

“Simple Payback: The Wrong Tool for Energy Project Analysis?”

ABSTRACT

Industrial decision-makers everywhere depend on "simple payback" as a way to evaluate proposed investments in their facilities. Compared to more sophisticated financial measures such as net present value and internal rate of return, payback is comparatively simple to understand and calculate — perfect for "back of the envelope" analysis. But its inherent simplicity also creates problems. As a managerial decision tool, payback remains grossly inexact and misapplied, especially when thousands or even millions of dollars are at stake. As a result, the reliance on simple payback to evaluate energy-related investment decisions leads to making the wrong choice—and losing money as a result. As this article explains, the “save-or-buy” calculation provides a better way.

INTRODUCTION

Most plant and facility staff recognize “simple payback” as a measure that describes the number of years that it takes for an investment to "pay for itself" through the annual savings or benefits that the investment creates. To calculate it, one merely divides the total cost of a proposed investment by the annualized net savings (or benefits) that the investment will provide.

An organization may, for example, observe a “two-year” payback criterion. If so, the organization makes an investment only if the value of its annual benefits pay for the investment in two years or less. Payback criteria tend to be durable—they remain fixed year after year. Meanwhile, interest rates and energy prices vary every day. As a result, so do an organization’s cost of capital and the profitability of its operations. By relying on simple payback, an organization explicitly ignores variation in interest rates, and consequently, the profitability of their operations. Why? Because payback measures *time*, not the cost of money (interest rates) or the profitability of an investment. Note that production targets and budget amounts are fixed in an annual format. So are performance evaluations and bonuses. By providing a measure of years, simple payback fits naturally with the priorities of a manager whose spending authority and performance criteria remain fixed in a calendar-driven framework.

More to the point, simple payback fails to describe the true investment potential of an energy efficiency improvement. Simple payback reduces investment choices to a yes/no decision. For any investment proposal, it gives the investor a choice: “Do I spend the money on this project,

or do I keep the money in my pocket?” If the proposed investment is a new initiative, such as the addition of a new production line or new branch facility, this yes/no proposition is logical and simple payback is an acceptable criterion. However, this approach does not work for the evaluation of proposed energy improvements. Here’s why: energy consumption is not a yes/no choice for an operating enterprise. By simply opening its doors, the enterprise commits to using energy and is exposed to the costs, liabilities, and opportunities posed by energy use. Energy-related costs are not a matter of *if* the money will be spent, but rather, *how much* should be spent—either to consume energy or to avoid the obligation of buying the energy. Managers typically question energy improvements by asking “How much does it cost?” This is only half the analysis. The remaining question is “How much does it cost to *not make* the improvement?” Simple payback does not answer this question. Energy-related investment decisions that rely on simple payback criteria can lead to bad financial choices.

If simple payback is not the *right* calculation for evaluating proposed energy improvements, then what is? The save-or-buy criterion, described in this article, is offered as an effective alternative.

TOWARD AN ALTERNATIVE EVALUATION

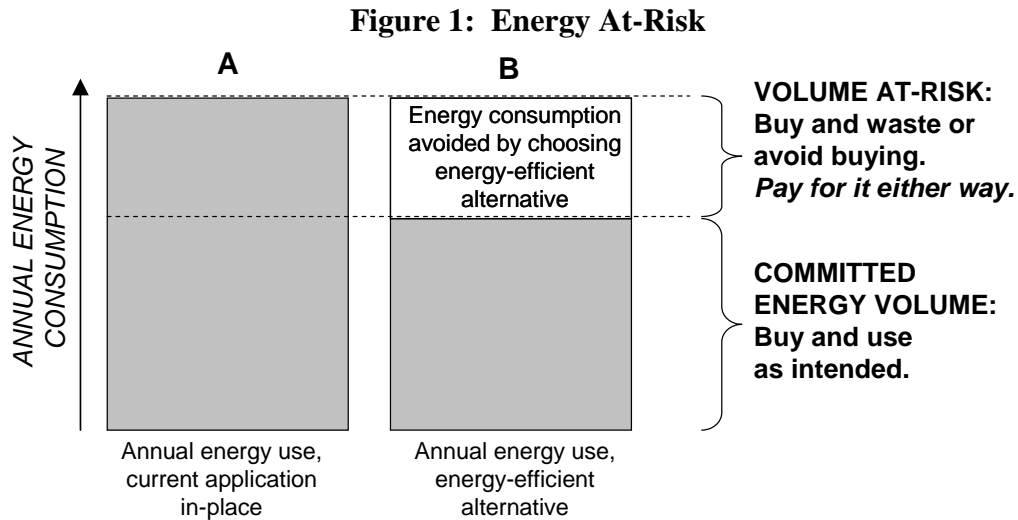
Think about why we perform financial analyses in the first place. Whenever a business invests in itself, it implies making a change. With change comes risk. Before committing money to creating change, top managers will want to know the risk of losing their investment, or at least the risk of failing to invest in more valuable alternatives.

Here’s how payback measures can frustrate energy management efforts. The greater the investor’s concern with investment loss, the shorter the payback time demanded. For example, a 12-month payback is preferred to a 24-month payback, and a 6-month payback is preferred to a 12-month payback. Now take this to its logical conclusion: **a zero-month payback would be best — because there’s no wait to get the money back!** The investor is assured of avoiding loss only by making no investment at all. Payback, as a risk management tool, only indicates if the investor should part with the money. It reduces investment analysis to a “yes/no” decision. As a consequence, energy management becomes a stop-and-go process. The company’s beleaguered energy manager has to reset his or her agenda back to zero with each project rejection.

Energy improvements need to be evaluated by a different standard. Why? Because once a business commits to operations, it commits to using energy, which is *not* a yes/no choice. All organizations experience energy waste, and some portion of that waste can be economically avoided. This portion is the *energy at-risk*. This concept presumes the following about energy-consuming business facilities:

- Energy consumption can be divided into a proportion that is purchased and used as intended (committed energy), versus the proportion that is currently wasted.
- Energy waste that can be economically avoided is *energy at-risk*.
- The facility **will pay** for energy at-risk, by either purchasing it, or paying the cost to avoid it. “Keeping the money” is not an option.

The energy at-risk concept is depicted here:



When considering the implementation of a specific energy improvement, the business choice is simple, as shown in the figure above: either (A) continue buying the energy volume at-risk at the prevailing price, or (B) implement an energy-reducing improvement when the cost to save energy on a per-unit basis is less than the price to purchase it.

SAVE OR BUY?

Here's what we want to do: develop a management tool for making energy cost-control decisions. This tool needs to compare the financial merit of implementing energy improvements against the choice of simply continuing to buy and waste the portion of energy at-risk as described above. Also, this tool needs to account for the organization's cost of capital and fit logically with the annual parameters that shape budget and performance accountabilities. That tool is the *save-or-buy* calculation.

The save-or-buy calculation requires the annualization of all relevant cash flows and investments, so that costs and benefits can be correctly compared on an "apples to apples" basis. As discussed above, most financial targets, measures, and budgets are already expressed on an annual basis. The total costs of large assets that will be in service for more than a year are typically financed over an equivalent number of years. To express the value of these investments as an annual equivalent, we use amortization — a calculation that organizes an investment's capital and interest costs in a series of regular payments of fixed amount.¹

¹ For this discussion, amortization is achieved on a monthly basis. The annual expense is then the sum of 12 monthly amortized values.

The cost to save a unit of energy is calculated in two steps. First, determine the total up-front cost to implement a specific energy-saving initiative, and annualize that project cost by multiplying it by a *capital recovery factor* as follows:

$$\text{ANNUALIZED PROJECT COST} = \left(\text{UP-FRONT PROJECT COST} \right) \times \left(\text{CAPITAL RECOVERY FACTOR} \right)$$

$$\text{CAPITAL RECOVERY FACTOR (CRF)} = \frac{(i/12) * (1 + (i/12))^{n*12}}{[(1 + (i/12))^{n*12}] - 1}$$

Where:

i = cost of capital or discount rate on future cash flows

n = economic life (years) of remedy (energy improvement project)

The second step is to distribute the annualized project cost over the volume of first-year energy savings (in units such as kilowatt-hours, therms, gallons of oil, etc.) that the project provides:

$$\text{COST TO SAVE A UNIT OF ENERGY} = \frac{\left(\text{ANNUALIZED PROJECT COST} \right)}{\left(\text{UNITS OF ENERGY SAVED} \right)}$$

Let's be absolutely clear about this: **use payback when the alternative to investment is to keep the money.** This is not the situation for an investment that reduces avoidable energy waste — because the alternative to the investment is to continue buying the energy that will be wasted! Proposed energy improvements should be evaluated by comparing the *annualized cost to save a unit of energy* to the *delivered price per unit for buying that same unit of energy*.

AN EXAMPLE

A community college contemplates replacing the current lighting configuration in its classrooms and office areas. The current fixtures each contain three T8 lamps in 24" by 48" bays with parabolic diffusers. While these fixtures could continue functioning for the foreseeable future, an alternative technology would employ two T8 lamps with a volumetric diffuser in each 24" by 48" bay. The current configuration draws 85 watts per fixture. The proposed alternative fixture consumes only 48 watts. There are a total of 2,581 bays to be swapped one-for-one. The relevant investment data is shown below. The up-front project cost is \$284,555, based on a per-fixture cost of \$100.75 for materials and disposal of old fixtures and \$9.50 for labor.

The college's investment criteria are as follows (see Figure 3 for a complete summary for this example):

- Current price per kWh (a summation of energy, demand, taxes, and fees, all expressed on an annual cost per kWh): \$0.1536.

- Economic life of the new light fixtures (n): seven years.
- Discount rate or cost of capital (i): 6% per annum.
- Capital recovery factor: 0.1753 or $\{[(i/12)*(1+(i/12)^{n*12})]/[(1+(i/12)^{n*12})-1]\} * 12$

The annual savings results are as follows:

	OLD	NEW	SAVINGS
kWh consumed:	811,725	458,386	353,339
kWh expenditure:	\$124,681	\$70,408	\$54,273

With these inputs, we get:

$$\text{ANNUALIZED PROJECT COST} = \left(\begin{array}{c} \text{UP-FRONT} \\ \text{PROJECT} \\ \text{COST} \end{array} \right) \times \left(\begin{array}{c} \text{CAPITAL} \\ \text{RECOVERY} \\ \text{FACTOR} \end{array} \right)$$

$$\$49,883 = \left(\begin{array}{c} \$284,555 \end{array} \right) \times \left(\begin{array}{c} .1753 \end{array} \right)$$

$$\begin{array}{l} \text{ANNUALIZED} \\ \text{PROJECT COST} \\ \text{PER ANNUAL} \\ \text{kWh SAVED} \end{array} = \frac{\$49,883}{353,339} = \$0.1412$$

In this example, the investor has two choices: continue to buy the energy at-risk (353,339 kWh that *could be* saved) at the current price of \$0.1536 per kWh, or pay an annualized cost of \$0.1412 *per kWh avoided* as the result of investing in the boiler replacement. The ratio of the price to buy versus the cost to save each unit of energy at-risk provides a cost-benefit measure:

$$\frac{\begin{array}{c} \text{COST TO} \\ \text{SAVE A kWh} \end{array}}{\begin{array}{c} \text{PRICE TO} \\ \text{BUY A kWh} \end{array}} = \frac{\$0.1412}{\$0.1536} = 0.92$$

Stated differently, this project would allow the investor to pay \$0.92 to avoid buying a dollar's worth of energy.

Note that the *annualized cost to save a unit of energy* effectively amortizes project costs, so that the annual budgeted value remains constant over the economic life of the project. Amortized project costs can be budgeted each year with certainty. In contrast, volatile energy prices will make it a chore to budget for energy purchases.

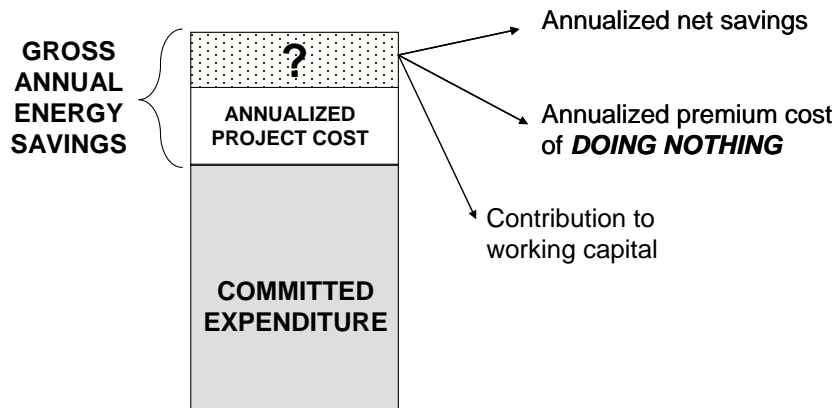
Note that the cost-benefit ratio described in the example above is 0.92. That may or may not be a large enough margin of savings in the manager's opinion. The point here is to demonstrate the decision tool itself. It is very easy to make an investment template using an electronic spreadsheet (see Figure 3). This allows a manager to update the investment analysis instantly in response to changes in energy prices, interest rates, and vendor quotes. Similarly, a tool like this

can support investment decision criteria. A management rule may, for example, declare that any improvement project with a cost-benefit ratio of 0.80 or less should be undertaken automatically, without the standard approval process. A decision tool like this can save money by reducing the time needed to seek layers of management approval. After all, energy waste doesn't wait for an organization to make decisions.

INTERPRETING THE VALUE OF ENERGY AT-RISK

While an organization may choose whether or not to implement an energy improvement, it should understand the final disposition of value in either case. To advance this discussion, consider Figure 2:

Figure 2: Interpretation of Energy Value At-Risk



The total height of the bar shown in Figure 2 represents the current, total annual energy expense incurred by an energy-consuming application. The portion labeled “committed expenditure” represents the value of energy that is actually required by that application to perform a desired amount of work. Accompanying the committed portion are *gross annual savings*, or in other words, the value of energy purchases that could be avoided if this application were to be replaced by a more efficient alternative. Those gross annual savings are achieved at a price, which is the *annualized project cost*. If the project in fact saves money, it yields value in excess of the project’s cost. There are several ways to interpret the role of that remainder:

- **Annualized net savings.** Quite simply, this is the annual reduction in energy expenditure attributable to the installation of an energy-efficient alternative.
- **The annual premium for doing nothing.** If the decision is made to reject the improvement and continue using the current application, the organization effectively forfeits the potential savings. The forfeited savings are a dollar amount that the organization will continue to pay to the energy provider. In effect, this becomes an annual premium that the organization will pay for “doing nothing,” or in other words, for relying on the existing configuration.
- **Contribution to working capital.** Working capital measures the organization’s liquid

assets that are available for day-to-day operational expenditures.² Working capital is employed at the organization’s discretion. Energy savings can be treated simply as new cash flow, in which case it is a direct contribution to working capital. The savings could be applied to the cost of additional analysis, design, or reconfiguration related to the specific energy improvement. Or, it can be applied to a budget for on-going energy management efforts. As multiple projects are considered, the savings potential for each can be accumulated to represent a budget for annual energy management activities. The best scenario may be one where the funds are divided across all these uses. Make sure that some value is assigned to cash flow, because to spend *all* the savings on additional project design and reconfiguration would defeat the purpose of the energy efficiency investment.

A manager can—and should—ask about the price tag for an energy improvement project. But this is only half the picture. A balanced approach also seeks the price tag for *not* making the investment. By refusing an energy improvement in favor of continuing with the assets (and operating cost structure) already in place, the organization alternatively purchases *nothing*, which in fact has a cost! For an electrical application, the *cost of doing nothing* is as follows:

$$\left(\begin{array}{l} \text{Price per unit} \\ \text{to buy one kWh} \end{array} - \begin{array}{l} \text{Annualized cost to} \\ \text{avoid purchasing} \\ \text{a kWh} \end{array} \right) \times \begin{array}{l} \text{Units of} \\ \text{avoidable} \\ \text{kWh} \\ \text{purchases} \end{array} = \begin{array}{l} \text{Annualized} \\ \text{Premium Cost} \\ \text{To Do Nothing} \end{array}$$

Using the example of the community college’s lighting retrofit opportunity, the cost of doing nothing is calculated this way:

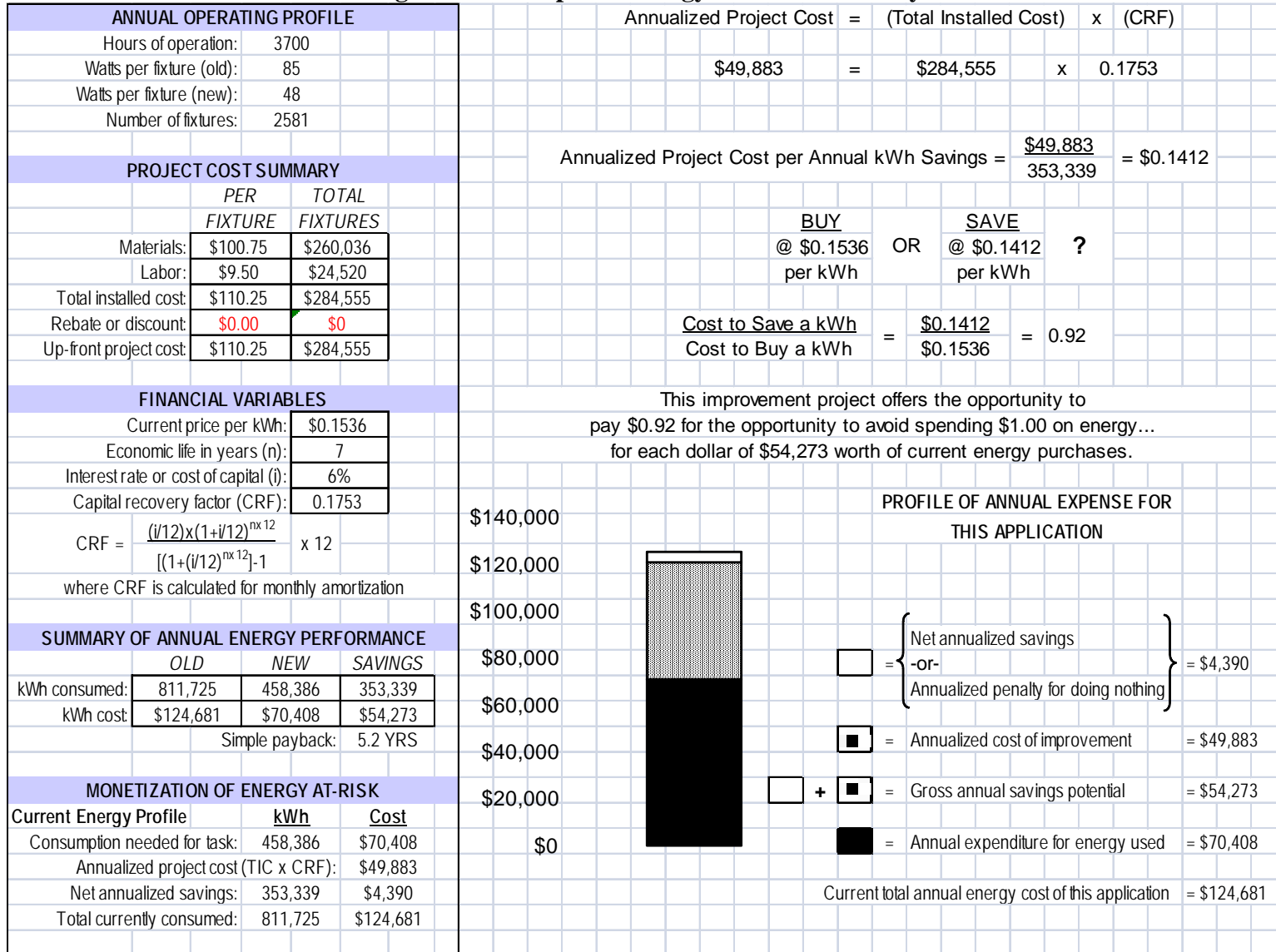
$$\left(\begin{array}{l} \$0.1536 \\ \text{per kWh} \end{array} - \begin{array}{l} \$0.1412 \\ \text{per kWh} \end{array} \right) \times \begin{array}{l} 353,339 \\ \text{kWh SAVED} \end{array} = \$4,390$$

The result, \$4,390, is an annual premium that the college will pay each year for seven years if it chooses not to invest in the lighting improvement. This result is based on current energy prices and interest rates. Naturally, of course, we expect those variables to change over time. Look carefully at the formula above: The cost of doing nothing will RISE both as (1) energy prices go up, and (2) as interest rates go down. To understand the latter point, recall that the *annualized cost to avoid purchasing a kWh* is predicated on the capital recovery factor, which incorporates interest rates. Keep this in mind when interpreting the annualized result for an improvement that will be in place for years to come.

The college’s lighting retrofit example is summarized in Figure 3.

² “Working capital” is an accounting measure that describes the net difference between short-term assets and liabilities that appear on an organization’s current balance sheet. Short-term or “liquid” assets include items such as bank accounts and accounts receivable. Short-term liabilities typically include accounts payable.

Figure 3: Example of Energy At-Risk Summary



CONCLUSION

An energy-consuming organization has one of two choices for the at-risk portion of their energy consumption. They are:

- **Buy it.** The facility chooses not to make the energy improvement. It will continue to buy more energy than it needs to accommodate its waste. For whatever reason, the organization is not motivated to change.
- **Save it.** Alternatively, the facility can implement efficiencies that allow the recapture of energy waste so that it can be re-applied to useful purposes. By “recapture,” we mean anything that reduces the loss of energy. Recaptured energy allows the facility to reduce its energy purchases by a corresponding amount.

Simple payback does nothing more than suggest how long it takes for an investment to pay for itself from the savings it provides. It cannot indicate profitability, so it is useless as a tool for comparing the financial performance of alternative investments. The most practical use of simple payback is to measure the risk of making an investment when the other alternative is to simply keep the money and not make an investment. As this article explains, once a business decides to operate, it commits to using energy, so “keeping the money” is no longer an alternative. It will either *buy and waste* the energy at-risk, or it will pay to reduce that volume of consumption. The save-or-buy criterion is the decision tool for making that choice.

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Christopher Russell is the principal of Energy Pathfinder Management Consulting, based in Baltimore, Maryland. His career features a consistent focus on energy program design, solution development, and project justification. Since 1999, he has become a nationally-recognized expert in the design and implementation of corporate energy cost control. Christopher has documented and evaluated energy management practices at dozens of facilities, and has advised corporations, utilities, trade associations, and government agencies in the planning and promotion of industrial energy programs. Christopher is in high demand as a writer, consultant, and keynote speaker at industry conferences. He is currently an energy columnist for *Maintenance Technology* and *Chemical Processing* magazines. He is recognized by the Association of Energy Engineers both as a Certified Energy Manager and a Certified Energy Procurement Specialist. Christopher joined the Board of Directors of the Fuel Fund of Maryland in 2006, and is also on the Advisory Board for the Texas A&M Industrial Energy Technology Conference. He holds an MBA and a Master of Arts from the University of Maryland, and a Bachelor of Arts from McGill University in Montreal, Canada. His energy management blog is found at: <http://energypathfinder.blogspot.com>