REAL TIME PRICING AND DEREGULATING THE ELECTRICITY MARKET

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ABSTRACT

Real-time pricing of electricity may result in major efficiency improvements in the consumption and production of electric power. It can be realized by using current microelectronic technology to implement a dynamic power marketplace, with low entrance barriers and adaptive pricing reflecting the marginal costs of generation.

A complex and interrelated set of technical, political, economic, and regulatory questions surround the notion of real-time pricing of electricity. They are briefly outlined in this paper. A current bibliography of material relevant to these studies is also included.

Real Time Pricing and Deregulating the Electricity Market

The cost of information processing devices is dropping at least as fast as the cost of energy is increasing. As time passes, it becomes increasingly sensible to ask the question: "How can information be employed to improve the production, utilization, and distribution of energy?" One answer to this question is to use modern information technology to implement a deregulated market for electricity. To most effectively match supply and demand, such a market would incorporate an information network on the existing power grid and using it to transmit buy-back and selling prices for electrical power. Prices would be updated frequently, on the order of once every ten minutes. Individuals and organizations connected to the grid would receive and process this price information using simple microprocessor-based devices to make the decisions to draw power, provide power, or modify loads based on the prices and programmed strategies designed to minimize user's costs while meeting their operational requirements.

This concept is a unification and generalization of many suggested utility rate reforms--including peak load pricing, marginal cost pricing, and interruptible services. In providing a buy-back price for power generated by sources other than the traditional central generating station, the system opens the electricity market to energy entrepreneurs who feel they may have a technological advantage in experimenting with new energy sources. The largest such source would initially be industrial cogenerators, who now face a difficult or impossible task in arranging to sell their excess capacity. The ability to make these sales often determines the economic feasibility of a cogeneration venture. By some estimates, industrial cogeneration has the potential to save the equivalent of over one million barrels of oil per day.

The same buy-back mechanism which encourages cogenerators provides a simple market entry point for wind, solar, and other new power sources. If a fair and equitable pricing policy is adopted, there is probably no better way to encourage innovation in the production and use of electricity.

The same mechanism also facilitates and simplifies wheeling (i.e., exchange) arrangements between different utilities. Real-time pricing technology can contribute to the extension of wholesale, bulk power markets in the U.S., and also with Canada and Mexico.

Peak-load pricing and interruptible service are both subsumed by a real time pricing (RTP) system, which simultaneously eliminates many of the problems associated with these rate structures. A static peak-load pricing scheme does not reflect changes in the true marginal cost of power that occur within any fixed period, due to outages and short-term load variations. There are also problems with peak-loads moving out of peak price periods. With real time pricing (RTP), the price moves with the peak. Interruptible service is managed by local price- and process-sensitive microcomputer controllers which eliminate high transaction costs involved in current negotiated service interruptions. If it is deemed economically sound to shed a load locally to avoid higher prices, then the load will be shed. If it is worthwhile to continue to provide power to a process, then power will be available.

This real time electrical pricing system embodies the notion of an efficient market. Buyers get what they need by paying the marginal cost of meeting those needs. Providers are paid for the value of their power at the time it is provided. And since it is currently difficult to store electricity economically, timing is the primary determinant of the value of electric power. (It should be noted here that the existence of a port yielding cheap electricity at night and buying back expensive electricity during the day offers a considerable incentive for improving storage technologies.)

Research Areas

This is clearly a promising concept, but there are a lot of hard questions, involving both the policy objectives and the feasibility of attaining them. These fall into four broad categories:

1. Institutional. Because electric utilities have exclusive service franchises, deregulation involves a partial redistribution of property rights, requiring legislative reform and inviting judicial challenge. Because of states' rights, the power of the federal government is mainly limited to wholesale markets. Changes in federal and state laws, and antitrust enforcement require attention. Existing financial instruments, such as bond obligations, constrain changes of ownership. The electrical transmission and

distribution system will require common carrier status. The information transmission system will require legislation to protect the pricing system from manipulation to effect the theft of services. Standards to assure compatibility across electric systems, and with decentralized providers must be imposed. What incentives are required for individuals and organizations to respond to such a system? What is the relationship between the degree of deregulation and degree of technological support required to realize the benefits of deregulation?

2. Economic. This system is based on marginal cost pricing. How can prices be adequately defined and determined? What will be the behavioral response to this price system--how does this technology affect the elasticity of demand for electricity? What do theoretical studies of price elasticity and market incentives imply about the structure and operation of a real time electrical pricing system? How can pollution and other social costs of power generation be internalized in this context? What are optimal strategies for using dynamic price information and simultaneously achieving operational goals? What forms of brokers and contracts will arise in this market? Under what conditions will the benefits exceed costs?

3. Technological. This is a communications network unlike those which have been built in the past. What hardware architecture is required to support it? What

communications protocols? Since price information is being passed, the channels must be secure and immune from tampering. The implementation must be robust, reliable, and easy to use. What kinds of standardized packages can be designed to enable people to use the system? It will be a substantial task of human engineering to design a flexible and understandable control interface. A class of simple and inexpensive devices to couple sources and loads to the grid via the intelligent controller is required. For industrial applications, complex devices at higher cost will be appropriate.

4. Motivational. What are the incentives and disincentives that will affect the motivation of key groups to commercialize real-time pricing (RTP) of electricity? Will deregulation or partial deregulation of electric generation be required? Can changes in tax and investment credits bring real-time pricing into use without deregulation? Are changes in sources of supply, e.g., cogeneration, and demand, e.g., electric cars, necessary to create RTP markets? Further exposition of these notions can be found in the attached copies of viewgraphs from a series of Rand talks given in 1979.

Many offices within the Department of Energy have expressed what can best be characterized as cautious interest in this concept. This list includes the Office of Energy Research;

Electric Energy Systems; Conservation and Solar Applications; Policy; Resource Applications; and the Energy Regulatory Administration. Technologically oriented groups question whether they should be supporting a project which requires substantial and wide-ranging institutional reforms in its implementation. Policy groups are dubious about exploring the implications of technology that most have not previously encountered without first establishing both its feasibility and desirability.

An initial study's goals would be, first, to survey the relevant literature* establishing the feasibility and desirability of RTP markets. Second, to show that RTP markets would accelerate commercialization of a substantial and growing set of power sources and sinks--e.g., electric car chargers, industrial cogenerators, thermal loads, and wind generators. Third, to make a preliminary estimate of the cost and value of a real time pricing system in this context. Fourth, to outline the fiscal, regulatory, and market incentives and barriers that exist, and potential mechanisms of marketplace transitions. And finally, to discuss how institutional transitions are coupled to technological opportunities.

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[*] The attached bibliography includes what we believe are the most relevant citations. It is a compendium of the work of several individuals over the last half of 1979.

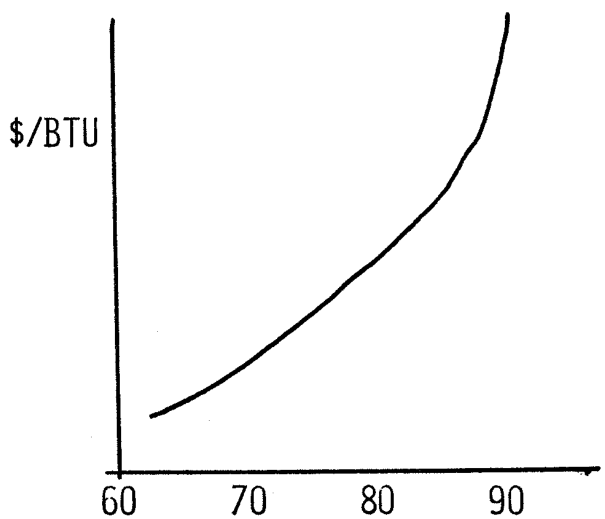
INFORMATION, ECONOMICS, AND ENERGY

-OR-

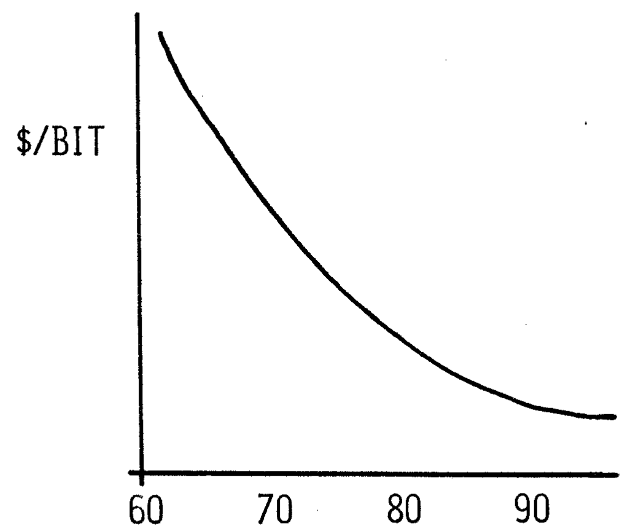
BITS, BUCKS, AND BTUs

TWO FACTS:

ENERGY IS GETTING MORE EXPENSIVE



INFORMATION IS GETTING CHEAPER



INFORMATION CAN BE USED TO

SAVE ENERGY

- SUBSTITUTION OF COMMUNICATIONS FOR TRAVEL
- INCREASED SOPHISTICATION IN END-USE CONTROL
  - MICROPROCESSOR FUEL-INJECTION
  - REAL-TIME, COST SENSITIVE PROCESS CONTROL - E.G., METAL AND CHEMICAL PLANTS, PAPERs
  - MICROSHEDDING/LOAD MANAGEMENT, E.G., ALL THE WATER HEATERS IN NEW ZEALAND
  - INTELLIGENT MOTOR CONTROLLERS, E.G., EXXON/RELIANCE, NASA
- EXTENDING THE CAPABILITIES OF ELECTRIC UTILITY GRIDS

USING INFORMATION TECHNOLOGY FOR ADAPTIVE UTILITY GRID MANAGEMENT

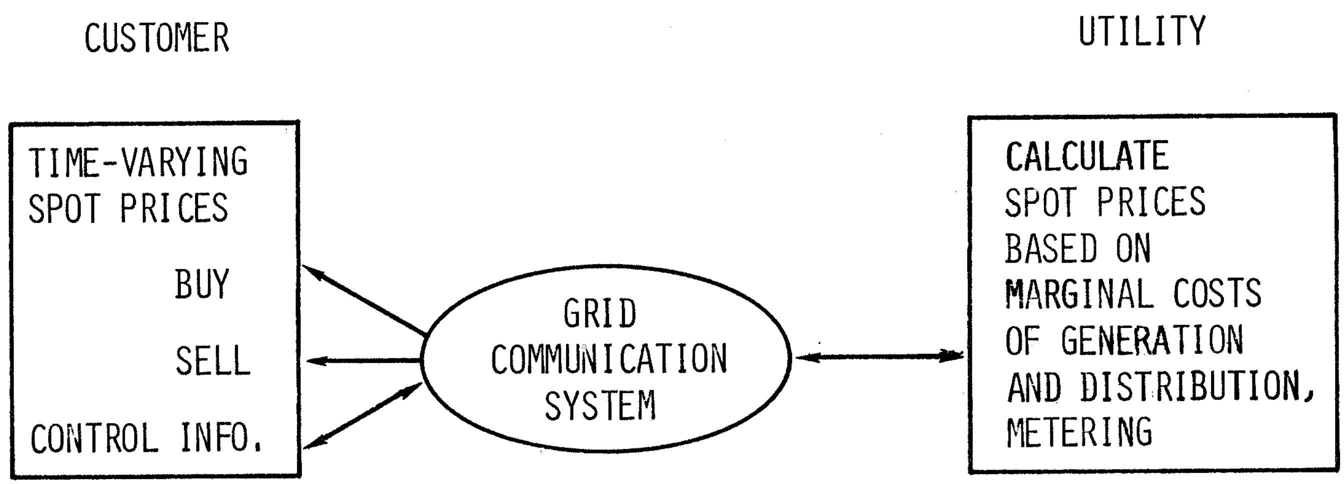
- ENGINEERING STUDIES HAVE ESTABLISHED THE PRACTICALITY OF BUILDING INFORMATION CHANNELS INTO POWER GRIDS
  - POWER LINE CARRIER
  - TELEPHONE CARRIER
  - RADIO
  - CATV
- WHAT TO DO WITH IT?

  ENGINEERING APPROACH-
  DEVICE CONTROL

  ECONOMIC APPROACH-
  PRICE INFORMATION
- ADVANCED PURPA AND POST-PURPA RATE STRUCTURES BECOME FEASIBLE

A PRICE BASED APPROACH TO UTILITY CONTROL

MICROPROCESSOR BASED - GENERALIZED CAPABILITIES



"HOMEOSTATIC UTILITY CONTROL"

GOALS: STABILITY
RELIABILITY
COST MINIMIZATION
TECHNOLOGICAL INNOVATION

ADVANTAGES OF ADAPTIVE DISTRIBUTED CONTROL

- AVOID THE MOVING PEAK PROBLEMS THAT HAVE OCCURRED IN EUROPEAN STATIC PEAK LOAD PRICING OPERATIONS
    - ALLOW THE PRICE TO MOVE WITH THE PEAK
- EASE TRANSITIONS SHARPENED BY STATIC PEAK LOAD PRICING
    - AVOID TWO MILLION WATER HEATERS TURNING ON AT 6:01
- ENABLE REMOTE METER READING
- PROVIDE A SIMPLE MARKET MECHANISM TO FACILITATE INCORPORATION OF
    - COGENERATORS
    - SOLAR
    - WIND
    - INNOVATIVE ENERGY MARKETEERS
    - STORAGE

ISSUES RAISED

INFORMATION PROCESSING

- SECURE TRANSMISSION OF PRICE INFO - PUBLIC KEY CRYPTOGRAPHY
- COMMUNICATIONS PROTOCOLS - NEAR-BROADCAST MODE
- COMMUNICATIONS ARCHITECTURE - WHAT DEVICES AT WHAT COSTS
- MEANS FOR CONSUMERS/PROVIDERS TO USE PRICE INFORMATION - STRATEGIES TO BE PROGRAMMED IN A STRAIGHTFORWARD YET GENERAL FASHION

ECONOMIC, INSTITUTIONAL, REGULATORY

- CONSTRAINTS ON STATE PUCs - PRICING BY ALGORITHM IS SOMETHING NEW
- PRICING ALGORITHM - HOW DOES UTILITY GATHER & USE DATA TO DETERMINE BUY & SELL SPOT PRICES
- SYSTEMATIC COST ANALYSIS - PRESENT, FUTURE, CROSS-OVER

ADDITIONAL QUESTIONS

- HOW DOES ECONOMIC JUSTIFICATION DEPEND ON MIX OF COGENERATION, SOLAR, WIND, STORAGE, AND CONVENTIONAL SOURCES IN A REGION?
- HOW CAN A SMOOTH TRANSITION BE EFFECTED IN A MANNER COMPATIBLE WITH THE INSTALLED TECHNOLOGIES?
- WHAT ARE THE LEGAL OBSTRUCTIONS - AT WHAT LEVEL(S) MUST THEY BE RESOLVED?
- CAN EXISTING DEMAND DATA AND MODELS OF BEHAVIOR IN THE ADAPTIVE ENVIRONMENT BE USED TO SIMULATE/PREDICT ENERGY AND ECONOMIC BENEFITS?

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