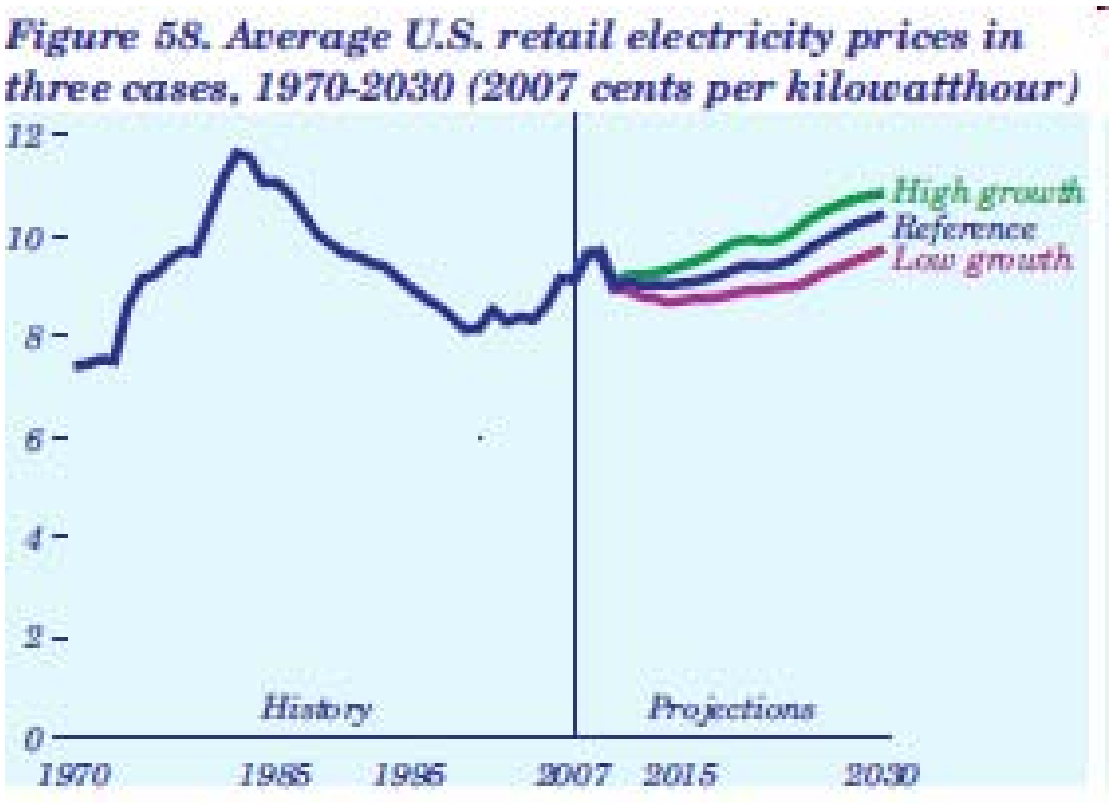
Automatic Daylight Dimming



Electricity Rate Differential Escalation

US Department of Energy :

http://www.eia.doe.gov/oiaf/aeo/electricity.html



- **Between 0.5% to 1.2% to 2030**
- **Did they consider global warming legislation?**

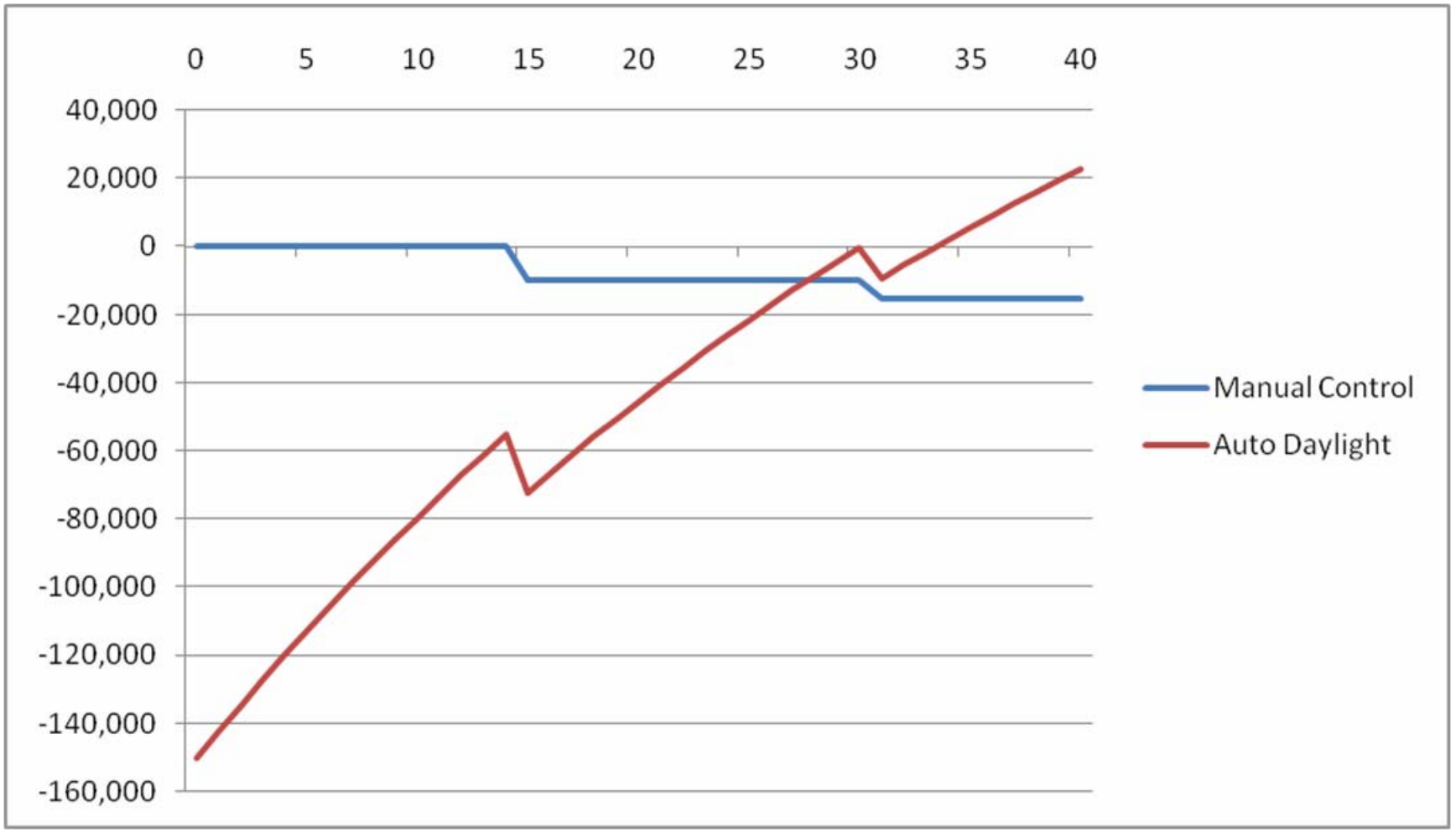
Differential Escalation Matrix

Differential Escalation = 1.2%

	A	B	C	D	E	F	G	H	I	J	K
1	Year	First Cost	Replacement Cost	Annual Energy Savings	Differential Escalation	Previous Year Energy Savings	Escalated Energy Savings	Annual Energy Savings Discounted Present	Total Cost	Total Discounted Present Value	Total Discounted Cumulative Costs Present Value
2	0	-150,000		8,000	1.20%				-150,000	-150,000	-150,000
3	1			8,000	1.20%	8,000	8,096	7,822	8,096	7,822	-142,178
4	2			8,000	1.20%	8,096	8,193	7,648	8,193	7,648	-134,529
5	3			8,000	1.20%	8,193	8,291	7,478	8,291	7,478	-127,051
6	4			8,000	1.20%	8,291	8,391	7,312	8,391	7,312	-119,739
7	5			8,000	1.20%	8,391	8,492	7,150	8,492	7,150	-112,589
8	6			8,000	1.20%	8,492	8,594	6,991	8,594	6,991	-105,598
9	7			8,000	1.20%	8,594	8,697	6,836	8,697	6,836	-98,763
10	8			8,000	1.20%	8,697	8,801	6,684	8,801	6,684	-92,079
11	9			8,000	1.20%	8,801	8,907	6,535	8,907	6,535	-85,544
12	10			8,000	1.20%	8,907	9,014	6,390	9,014	6,390	-79,154
13	11			8,000	1.20%	9,014	9,122	6,248	9,122	6,248	-72,906
14	12			8,000	1.20%	9,122	9,231	6,109	9,231	6,109	-66,797
15	13			8,000	1.20%	9,231	9,342	5,973	9,342	5,973	-60,824
16	14			8,000	1.20%	9,342	9,454	5,841	9,454	5,841	-54,983
17	15		-38,000	8,000	1.20%	9,454	9,567	5,711	-28,433	-16,971	-71,954
18	16			8,000	1.20%	9,567	9,682	5,584	9,682	5,584	-66,371
19	17			8,000	1.20%	9,682	9,798	5,460	9,798	5,460	-60,911
20	18			8,000	1.20%	9,798	9,916	5,338	9,916	5,338	-55,572
21	19			8,000	1.20%	9,916	10,035	5,220	10,035	5,220	-50,353

Cumulative Present Value

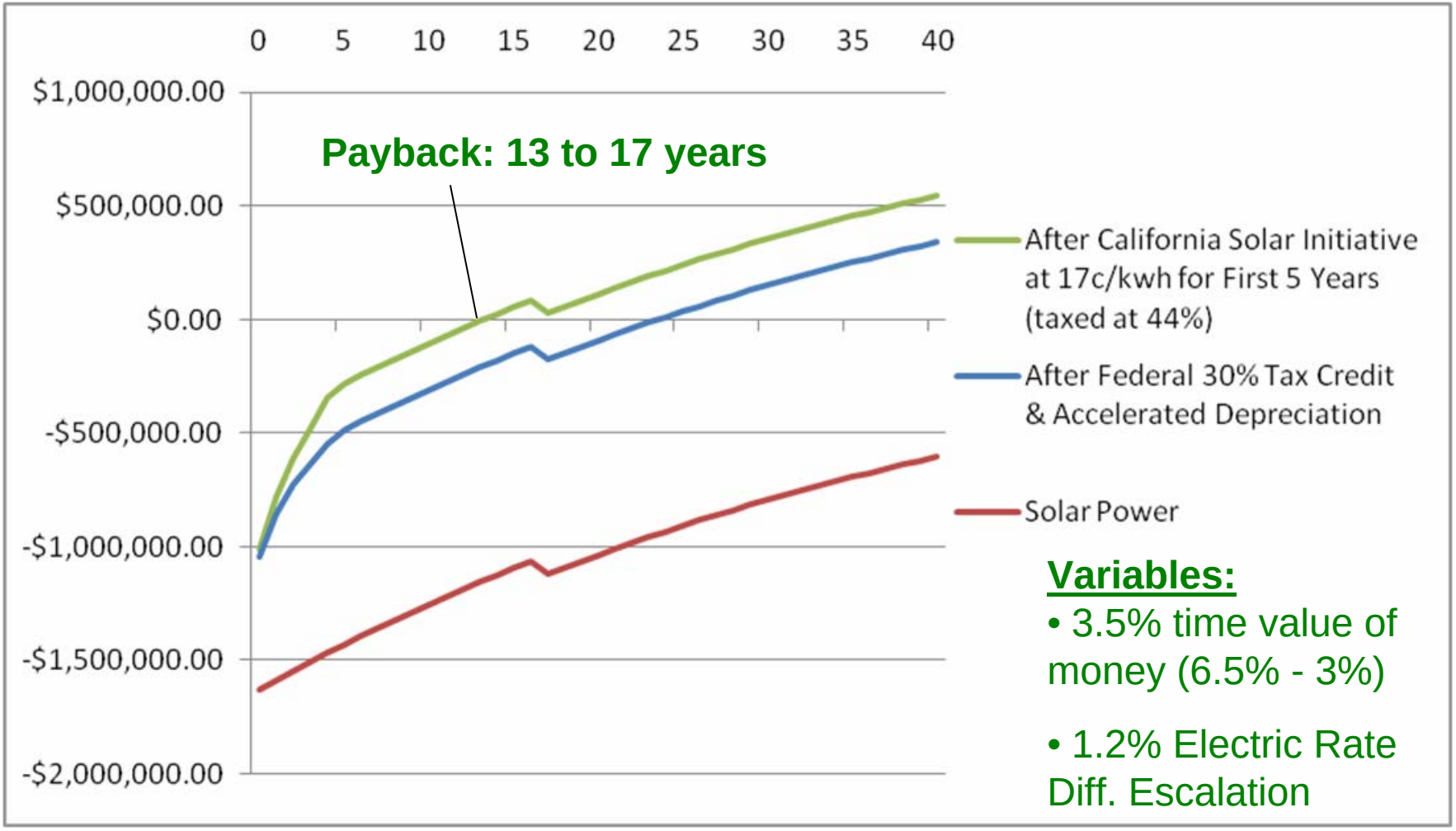
Automatic Daylight Dimming – Payback with 1.2% Energy Rate Diff. Escalation



Solar Power - Analysis Data

- **Life Cycle Cost Assumptions**
  - **$6.5/watt installed cost**
    - 250kW system = $1,650,000 first cost
    - 30% Federal Tax Credit
    - 5-year Asset Depreciation (MACRS) applies to 85% of install cost.
    - California Solar Initiative = 17 cents/kwh for first 5 years (program reduces with time)
  - **Energy Savings**
    - Located in Bay Area
    - 10 degree fixed panels
    - 340,000 kWh / year calculated with PVwatts online program
    - At 12.5 cents / kWh = $42,500 annual savings
  - **Maintenance**
    - 250kW inverter replaced at year 17 = $150,000

Solar Power – Payback Analysis



Life Cycle Cost Analysis

Q&A?

Presented by:
Jamie Fox, PE, LEED AP
The Engineering Enterprise