A Formal Strategy to Expedite The Evaluation and Selection of Components of a Comprehensive Energy Management Plan

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ABSTRACT

This article introduces a decision-making method to expedite the evaluation and selection of alternative energy and energy-cost savings opportunities in a comprehensive energy management plan. The method promises to reduce uncertainty in the selection of a single or field of alternatives because of its application of equal weight criteria, limited threshold ranking, and absolute disqualification rules. When applied in a strategic energy management plan, the method reduces uncertainty by the process of filtering and selecting the best opportunities for energy use improvement and evaluating them against multiple criteria of an organization's energy management objectives. The value of the method is in its simplicity and expediency to identify, assess, and then integrate into the energy management plan the most appropriate opportunities.

Keywords: Decision making, multiple objective analysis, energy methods, evaluation, management methods.

INTRODUCTION

An organization contemplating the development of a comprehensive energy management plan has a significant challenge in evaluating and selecting which energy and energy-cost savings opportunities to purse. Compromises and conflicts include expected organization acceptance of any energy behavior changes, immediate versus long-term finan-

cial benefits, fitting to present infrastructure (hidden costs of implementation), indeterminable future costs, and other issues. This article describes a decision-making method appropriate to energy management plans that was developed for fast and reliable filtering of alternatives in a complex decision environment (Walk 2011). The method is a modified outranking; i.e., a weighted attribute scoring method. In classical outranking methods, alternatives are evaluated by assigning a rank or score, on a continuous scale, in proportion to its compliance with individual criteria in a list of criteria relevant to the decision-making environment. The total or composite score for each criterion is calculated, and the alternative with the highest score is selected (Roy 1968). The criteria themselves can be ranked, where some criteria are more important than others, providing a more quantitatively sophisticated method.

The proposed filtering method is especially useful when the decision maker must evaluate and select from competing opportunities against independent criteria having different metrics, with uncertain and imprecise ranking information, and within other constraints, such as high risks, time pressures, resource limitations, rapidly changing criteria, external competition, etc. In these cases, traditional, multi-attribute decision-making methods might have limited applicability because of model information needs, criteria sensitivity issues, etc. The objective in using the proposed method is to achieve fast and reliable (valid) results that would minimize over- or under-investment of critical resources and increase the probability of successful measured outcomes. The method has shown excellent success, as reported by users evaluating and selecting new strategic initiatives in various organizations. Sample applications and results are described below.

The method is called the *Opportunity Wheel* method, with the process being visualized as a spoked wheel, wherein each spoke represents a criteria, attribute, or objective, and the level assessment is indicated by the spoke radial length. A well-designed wheel, one that assures smooth rolling, is a wheel of equally long spokes, while a poor quality wheel has one or more missing or shortened spokes. By analogy, a well-decided business opportunity is one that helps sustain the entire organization.

IMPROVEMENT OF ENERGY MANAGEMENT PLAN DECISIONS

Identifying and setting reduction objectives in an energy management plan is a complex and therefore difficult task. The decision making

combines a great deal of ambiguous data, such as future comparative fuel costs, compliance levels of end users to new behaviors (such as turning off equipment when not in use), technological change, etc. Trade-offs must be made among often conflicting objectives, such as immediate energy or cost reduction, return on investment, financial resource availability, legislative and regulatory compliance, etc. In a plan that attempts to meet many (and perhaps conflicting) objectives, such as life cycle cost, ease of implementation, return on investment, efficiency improvement, etc., most opportunities will be strong candidates for meeting some objectives but rarely for meeting all objectives. Typically, a decision matrix is employed, where opportunities are given weighted values against objectives, and a "winner" is chosen by the highest aggregate score. Greening (2004) and Pohekar (2003) present extensive reviews of multi-criteria, decision making (MCDM) and related techniques applied in energy management planning. Original approaches and results of using MCDM methods in energy planning and environmental issues are described by Hobbs and Meier (2000), Paruccini (1994), Huang, et al., (1998), and Georgopoulus, et al., (1997).

The proposed method can be used to alleviate some of the ambiguity and over-reliance on a strictly quantitative aggregate assessment, or on bias-prone qualitative methods; thus the method presented here is suggested for the development of energy management plans.

OPPORTUNITY WHEEL DECISION TOOL

The Opportunity Wheel decision tool is recommended to filter promising opportunities that meet some of the overall program preferred objectives but not all, and then not all of those to a high level of advantage. This tool greatly reduces the effort of selecting weighing factors by limiting choices to a tri-level scale: *Doesn't Meet* (or unknown), *Just Meets* (or level in dispute), or *More Than Meets*, a critical objective. Selection efforts are further enhanced by a filtering technique that excludes potential opportunities not delivering a sufficiently broad array of advantages, or representing too many objectives deficiencies.

An example is given below for a manufacturing enterprise, followed by a suggested array of objectives for an energy management plan. A sample analysis of an energy reduction opportunity is then presented.

The Opportunity Wheel tool for a manufacturing concern is depict-

ed as an arrangement of spokes about a hub. (See Figure 1.) The spokes represent the major mission areas of the company that are affecting or affected by new technology initiatives; the hub is the new idea or opportunity. The definitions of the organization mission or impact areas and the thresholds of each spoke criteria are achieved by team consensus. In the case of the manufacturing concern, the major impact areas to be evaluated are customers, sales channels, technology strategy [from technology forecasts; see for example, Modis (1992)], competition, profit, product portfolio, skills/resource plan, and production. Figure 2 lists the evaluation criteria and scoring template.

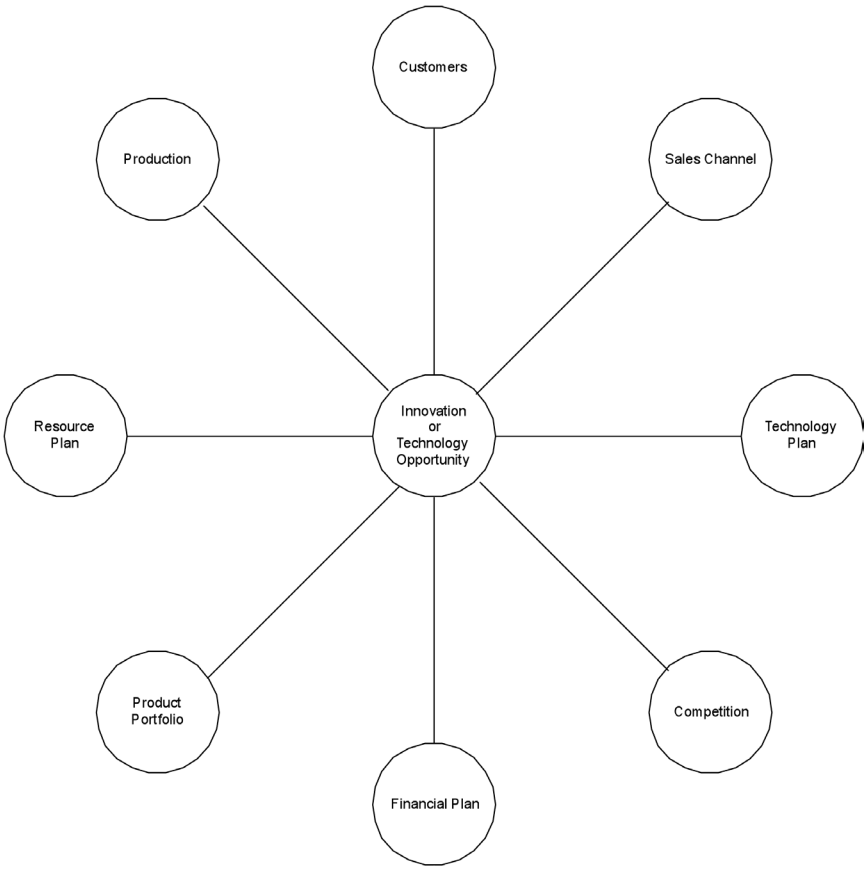

Figure 1. Technology Opportunity Wheel

1. Customers
   - 0 Customer opportunity not identified
   - 5 Solves a known problem or presents a known opportunity
   - 10 Builds a key relationship or works for all customers
2. Sales Channel
   - 0 Not a good fit with sellers' motivation or abilities
   - 5 Easy to sell
   - 10 Sells itself, builds a key seller relationship, or works for all sellers
3. Technology Plan
   - 0 Outside
   - 5 Fits
   - 10 Enhances
4. Competition
   - 0 No real advantage
   - 5 Meets competition
   - 10 Certain advantage
5. Financial Plan
   - 0 Unknown profitability
   - 5 Reasonable or customary profit
   - 10 >10% profit assured
6. Product Portfolio
   - 0 Outside
   - 5 Adds to portfolio
   - 10 Fits
7. Resource Plan
   - 0 Resources unavailable
   - 5 Resources available
   - 10 Frees up resources
8. Production
   - 0 Can't meet delivery
   - 5 Can meet delivery
   - 10 Can exceed delivery

Overall Score < 40 Points: Reject opportunity.
Overall Score = 40 Points: Consider ways to improve scores.
Overall Score > 40, with at least two 10's and no more than two 0's:
Pursue opportunity.

Figure 2. Technology Opportunity Wheel Criteria and Scores

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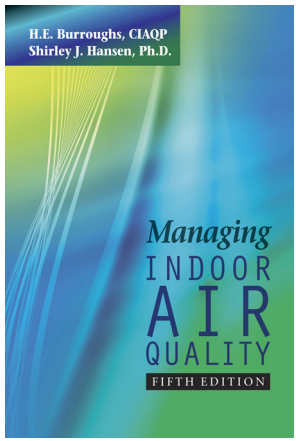

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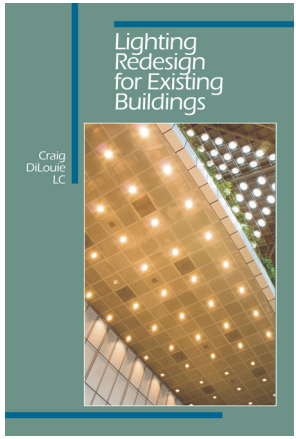

In this insightful and practical desk reference, veteran journalist and educator Craig DiLouie identifies, details and compares a variety of opportunities which can be effectively utilized, both to improve lighting performance, as well as to save energy in existing buildings. The book explains in clear terms the decision-making process behind whether retrofitting or redesigning an existing building's lighting system will yield the best, most cost-effective results. Included are a discussion of basic lighting design techniques, advanced lighting strategies, how to evaluate and compare lighting equipment, and the important role that planned maintenance can play in saving energy and ensuring long-term performance. Also covered are details of the current status of lighting-related legislation and energy codes.

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The decision-making process proceeds as follows.

1. A new opportunity is written in the middle circle.
2. The evaluation team assigns a point value at each spoke based on criteria specific to that area.
3. The scores are tallied to get an overall score for the idea or opportunity.
4. A failing score means the idea is rejected.
5. A marginal score means that low-scoring areas are reconsidered to see what changes can be made to increase the overall score of the idea.
6. A passing score means a development plan begins.

The criteria are scored on a simple, three-value (0, 5, 10) point scale. Usually "10's" and "0's" are quickly identified and consensus easily achieved. If the group is divided or deadlocked on a score, a compromise "5" is assigned and discussions quickly move on to the next impact area.

A high overall score, or O-score, in itself is not sufficient to pass the test. A new product or technology could score high in many areas and fail in several others. To select a "lop-sided" idea could spell disaster for the company, as the zero-score areas face possible serious disruptions or fail to meet objectives. To avoid such problems, a new idea is rejected if it has two or more "0" scores. In addition, the new idea must have at least two "10" scores to pass. It is of no use to pursue a new, mediocre (too few "10's") or high-risk (too many "0's") process or product technology.

SUMMARY OF COMPUTATIONAL ASPECTS OF THE PROPOSED METHOD

The decision space is defined by N criteria, ci, i = 1, 2, 3…N, and three integer performance assessment levels, ai = 0, 5, or 10. An alternative receives an acceptance outcome by meeting the threshold requirement

$$\sum_{i=1}^{N} a_i > 5N \qquad (1)$$

subject to the constraints

$$\sum_{\alpha=1:a_i=10}^{N} \alpha \geq N / k_i \tag{2}$$

and

$$\sum_{\beta=1:a_j=0}^{N} \beta \leq N / k_j \tag{3}$$

where integers $1 \leq ki \leq N$ and $1 \leq kj \leq N$.

The selection threshold is that the alternative have a composite score (its opportunity score, or O-score) greater than 5N, with at least N/ki "10" level performance assessments, and no more than N/kj "0" level performance assessments.

SAMPLE APPLICATION OF THE OPPORTUNITY WHEEL DECISION TOOL

A high-tech company serving in the electric power industry was considering expanding its product offering to include online measurement systems replacing standard handheld devices. It seemed to be the trend in other industries and thus made some strategic sense. The product manager, marketing manager, and technical specialists used the Wheel to evaluate this new product technology platform. The exercise resulted in the following:

- Customers: 10 (same customer base)
- Sales Channel: 0 (sales team technically inadequate)
- Technology Forecast: 5 (within forecasts)
- Competition: 5 (equal to the competition's recent initiatives)
- Profit: 5 (nominal profit expected)
- Product Portfolio: 0 (all new concept)
- Resource Plan: 0 (no proficient design engineers on staff)
- Production: 5 (requires some modification of production facilities and supply chain)

The new product concept was rejected because of a low O-score. With three "0's," it was decided that raising the overall score would in-

volve considerable time and expense, resources which could be applied to potentially higher-scoring initiatives.

Other sample applications of the Opportunity Wheel in education and other organizations' strategic plan development have been published (Walk 2001, 2011).

ADVANTAGES OF USING THE OPPORTUNITY WHEEL IN MULTI-OBJECTIVE DECISION MAKING

The list of advantages using the Opportunity Wheel as a filtering technique in developing an energy management plan is long. To mention a few:

- The old organizational politics such as influence peddling, intrigue, and favoritism are replaced with an objective, consensus-based process, optimizing company investment and resources in future activities.
- Planning documents will have less visionary language and wishful thinking but contain more specific, realistic, high-yield goals and objectives.
- All new ideas are given full attention and evaluated using consistent criteria, assuring all individuals that their ideas will receive equal due process in evaluations.
- After some experience with the Wheel, incomplete or otherwise poorly considered ideas do not even make it to the group for consideration, saving time and effort.
- Everyone involved in the process becomes familiar with and learns to respect the expertise, experience, and opinions of others—to see other departments not as barriers to overcome but as partners with whom to work together for success.

SAMPLE APPLICATION IN ENERGY MANAGEMENT PLANNING

Figure 3 depicts the proposed filtering process for an energy management plan application, in this case for a municipality developing a plan for its central government. The spokes represent the major mission

areas of the city affecting or affected by new energy and energy cost-saving initiatives. The hub, of course, represents a potential opportunity identified, for example, through research of best practices, suggestions from vendors, or ideas submitted by city personnel. In any organization, the definitions of the mission or impact areas (wheel spokes) and the thresholds of each spoke's criteria are achieved by team consensus.

Figure 4 lists a sample set of evaluation criteria and the scoring template compiled from the results of application of the tool at one municipality, and from decision criteria listed in published energy management plan reports by various municipalities (12, 13, 14). The major impact areas to be evaluated are end-user acceptance, technology curve, city plans, return on investment, budget, human resources, infrastructure integration, and behavior based.

Figure 3. Energy Management Plan Opportunity Wheel

1. End-user Acceptance
   - 0 Affected parties generally not supportive
   - 5 Evidence of support or little resistance
   - 10 General enthusiasm of affected parties
2. Technology Curve
   - 0 Early phase
   - 5 Mature phase
   - 10 Growth phase
3. City Plans
   - 0 Outside
   - 5 Meets a significant objective or goal
   - 10 Exceeds a significant objective or goal
4. Return on Investment
   - 0 ROI > 5 yrs
   - 5 2< ROI < 5 yrs
   - 10 ROI < 2 yrs
5. Budget
   - 0 Beyond budgeted funds
   - 5 Fits within budgeted funds
   - 10 Frees up budgeted funds
6. Human Resources
   - 0 Resources not available
   - 5 Resources available
   - 10 Frees resources
7. Infrastructure Integration
   - 0 Incompatible in general
   - 5 Fits, in general
   - 10 Enhances or enables further integration
8. Behavior Based
   - 0 Predominantly behavior based
   - 5 Somewhat behavior based
   - 10 Not behavior based

Overall Score < 40 Points: Reject opportunity.
Overall Score = 40 Points: Consider ways to improve scores.
Overall Score > 40, with at least two 10's and no more than two 0's: Pursue opportunity.

Figure 4. Energy Management Opportunity Wheel Criteria and Scores

In this example, a municipality was considering a partial fleet changeover from liquid fuels to natural gas to reduce motor fuel costs in the Department of Public Works. The scoring is given in Table 1.

Opportunity: Partial Fleet Fuel Changeover, DPW	Score
1. End-user Acceptance	10
2. Technology Curve	10
3. City Plans	0
4. Return on Investment	5
5. Budget	5
6. Human Resources	5
7. Infrastructure Integration	0
8. Behavior based	10
Overall Score:	45

Table 1. Energy Management Opportunity Sample Results

In Table 1, the Overall Score is 45, with two "0" scores, and three "10" scores; the choice would be to pursue this opportunity. The zero scores should be looked at first to identify creative means to improve the score in the near term. The "5" scores would be reviewed to see also whether these could be increased to "10" scores by some new approaches. Lastly, in comparison with all other "winning" (filtered for pursuit) opportunities, further cost financial analyses would be undertaken and a more detailed return on investment study carried out.

INTEGRATION OF OPPORTUNITY WHEEL RESULTS INTO THE ENERGY MANAGEMENT PLAN

The primary purpose of the proposed method is to filter the variety of energy and energy-cost savings opportunities and select only those that will best meet the organization mission goals. After all opportunities are evaluated using the decision wheel, the "winning" opportunities are then integrated into the energy management plan. Plans are custom-designed for the needs of the organization, more or less along the guidelines suggested in the StarEnergy program of the US Department of Energy (15). The DOE guide includes seven steps:

STEP 1: Make commitment
STEP 2: Assess performance
STEP 3: Set goals
STEP 4: Create action plan
STEP 5: Implement action plan
STEP 6: Evaluate progress
STEP 7: Recognize achievements

In the DOE plan, the decision wheel criteria would follow from the work in Step 3 and the opportunity evaluations conducted in Step 4. In Step 5, the scheduling, tasks, and resource allocations for individual opportunities would be completed, with tasks and times scheduled according to appropriate project management procedures.

CONCLUSION

This article has introduced a decision-making method to expedite the evaluation and selection of alternative energy and energy-cost savings opportunities in a comprehensive energy management plan. The method promises to reduce uncertainty in the selection of a single or field of alternatives because of its application of equal weight criteria, limited threshold ranking, and absolute disqualification rules. When applied in a strategic energy management plan, the method reduces uncertainty by the process of filtering and selecting the best opportunities for energy use improvement and evaluating them against multiple criteria of an organization's energy management objectives. The value of the method is in its simplicity and expediency to identify, assess, and then integrate into the energy management plan the most appropriate opportunities.

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