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Research Article

EVALUATION OF INTEGRATED RESOURCE PLANNING STRATEGIES IN RESPECT OF ENERGY DEMAND MANAGEMENT

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ABSTRACT
Today's advanced planning's either develop supply with minimum costs or notice Integrated Resource Planning (IRP). This means integration of technical options, including energy productivity technologies and load control in demand sector, and non-concentrated and renewable resources combined with potential resources. This also means diversity of components and costs, including environmental and social costs, for evaluation and selection of potential resources. The main goal of IRP is viewing economic concerns about energy return together with development of supply sector. In an IRP process, investments in energy productivity are evaluated by the same discount rate as supply discount rate while customers' needs for energy services are supplied. The reason that IRP needs government or energy supply centers that can select either investment in energy productivity opportunities or payment of electricity supply costs is that their final consumption practices do not merely depends current economic situations of buyers. Thus, we cannot expect that increment of taxes for emission of pollutants and energy prices lead optimum investment towards energy optimization strategies, even though increment of prices in necessary when subsidies are paid for energy. This justifies demand to other practices to help energy productivity activities, direct government policies, and industrial plans such as DSM and IRP processes.

Keywords: *Integrated Resource Planning (IRP), Evaluation, Demand Management, Energy*

INTRODUCTION
The complex nature of modern planning in electricity, to meet economic, social, and environmental goals simultaneously, requires applying a planning process to integrate these mostly opposite goals and to address different traditional and modern resources.

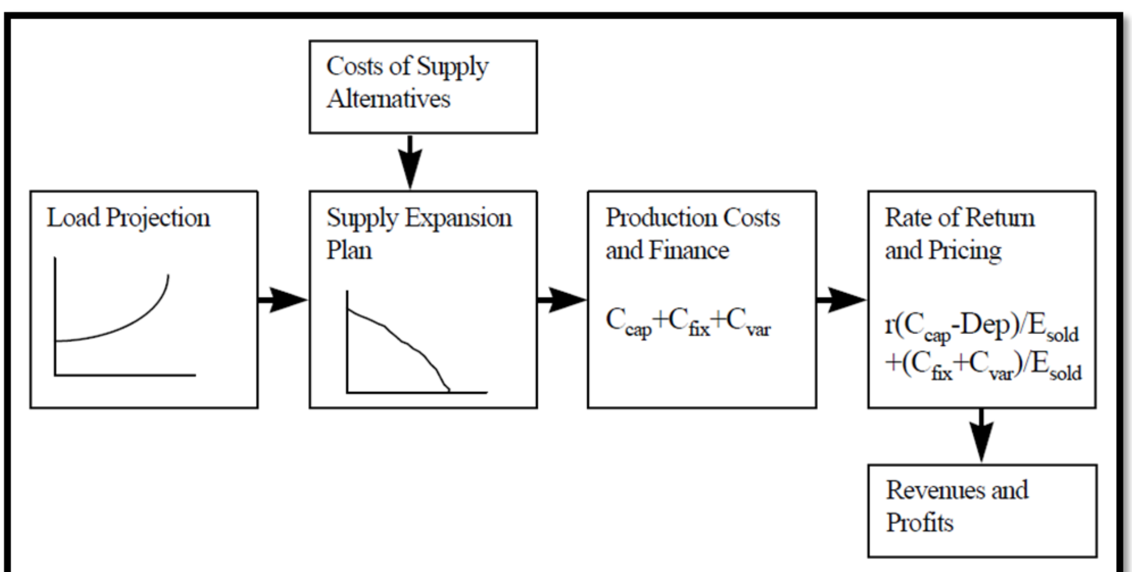

Figure 1: Traditional least cost planning model in electricity sector

Traditional electricity planning's have come toward high reliability supply resources and minimization of economic costs in order to provide increasing demand (figure 1). These criteria, which have been recently improved by economics scale in electricity production, were modified to this nearly integrated strategy, which must increase capacities to meet progressively increasing energy demand. Recently, these primary views have been removed by increment of supply costs and environmental limitations, and “least cost utility planning” concept has been reviewed in some countries.

Today’s advanced planning's either develop supply with minimum costs or notice Integrated Resource Planning (IRP) (figure 2). This means integration of technical options, including energy productivity technologies and load control in demand sector, and non-concentrated and renewable resources combined with potential resources (Production costs are sum of capital costs (Ccap), fixed performance costs (Cfix), and variable performance costs (Cvar). Traditional planning considers full recovery of these costs plus a fixed return to capital (r) and capital depreciation (Dep), and divides the result by total sold energy (Esold). This model helps describing desire of producers for increment of capacity in national and exclusive systems).

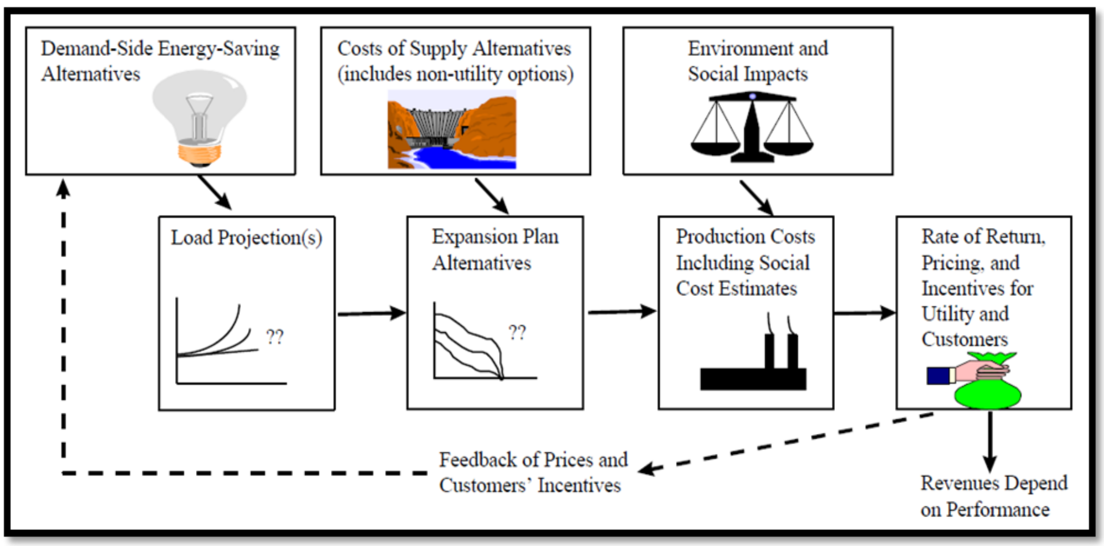

Figure 2: Integrated model of electricity load and cost with least cost

The results provided by IRP about market and non-market changes create a more desirable economic environment for development of optimum consumption processes and clearer supply technologies (including renewable resources). IRP means inclusion of these items and considering environmental costs means these discussions are more desirable than traditional supply views. The problem of using these changes in a market economy is that environment quality value is not transacted in market, because environment is a public social commodity and benefits of energy technologies are not completely attracted because of complexity of market and agency barriers. Therefore, we need legislation and planning to move toward clearer and more efficient technologies to remove these problems. This requires higher electricity prices, but price practices are not efficient alone in weak and incomplete competition markets.

IRP Process Framework

IRP is concurrent development of supply and energy return improvement strategies, including DSM, to provide energy services with minimum social and environmental costs. Implementation of an IRP process requires the following steps:

1. To gather valid data for electricity demand patterns and different technical strategies to enhance energy return or its load profile
2. To define and anticipate future energy services demand scenarios

3. To calculate electrical load effects and costs due to different demand types
4. To compare IRP costs with economic costs and environmental impacts of electricity supply
5. To design an integrated plan for demand and supply sectors to ensure least cost economic and environmental impacts
6. To implement least cost strategy

The planning horizon is determined by temporal and geographical parameters of than plan and IRP goals. Total electricity demand is declared by final detail consumption and technology.

Step 3 examines final consumption productivity technologies of strategies affecting load form. Economic and technical functions of these technologies are estimated and are prioritized by their economy. Then, DSM programs and other energy productivity enhancement strategies are analyzed by their acceptance and cost bases.

Step 4 analyzes production costs of existing and new power plants to prioritize them by their final production costs. These results are compares with final costs of demand sector, considering environmental costs. Finally, two sets of strategies (supply and demand sectors strategies) are compares, and electricity production plan is obtained by integrating them.

Integrated power planning must be studies before completion of final plans in policy-making, economic evaluation, sensitivity analysis, and complementary programs. Considering these discussions together may change these priorities or may remove some resources from the plan. Generally, this step can be addressed as "detailed setting" of IRP results in national and regional levels.

IRP Options

IRP provides a complete set of strategies for investment in energy services development. This section introduces some of principles of IRP process.

1. Integration of DSM programs and decrement of system losses by development of supply network

The main goal of IRP is integration of economic discussions about energy return improvement by development of supply sector. In an IRP process, investments in energy productivity are evaluated by the same discount rate as supply discount rate while customers' needs for energy services are supplied. Energy and supply planners classify the energy processes and services by their costs, and then select the least cost one. The reason that we need energy supply centers or governments, which can select either investment in energy productivity opportunities or pay more electricity supply costs, is that implementation of their final consumption practices are not merely depend to current economic conditions. The discount rate that is used by energy consumers for investment in energy productivity opportunities is between 20-200 percent, while the discount rate for producers is between 6-10 percent. Therefore, one cannot expect that increment of taxes for emissions and energy price lead to optimum investment in energy optimization strategies, although sometimes prices must be increased when subsidies are paid for energy. Thus, this justifies other practices that help energy productivity activities, direct governmental policies, and industrial plans, such as DSM, and supply side strategies in IRP processes.

The most common change obtained from application of IRP is energy productivity strategies through DSM. Planning structure is designed so that to reconcile load management activities, supply side return, and common electricity production and distribution methods. These planning methods help enhancement of optimum technologies and supply methods in developing countries. Today, environmental concerns play an important role in planning's of developing countries, and these concerns can be addressed in IRP framework.

2. Integration of private producers and concurrent production

In the recent years, best efforts were done by electricity producers to avoid concentrated power plants. This is due to two opposite trends. First is broad usage of DSM in USA and Canada, especially in the states that have prioritized environment concerns. Such a precise monitoring is not observed in other countries that don't encourage energy productivity through training, pricing, legislation, etc.

The second trend is deregulation, which exists in different countries, either industrial or developing. Even in USA, the state rules are very severe and encourage Public Utilities Regulatory Act (PURPA), presence of Independent Power Producers (IPP) and small producers. This caused competition in electricity supply and more deregulation.

Notwithstanding energy productivity and DSM, many countries emphasize dispersion and privatization of electricity sector. Deregulation assumptions have strong economic supports (Anderson, 1993). The main goal is that private sector would have stronger motives than public sector. Also regulations are cost-bearing and inefficient since they limit selection right of market. Finally, encouraging better functions develops innovation. Accomplishment of these topics is based on ideology rather than realistic analysis.

Because of higher demand rate in electricity services in developing countries, they need development of large and concentrated demand capacities. However, there are significant potentials for development of small enterprises in many countries, beside concurrent production and renewable energies. The other goal of IRP is comparing these resources with development of concentrated supply units.

Selection of Demand-side Strategies: DSM Economy Tests

As aforementioned, we can compare strategies of demand and supply sectors. In addition, we need economy criteria to identify the strategies that must be used in IRP planning. Different groups have different strategies to judge about economy of demand-side strategies. For example, producers (executive entities), consumers (participants or non-participants in a DSM program), and society follow their own goals in a DSM program. Therefore, an IRP plan must clearly indicate the criteria used to select demand-side strategies (Hirst, 1992). There are 5 economy tests in this research:

1. Participant test
2. Ratepayer impact measure (RIM) test (non-participant test)
3. Total resource cost test (TRC)
4. Social test
5. Utility cost test.

The goal of resources planning and investment is providing reliable energy services with minimum cost. Unfortunately, economy depends the views of observer; namely, the most economical DSM strategy by view of producer may be different by views of buyers. Also, buyers may have different views if they benefit for optimization activities of a producer or not.

1. Participant Test

This test measures the difference between incurred costs by a participant by participation in a DSM program and its benefits. The benefits include bill discount, incentives by producer or third parties, or tax exemption. The incurred costs are equipment purchase cost, operational costs, and maintenance costs.

By view of a participant, a program is economical when present value of its benefits is more than present value of its costs. This can be expressed in many ways; e.g. Net Present Value (NPV) must be greater than zero; or Benefit to Cost Ratio (BCR) must be greater than one. The problem in a test is selection of appropriate discount rate and future benefits. Participant test is very weak. It is unreal if a DSM program is successful but its participants lose.

2. Ratepayer impact measure (RIM) test (non-participant test)

This test measure the changes of utility prices by execution of a DSM program (e.g. cent/kWh or $/GJ). If a DSM increases benefits, those purchasers who haven’t changed their consumption would encounter excess bills. The other participants also encounter price increments, but since they consume less, they have lower bills (i.e. their bills are lower when the DSM program passes the test).

If benefits of a utility are less than the cost of a DSM program, then the producer will increase its prices. The benefits of a RIM test are, in fact, savings by decrement of energy supply of that producer. These inevitable costs are final costs of production resources that are replaced by DSM or other strategies, and they include decrement of production, transfer, distribution costs and making capacity for low-load periods (assuming the goal of DSM program is load decrement). The RIM test costs include DSM programs expenditures (incentives to participant, execution costs), and decrement of producer’s income.

In a DSM program that is economical by a RIM test, utility prices should not be increased by execution of this program. It means that bills of customers not participated in the program should not increase. Although this case is sometimes called “no loser test”, however in a real no-loser test, prices can increase

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while the increment by DSM is less than the increment without DSM. Prices can increase. In other words, without DSM, a producer may be obliged to construct a new power plant, and cost of all consumer will increase say 0.001 $/kWh. If DSM increases prices less than 0.001 $/kWh by the same service level, consumers that haven't participated in the DSM program may not protest.

Describing a RIM test nature is very useful. Assume a producer works in point A of figure 3. The slope of the line connecting the origin to point A shows the average cost of electricity before DSM. For example, assume final cost of electricity is very high, as the slope of income curve shows. If a DSM program can decrease electricity demand without any excess cost, this means that the producer's income must cover DSM costs and electricity production costs, that is point C. In point C, the utility cost (by slope of line) is less than the cost before DSM. In this scenario, all purchasers will benefit, even those that not participated in DSM program, because prices are low.

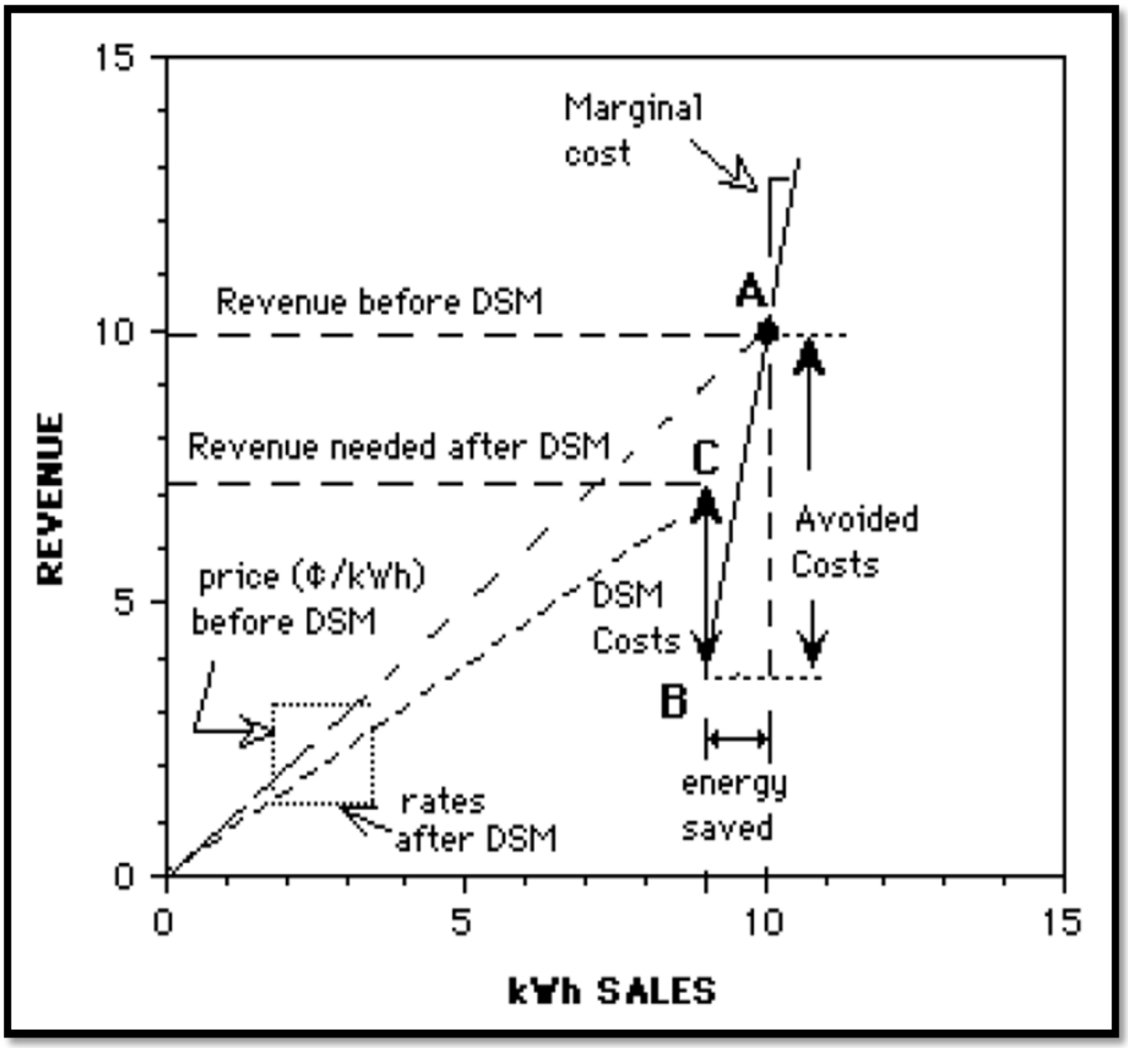

Figure 3: Example of RIM test when final costs are high

Note: If a DSM program moves the producer from A to C, then electricity price will be low even for those not participated in the DSM program.

Extending this example, we have: while saving cost for 1 kWh is less than the difference between final cost and average cost of electricity, RIM test is satisfied; namely, purchasers would not encounter price increment. In the above example, we assumed final cost is greater than average cost. But, if final cost is less than average cost, any lower consumption will increase prices even if DSM has no cost. This is shown in figure 4, which saving moves producer from A to B. Notice that total producer's income in point B is lower but prices have increased. This indicates an important point. Bills decrease after DSM, but bill of customers not participated in DSM will also increase while prices increase. Therefore, if average costs are more than final costs, DSM program is rejected in a RIM test. RIM test is a hard and explicit one.

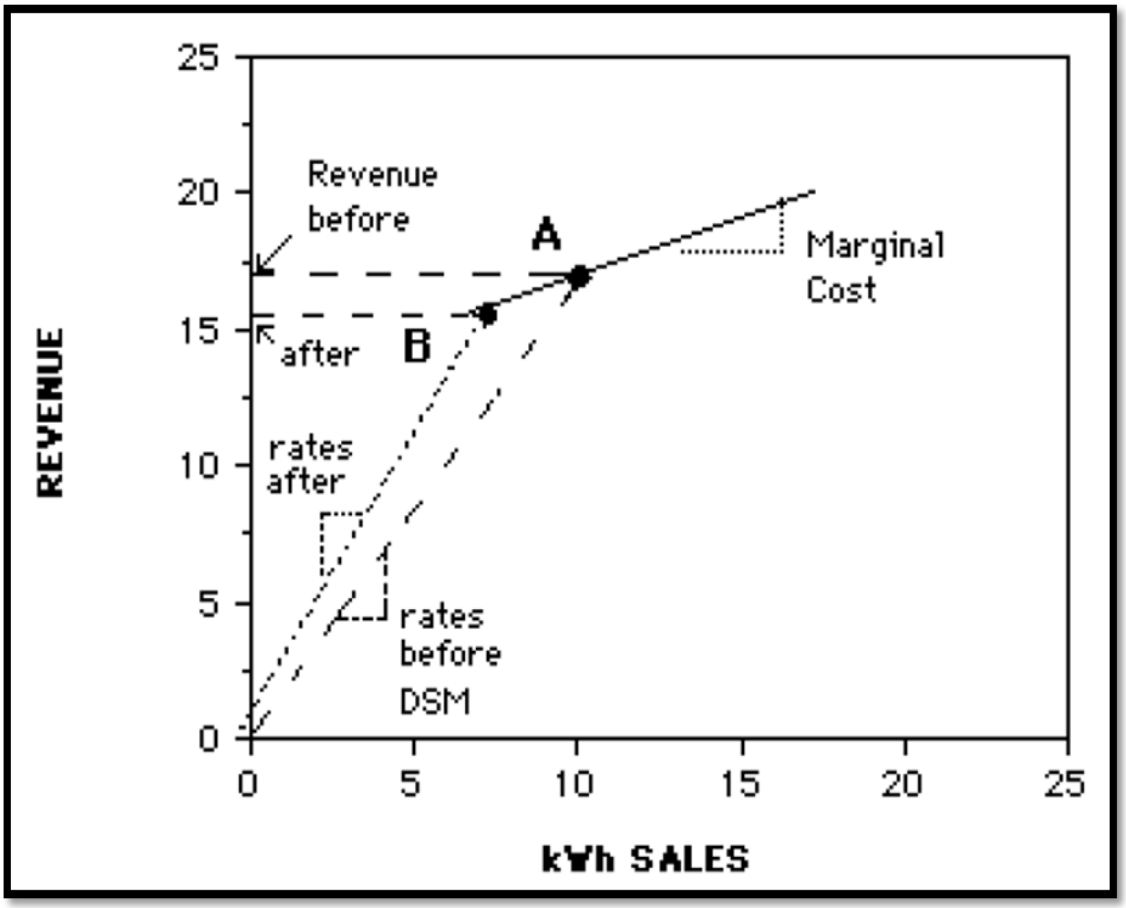

Figure 4: When final costs are less than average costs

Note: Any selling decrement from A to B will increase prices even if DSM has no cost. The average bill in B is less than that in A by increment of prices.

Total Resource Cost (TRC) Test

TRC (which is called "total ratepayers test") compares total cost of a DSM program (including the incurred costs for producer and participants) with supply-avoiding energy costs. By this test, a program is economical when its benefits, i.e. supply-avoiding costs, are more than the incurred costs for producer and participants). TRC test is the most common scale for determination of usefulness of DSM, because it indicated whether total producer's and consumers' costs have been decreased or not. In other words, TRC test is a combination of a utility cost test and a RIM test. It means that benefits are total supply-avoiding energy costs, but costs include producer's and consumers' costs. For example, assume a plan for development of using CFL tubes has 0.03 $/kWh costs. Consider a consumer purchasing a CFL tube and prorates its price (minus facilities) over its life; thus the consumer has invested 0.02 $/kWh. Then, as calculated in TRC test, total cost is 0.05 $/kWh. If a producer saves more than 0.05 $/kWh in its production, transfer, and distribution costs, then TRC is satisfied.

Note that a DSM program may be success in a RIM test while fails in a TRC test (figure 5). In contrast, a DSM program may fail in a RIM test but be success in a TRC test (figure 6). In other words, neither of these tests is harder, although DSM programs usually are success in TRC test and fail in RIM tests (figure 6).

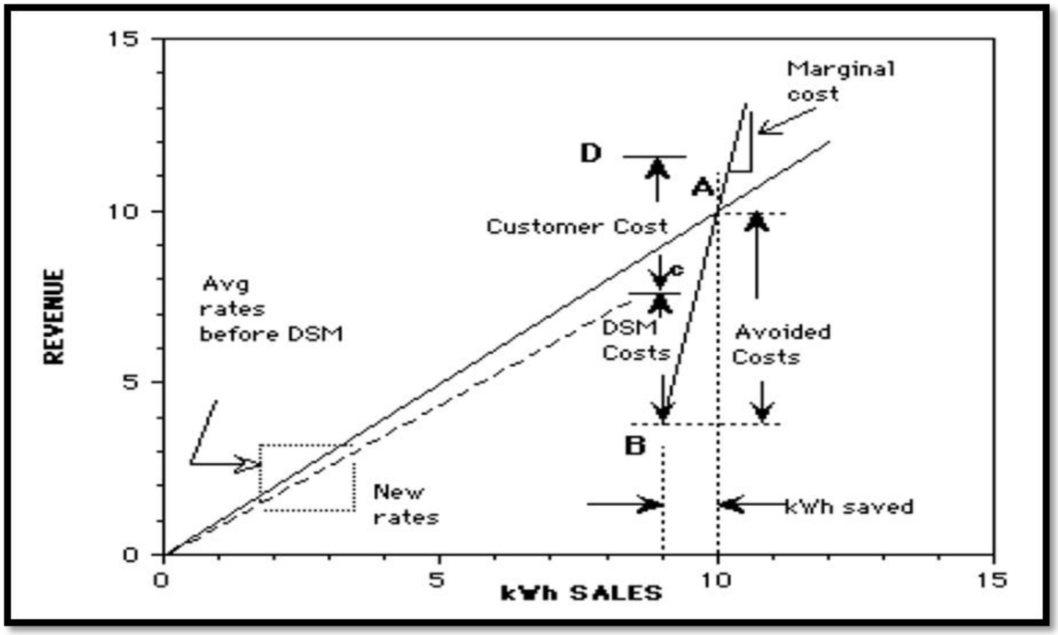

Figure 5: A fail in TRC test

Note: Point D is higher than point A, but was success in RIM test (new prices after DSM are lower than old prices).

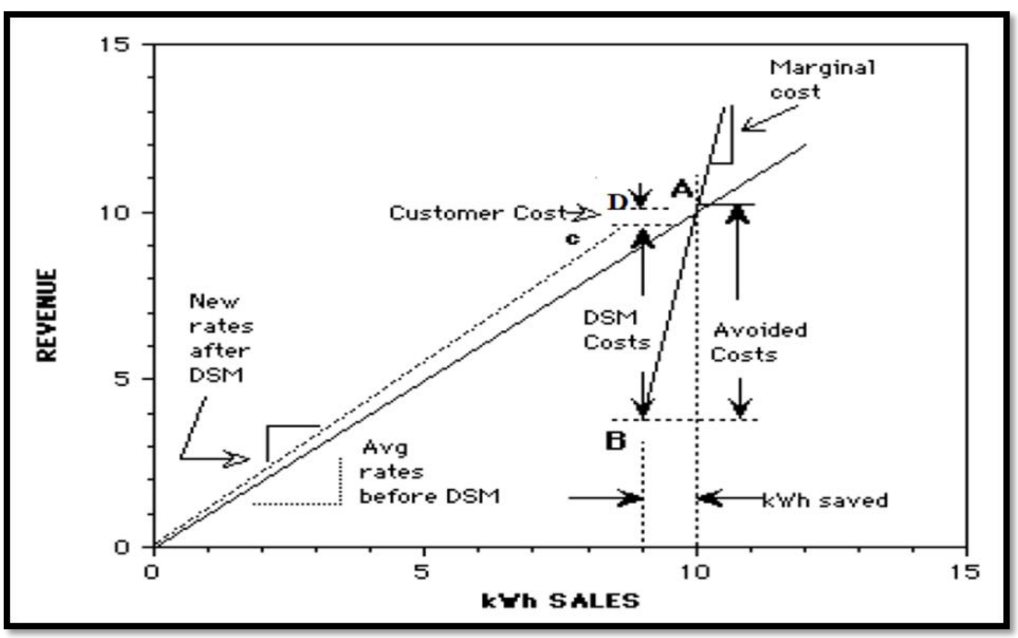

Figure 6: A success in TRC test

Note: Point D is lower than point A, but failed in RIM test (new prices after DSM are higher than old prices).

Social Test

This test is in fact, the modified form of TRC test, but social test can address exogenous factors (such as environment costs) in calculations.

Utility cost test

Utility cost test is another method for comparing costs and benefits. In this test, benefits are optimization-avoiding costs (fuel, performance, making capacities); and costs are utility costs and DSM costs (execution and facilities). This test is different with TRC test since it merely addresses utility costs, not purchasers' costs. When benefits are more than costs, this test is satisfied.

Table 1: The elements of major economic tests to evaluate benefits and costs of a DSM program by different perspectives

Perspective	Benefits	Costs
Participant	Supports from producer and others; bill decrement	Direct costs by participation of participant
Price strategy	Avoided supply costs (production, transfer, distribution) based on energy and load decrement	Producer costs (including incentives) plus lost income by lower sell
Producer's income	The same as above	Producer costs (including incentives)
Total resource cost	The same as above	Producer costs (without incentives) plus consumers' costs
Social costs	The same as above plus exogenous benefits such as lower emissions	The same as above

This means that producer's income and purchasers' bills have decreased. Despite drop of producer's income, real $/kWh may be increased after DSM (the case in which a DSM programs fails in a RIM test). Therefore, bills of customers haven't participated in the DSM program may be increased, while the average of customers' bills is decreased. Satisfaction of utility cost test is easier than TRC test. In fact, examples of fig. 5 and 6 both satisfy utility cost test; while only fig. 6 satisfies TRC test.

Summation and Conclusion

The following table shows a summary of economy tests (RIM, TRC, utility cost test). RIM test measures if prices go higher or lower after a DSM program. If a RIM test satisfies for a DSM program, then those people not participated in the program will not see increments in their bills. This test is success when final costs are more than average costs; and their difference is maximum money that can be spent in a DSM program.

In a TRC test, the question is that whether the society benefits by a DSM program or not. So, if total saving cost (paid by producer and consumers in a DSM program) is less than benefit of demand decrement, then that strategy is accepted. While the average of bills may decrease, prices may increase. Thus, those not participated in the program many pay more. TRC test is the most common test to determine DSM profitability. In a utility cost test, the question is that whether the benefits from avoided costs are more than the cost of a DSM program or not. Satisfaction of a DSM program means the average costs of bills will decrease. So, customers not participated in the DSM programs may pay more, while participants pay the cost of purchasing optimization equipment and producers pay DSM execution costs. Thus, society bears more expenses and the test satisfies the DSM program.

REFERENCES

ACEEE (1992). Summer Study on Energy Efficiency in Buildings. *Proceedings: Integrated Resource Planning, American Council for an Energy-Efficient Economy*.

ADSMP Program Plan & Implementation Manual / Glossary (No Date). Glossary of Demand-Side Management Terms.

Anderson D (1993). Energy-Efficiency and the Economics of Pollution Abatement. *Annual Review of Energy and the Environment* **18** 291-318.
Arrieta Felipe Valdes (1993). Saving Energy in Chile: An Assessment of Electricity Use and Potential Efficiency Improvements, IIEC.
Asian Energy News (1994). *The New Environmental Accouunting: A Status Report* **4**(10) 11.
Atkinson BA, McMahon J and Mills E (1993). Analysis of Federal Policy Options for Improving US Lighting Energy Efficiency: Commercial and Residential Buildings, LBL31469, Lawrence Berkeley Laboratory.
Barker Ann H (1993). Climate Crafted Homes: Using a Branded Product to Promote Energy Efficient New Home Construction. *Proceedings of Second National New Construction Programs for Demand-Side Management Conference, October 24-27*.
Barnes DF and Qian L (1992). Urban Interfuel Substitution, Energy use, and Equity in developing Countries: Some Preliminary Results. The World Bank Industry and Energy Department, PRS.
Beck FA and Arasteh D (1992). Improving the Thermal Performance of Vinyl-Framed Windows, Energy & Environment Division, Lawrence Berkeley Laboratory, University of California.
Berry L (1989). The Administrative Costs of Energy Conservation Programs. ORNL/CON294, Oak Ridge National Laboratory.
Joel N, Swisher Gilberto, de Martino and Jannuzzi Robert Y (1997). Redlinger, Tools and Methods for Integrated Resource Planning. *Improving Energy Efficiency and Protecting the Environment*.