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Countdown For Energy Research, Development and Demonstration In America

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COUNTDOWN FOR ENERGY RESEARCH, DEVELOPMENT AND DEMONSTRATION IN AMERICA

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Abstract

The energy research business is rapidly developing an appreciation of time elements which indicate that in order for "a system" to compete with the big five prime fuels for the generation of electric energy, 1982 is going to be a critical year whereby RD & D efforts must provide on-line results.

INTRODUCTION

Identifying the energy problem in this country is the greatest difficulty in solving it. This handicap of identification is caused by a lack of awareness toward real and pressing energy issues of cost and supply. Whatever happened to Project Independence? The realities of supply and demand surpassed the mare's nest of tidy assumptions regarding our energy resource capabilities.

This identity crisis also extends to the laboratory. Researching energy alternatives has resulted in an attitude development which I feel represents a new research philosoply -- having to maintain the basics in basic research and liking it.

Basing comparative evaluations on cost-per-unit basis is the cleansing agent. A cost/benefit ratio concept is difficult to sell on the laboratory bench because cost options are discussed as the aftermath of a project and very seldom as cost control at the pre-investigatory level. This is the energy business and cost control can point the way in spite of wearisome group leaders and customary viewpoints of some directors with personally confined truth drives.

In this energy business, with which we have surrounded ourselves, I wish to reduce this new research philosophy to a simple colloquialism: inverse bare-bones. Rather then starting with the physical flow of an idea to hopefully reach a reasonable cost comparison, begin with the target cost of the idea, whether this is in dollars per million BTUs or cents per kilowatt-hour, work the creative process in reverse. What sticks and what falls through will depend on the confines or dollar limits which you impose. One of the benefits of such a path is the ingredient which money cannot buy and that is TIME. By taking the conventional path of R & D, the process of idea-to-product-to-cost chain, extended research is inevitable because the goal of cost reduction is a continuing task. By using the inverse method, the bare-bones path is achieved with cost reduction as a side benefit.

One of the more noticeable deficiencies in energy research results is the method of producing electric power from centralized points of distribution. There have been no significant gains to improve the loading characteristics of electric power plants.

Table A. <u>BTU Loading Spectrum of Thermal Sources for Electric Energy Production</u>.

INPUT		BTUs	1 kWh	OUTPUT
NATURAL GAS[1]	High Rate	58,333	5.8%	3412 BTUs
	Low Rate	4,906	69.5%	
FUEL OIL[2]	High Rate	62,100	5.5%	
	Low Rate	6,511	52.4%	
COAL[3]	High Rate	17,478	19.5%	
	Low Rate	10,319	33.0%	
Smith Constant[4]		10,250	33.4%	
NUCLEAR FISSION[5]		10,500	32.3%	
NUCLEAR FUSION[6]	(Estimated)	7,500	45.5%	
MHD (Magnetrohydrodynamics)[7]		6,800	50.0%	
Energy RD & D Target		3,750	90.0%	
Not in this World		3,412	100.0%	
			Conversion Efficiencies	

While many billions of dollars are being spent on related distribution and pollution control, 88.4% or 1.8 trillion kilowatt-hours of electric energy in this country were produced from thermal fuels in 1976. (Table A)

Table B. U.S.A. Peak Demand Data in Megawatts and Production History in trillion kWh with generation capability per given year. % of variation given.

YEAR	SUMMER PEAK	WINTER PEAK	CAP	PRODUCTION
1970	267,516	241,849	332,667	1.494
1971	284,757	254,642	360,004	1.613
1972	311,102	283,108	386,991	1.752
1973	335,340	287,056	424,014	1.860
1974	340,778	294,351	456,979	1.867
1975	348,318	322,222	482,546	1.916
1976	362,077	340,689	501,705	2.037
1977	395,208	359,903	534,234	2.180
. .				
1978	420,696	383,433	561,686	NA
. . .				
1985	?	?	850,000	3.50
	Average Annual Growth Rate			
	5.9%	6.0%	6.8%	4.9%

Sources: Edison Electric Institute and National Electric Reliability Council

Table C. An Estimate of BTU requirements to yield the production values for Table A based on the Smith Constant of 10,250 BTUs/kWh_e. (10^{15} BTUs)

	1970	1971	1972	1973	1974	1975	1976	1977	... 1985
OIL	2.02	2.44	3.03	3.51	3.37	2.96	3.51	3.81	4.77
COAL	7.25	7.03	7.55	8.31	8.43	8.74	9.78	10.57	16.80
NG	3.88	4.27	3.95	3.55	3.23	3.08	2.66	2.61	1.11
NUCLEAR	0.22	0.37	0.55	0.86	1.15	1.74	2.43	2.92	10.73
HYDRO	2.53	2.71	2.81	2.86	2.95	3.07	2.41	2.38	2.47

	1970	1971	1972	1973	1974	1975	1976	1977	...	1985
OTHER	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-		0.18
	15.90	16.82	17.89	19.09	19.13	19.59	20.8	22.3		36.0

In Table C the RD & D deficiency gap which I am speaking about is the obvious stretch of zeros for other means of generating electric energy on a commercial scale other than the big five; oil, coal, natural gas, nuclear and hydropower. Where are the solar power plants? Where are the hydrogen gas plants? Where are the fossil fuel conversion plants? Where are the new generator systems which yield 50% efficiency or better?

In a scenario developed by Basile and Sternlight[8] a rapid economic growth rate at 4.4% per year average is placed from 1972 to 2000. Electricity constitutes 42.2% of the total energy base with only nuclear power, hydropower and Other generating three times the energy we are getting from conventional mixing of resources today. Natural gas, oil and coal are excluded from the projection.

We hear so much about cost problems and uncertainties of the future but I can assure you that we are approaching an era where I feel very confident it is going to be the Age of Certainty.

We are now certain that unless we come to grips with our own energy deficiencies we will never again have the opportunity to control our economic and social destinies. We are now certain that without a concentrated effort of researching all energy alternatives, our future options will be restrictive. We are now certain that by being more dependent on imports of crude oil and other fuels, we are sacrificing needed research capital for short term solutions to our current energy supply demise. We are now certain that energy conservation techniques and gadgets will eventually give way to a new era of supply developments which promise hope, encouragement and the reality of energy goals from which to build and expand.

Dr. Gloria Caton and her staff at Oak Ridge National Laboratory, have put together the only nationwide comprehensive effort of reporting on research and development activities associated with future national energy needs. The project is updated every two years with a new "inventory" list and is distributed through the U.S. printing office. The next update, which will be the third edition, should be ready in February, 1978, with an estimated 8,300 items or projects. Time does not permit me to elaborate on this important subject matter, but a look at the subject categories will give you an idea of the topics covered. (Table D)

Table D. Subject Categories-Inventory Project of Energy Research

a. <u>Energy Sources</u>

  Fossil Fuels

  Nuclear

  Solar

  Others

b. <u>Electric Power</u>

  1. Preliminary & General Studies
  2. Generation Hardware & Systems
  3. Transmission & Distribution Systems
  4. Storage & Conversion
  5. System Planning
  6. The Electric Power Research Institute

c. <u>Energy Uses</u>

  1. Residential
  2. Commercial
  3. Industrial
  4. Transportation
  5. Agriculture
  6. Supply, Demand & Economic Studies
  7. Specialized Applications
  8. Pooled assessments

d. <u>Health & Ecological Effects</u>

  1. Environmental Systems
  2. Biomedical Studies
  3. Radiation Effects
  4. General Studies

When the National Electrical Code was originated in 1897, the great Edison-Westinghouse debates centered around the switch from Direct Current to Alternating Current on a national scale to facilitate the transmission of this new form of energy. How ironic, that after so many years, we have found that the most efficient artificial light source is from a DC power supply, namely High Pressure Sodium. And the most efficient heating source we have is in the form of microwave, which is also from a DC source. And what a turnaround for the electric power industry as Minnesota Power & Light prepares for extensive testing of a high voltage DC transmission line some 456 miles long with inverters at both ends to lower costs of AC power distribution.

CONCLUSION

Where do we go from here? As we enter the Age of Certainty we are certain that <u>one day</u> our nonrenewable fuel supplies as we know them, will be depleted. We will continue to debate among ourselves the extent of time remaining as economic and environmental trends shift on a sea of uncertain and unpredictable human events.

We cannot afford to be satisfied with searching for the "ultimate" energy base as we Americans will have to shift from a petroleum fortified economy to whatever results from our energy RD & D efforts.

How good if good enough? The present projection concerning nuclear fusion energy research indicates that by the year

2020 we will be off and running with the replacement for nuclear fission reactors. In spite of the stated benefits to be gained, one prospect poses to minimize the impact of this "progressive" venture. Somewhere within the heat exchange medium of a future fusion reactor, water will be heated to produce steam and the steam will turn the turbine and so forth ---. The change represents essentially no change because the cooling water requirements for such a thermal system are going to yield an estimated conversion:

7800 BTUs $\rightarrow$ 1 kWh $\rightarrow$ 3412 BTUs

Cost governance and common sense will be the ultimate criteria for energy system developments in the industry. The closer to unity that we can bring the BTU conversion the more efficient and desirable such a system or combination of systems will be. Perfect unity cannot be achieved by wishful thinking or legislative mandates, because the Laws of Conservation of Mass and Energy and a few other rules of nature cannot be altered by man and rightly so. The marketing palatability of a "system" of the future will be based on a factor never before seriously considered in the energy industry -- putting equity into an energy system.

Time compressions and critical flow charts indicate that alternate energy resources must contribute between 180 and 200 billion BTUs of equivalent energy to the electric system by 1983 in order to be a viable addition by the year 2000. A viable addition for the item marked as Other from Table C, regardless of what it is, must represent at least 30% of the prime energy base in the year 2000, which means that from 1983 to 2000 A.D. the "system" must contribute to the base and incrementing rate of 12% per year, compounding for 18 years. This exponential rate of improvement must account for increasing demand for electric power, replacement of obsolete equipment, and reduced ability of the government and industry to control conventional energy resources in the future.

We need to unlock the barriers which constrain freedom and nonconformity in our technological pursuits of new and hopefully better energy systems. Our future and more importantly, our children's future depends on freedom to explore the possibilities because our most difficult challenge is yet to be faced in our Age of Certainty: Will we control our energy needs in the future or will our energy needs control us?

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