

Where is my payback?

Building or buying a home is one of the most consequential decisions, people ever make. Until recently, the considerations focused on location, re-sale value, esthetics, size, lot, number of bedrooms, and various features of luxury. The average family in the US lives seven years in one home, not long enough to appreciate the life cycle qualities of a building. Times are changing: a large number of people are now interested in energy efficiency, distance to the train station, and the walkability of the neighborhood. Fuel cost for transportation has risen 64% over the last year; Cost for natural gas is up 23%. This volatility is causing a market transformation, both in transportation and housing, toward more energy efficiency.

Still, in discussions about energy efficiency of a house, the most common question is: what is the payback of this and that? This paper discusses the payback question in relation to investing in a One-Watt-House™ - an ultra efficient house provided by CTI.

Let's take a closer look the question: We define Simple Payback as:

Simple Payback (years) = Initial investment / Annual relative energy savings

The calculation is used to compare investment alternatives and is acceptable for capital investments with relatively short life spans, like a light bulb. But for assessing the cost of ownership over the life span of a house, it is insufficient. The payback calculation doesn't include

- the remaining asset value after payback
- the volatility of energy cost vs. cost of capital
- any future cash flows after payback

Payback calculations assume yesterday's energy cost and investment and are obsolete within a short period of time.

Imagine having considered the purchase of a fuel-efficient vehicle 3 years ago when gasoline cost under \$2/gallon and ended up concluding it is better to buy the less expensive gas guzzler. No DOE, EIA data, simple payback would have guided us correctly in that purchase decision. Nobody prepared or predicted the hyperinflation of fuel within such a short time. What did we learn?

Maybe that we should ask different questions:

1. What is the total cost of ownership and what are all consequences of the investment over the life span of the building? Monetary, non-monetary, personal and for the community, and for the environment we live in.
2. When energy costs continue to rise, how can we model various energy inflation scenarios? Especially for buying a house, it seems like a wise thing to do, as the purchase will affect us in so many ways.

3. What are commonly accepted calculation methods for comparing various investments?
4. How can we hedge our bets and reassess our values in light of what we see today?

In the business world, many investment decisions are made based on the Net Present Value, a method that accumulates all future cash flows of an investments and projects them to the present time by calculating the time value of those cash flows.

According to Wikipedia:

http://en.wikipedia.org/wiki/Net_present_value

Net present value (NPV) or net present worth (NPW) is defined as the total present value (PV) of a time series of cash flows. It is a standard method for using the time value of money to appraise long-term projects. Used for capital budgeting, and widely throughout economics, it measures the excess or shortfall of cash flows, in present value terms, once financing charges are met.

The discounted cash flow is very similar.

Formula

$$\frac{C_t}{(1+r)^t}$$

Each cash inflow/outflow is discounted back to its present value (PV). Then they are summed. Therefore NPV is the sum of all terms, where

t - the time of the cash flow

r - the discount rate (the rate of return that could be earned on an investment in the financial markets with similar risk.)

C_t - the net cash flow (the amount of cash, inflow minus outflow) at time *t* (for educational purposes, *C₀* is commonly placed to the left of the sum to emphasize its role as the initial investment.).

Our method

Starting out, we need a reference point from which to assess our investment. That reference is a house with HERS (Home Energy Rating System) score of 100, modeled with RemRate Energy modeling software and compliant with Residential Building Code 2006. The reference house is of identical size and with the same basic shape as our test house. Our test house of question, completed in Batavia, Illinois in 2008, is much more efficient than the reference house. It scores a HERS 42 or 58% less in total annual energy demand.

Next we determined the incremental cost that it took to achieve that difference between reference and our house. We have included only those items, which are relevant to the energy performance: windows, walls, insulation, HVAC systems and various other details. As expected, our more efficient house costs more, in our case 16%.

The standard Net Present Value formula needed some work too. The discount rate and future cash flows will be affected by the inflation in energy cost and how this inflation rate

compares with the discount rate. We assumed that discount rate is the cost of capital or, in our case the average % rate of a 30year mortgage – the typical financing of homes.

The energy inflation e_i is a variable for which we introduced three scenarios – a low a medium and a high inflation presenting the probably spectrum of possibilities.

$$NPV = -C_0 + \sum_{t=1}^T \left(C_t \times \frac{1 + e_i}{1 + r} \right)^t$$

e_i - energy inflation
 C_0 - the initial investment
 C_t - cash flow at year t
 T - duration, life span of invest
 r - discount
 (OWH Cost-Spec. Home Cost)

If the NPV is greater than 0, it adds value to the owner it is less than 0, it reduces the value.

Example evaluation of a recent One-Watt-House™

	Local Reference House	One-Watt-House	Difference
Size	2,800ft ²	2,800ft ²	
Location	Fox Valley, IL	Fox Valley, IL	
Energy Efficiency	HERS 100 (complies with IBC 2006)	HERS 42	58%
Annual Energy Cost	\$3,245	\$1,502	\$1,743
Discount rate – 30year mortgage	6.5%	6.5%	
Annual building repair savings: resulting only from elimination of furnace and increased window life of 25year instead 15year			\$1,245
Total annual operating cost difference in today's USD:			\$2,988
Incremental initial investment of 1WH over local reference:			\$53,140

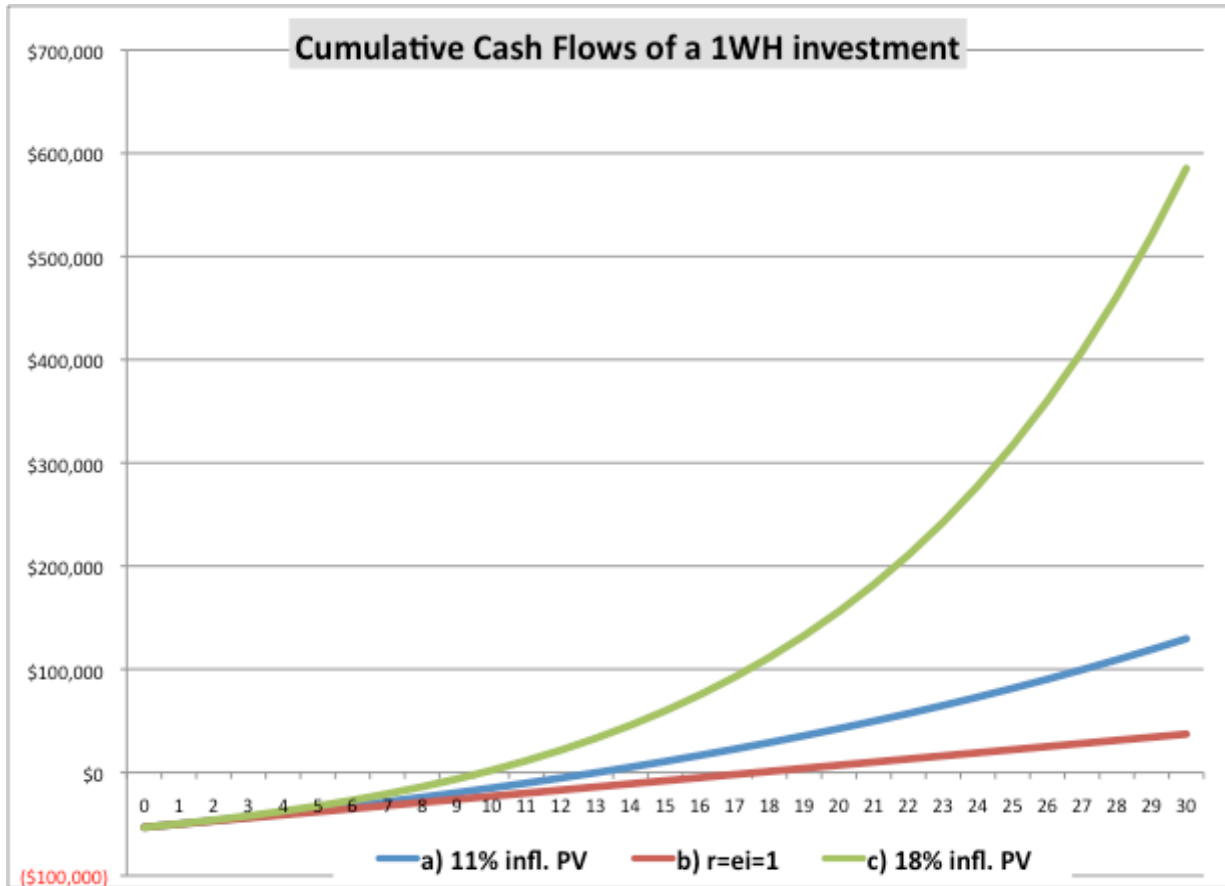


Chart 1: Present Value over a 30-year mortgage assuming 6.5% interest rates as well as three different scenarios for energy cost inflation. Comparing operating cost of a One-Watt-House to a local Reference House:
 a) 11% - extrapolated energy cost inflation based on last 5 years average increase
 b) 6.5% - interest rates equal energy inflation and result in linear PV increase
 c) 18% - high energy inflation scenario

Summary of results

	a) 11% energy inflation	b) 6.5% energy inflation = interest rate	c) 18% high inflation scenario
Time span of full amortization (payback)	13 years	18 years	10 years
Present Value after 30 years	\$129,546	\$37,143	\$585,310
Internal Rate of Return	10.1%	5.6%	17.1%
Remaining asset value after 30 years - relative to reference house	A	B	C
Net Present Value of 1WH invest	\$129,546 + A	\$37,143 + B	\$585,310 + C
Is NPV > 0?	Yes	Yes	Yes

It becomes evident that the investment in a 1WH adds value to the owner's assets even with a very short building life assumption of 30 years. The remaining asset value difference to the reference house (A, B, and C) is added upside to the Net Present Value. Presuming that free market rules work, it is expected that the remaining asset value of the ultra efficient house will rise higher, the higher the energy cost inflation is ($C > A > B$). For example: the market demand of leading hybrid cars as function of gasoline price increase. We are not speculating on that value difference but it provides a significant up-side to the already very attractive Net Present Value calculation of scenario A) and C).

Which scenario one chooses actually matters little: As long as the investor likes to achieve a positive Present Value within a 20 or 30 year mortgage, he will get it.

Our modified payback, which now includes the time value of money, varies between 10 and 18 years with plenty of cash flow left thereafter.

It is probable that, like in the European housing market for ultra-efficient houses, the market value alone will justify the extra effort for efficiency, which then makes the NPV calculation efforts an academic effort.

Intangible Benefits

Comfort and health: Simply looking at the investment prospects of owning a One-Watt-House is beneficial, but there are many qualities difficult to measure by dollar amount. The significantly higher thermal comfort along with healthier indoor air, due to constant fresh air supply make our life's better.

Investment Security

Inevitably our government will be moving to rebuild the standards on new and existing building codes, in order to achieve more efficiency. If we compare the US with Germany, where selling any building requires an "Energy Pass", inefficient and poorly build houses, significantly sell for significantly less. Expect our reference house value (HERS 100) decrease while a One-Watt-House's value will increase proportional to the cost of energy.

Adaptability

Passive energy savings is easily attainable through the right methods of building, but it is also the logical basis for those who want to own a Zero Energy House by using renewable sources, solar, wind, etc.. The ultra-efficiency is the basis for achieving that goal.

Summary

We realize that buying and building a home will always be personal and emotional. But, doing some extra research about resource efficiency and its life cycle consequences is necessary. What we build today, will likely stand throughout the 21st century with an uncertain energy future. One-Watt-Houses are not only better homes; they are also the most economical type of house over its life. The financial justification of a One-Watt-House becomes an easy task once we can abandon short-term thinking. Considering the

modest extra cost, 16% in our example, as well as all the added qualities, it might as well be your first option when building or designing your new home.

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