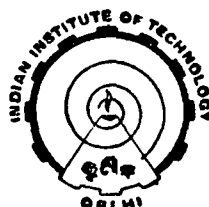


SYSTEMS ANALYSIS FOR DEVELOPMENT OF ENERGY CONSERVATION POLICY AND STRATEGY IN INDIAN CEMENT INDUSTRY

BY
JAGENDRA PRASAD SAXENA

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INDIAN INSTITUTE OF TECHNOLOGY
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CERTIFICATE

The thesis entitled **Systems Analysis for Development of Energy Conservation Policy and Strategy in Indian Cement Industry**, being submitted by Mr J P Saxena to the Indian Institute of Technology, Delhi, for the award of the degree of Doctor of Philosophy, is a record of bonafide research work carried out by him. He has worked under our guidance and supervision, and has fulfilled the requirements for the submission of this thesis which has attained the standard required for a Ph D degree of the Institute. The results presented in this thesis have not been submitted elsewhere for the award of any degree or diploma.



(Dr PREM VRAT)
Professor of Industrial Engineering
Department of Mechanical Engineering
Indian Institute of Technology
New Delhi



(Dr SUSHIL)
Associate Professor
Centre for Management Studies
Indian Institute of Technology
New Delhi

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J P SAXENA

ABSTRACT

The primary objective of this thesis is to develop energy conservation policy and strategy in Indian cement industry by using qualitative techniques of systems analysis; followed by the secondary objective : to develop methodology for evolving policy and strategy.

The research study has been divided into three phases. The first phase of the research deals with the identification of the problem through literature review and efforts made in energy conservation by cement industry in foreign economies as well as in India. The scheme of literature review comprises of four areas: energy conservation, energy management and policy, energy modeling and qualitative techniques for modeling on policy issues. The literature review revealed the need for new dimensions to the concept of energy conservation from systems point of view and to integrate all aspects in systems planning which would result in effective policy frame work and strategy for energy conservation at industry level.

The second phase of the research study deals with the systems analysis and scenario building for energy conservation. Fuzzy set theory has been integrated with the techniques of program planning, interpretive structural modeling and MICMAC analysis (the indirect relationship analysis) [133]. The focus of the systems analysis is on identification of program plan elements, sub-elements, their ranks and hierarchy, the key elements and sub-elements, the linkage of key sub-elements with other sub-elements, and

classification of sub-elements to understand their characteristic role in the system. This phase of the research contributes in development of the methodologies for ranking the sub-elements following different qualitative techniques. The problem of feed backs and cycles in interpretive structural modeling has been tackled by using driver power of the sub-elements in determining the ranks or hierarchy of the sub-elements. Application of fuzzy set theory has also been demonstrated with case study. Based on the systems analysis results, scenario for energy conservation in Indian cement industry has been projected and a methodology has been developed for building the scenario.

The third phase of the research deals with identification of energy conservation options (ECOs) and Energy Performance Indicators (EPIs) using Delphi technique; and developing the policy for energy conservation using the multi-criteria, multi-persons approach for decision making. Appropriateness of the various qualitative techniques used in systems analysis to different situations have been discussed. The strategy of each actor for energy conservation in Indian cement industry, strategy on key sub-elements, strategy at industry/government level and at the plant level have been developed. Methodologies for development of policy frame work and strategy planning have also been covered in this phase.

The research study concludes with the discussion on significant contributions of the research, limitations of the research and futuristic considerations.

CONTENTS

	Page No.
ABSTRACT	iii
LIST OF FIGURES	xiv
LIST OF TABLES	xxi
LIST OF APPENDICES	xxiv
ABBREVIATIONS	xxviii
 CHAPTER I INTRODUCTION TO RESEARCH PROBLEM	
1.1 Introduction	1
1.2 An Overview of Cement Industry	3
1.2.1 Manufacturing Process	3
1.2.1.1 Wet Process	4
1.2.1.2 Semi-wet/Semi-dry Process	4
1.2.1.3 Dry Process	4
1.2.2 Growth of Cement Industry in India	5
1.2.3 Modernization and Expansion Program	10
1.3 Problem Definition	11
1.3.1 Objectives of the Study	11
1.3.2 Issues	12
1.3.3 Scope of the Study	13
1.4 Proposed Methodology	14
1.5 Organization of the Study	15
1.6 Concluding Remarks	19
 CHAPTER II LITERATURE REVIEW	
2.1 Introduction	20
2.2 Basis of the Present Review	21
2.3 Energy Conservation - Technology Aspects	27
2.3.1 Operational Aspects	29

2.3.2	Energy Efficient Equipment and Systems	31
2.3.3	Significant Developments	33
2.4	Energy Management and Policy	35.
2.4.1	Energy Management	35
	i Energy saving controls	39
	ii Standardization of energy equipment	39
	iii Program phasing	40
	iv Planning	40
	v Target setting	41
	vi Energy auditing	41
	vii Communication	41
	viii Training of personnel	42
	ix Load management	43
	x Organisational structure	43
2.4.2	Energy Policy	43
	i Role of Government	44
	ii Fuel substitution	44
	iii Distribution of fuel	45
	vi Leasing of energy saving equipment	46
	v Energy performance contracting	46
	vi Financial support	47
	vii Tax incentives	47
	viii Energy conservation law	48
2.5	Energy Modeling	48
2.6	Qualitative Techniques for Systems Analysis	58
2.6.1	Systems Approach and Program Planning	59
2.6.2	Interpretive Structural Modeling (ISM)	63

2.6.3	Analytic Hierarchy Process	64
2.6.4	Fuzzy Set Theory (FST)	66
2.6.5	Delphi	68
2.7	The Current State of Research	71
2.8	Limitations of the Existing Approaches	73
2.9	Need for Further Research and Areas of Study	76
2.10	Concluding Remarks	77
CHAPTER III STATUS AND TRENDS IN ENERGY CONSERVATION IN CEMENT INDUSTRY		
3.1	Introduction	79
3.2	Energy use Pattern in Some Foreign Economies	79
3.3	Energy Conservation Status in Indian Cement Industry	82
3.3.1	Various Studies	82
3.3.2	Energy Requirements	86
	i Energy requirements of 1990-91	86
	ii Energy requirements of 1994-95	87
3.3.3	Salient Findings of Energy Audit Studies	89
3.3.4	Impact of Energy Conservation Actions	95
	a) Shift in process technology	95
	b) Increase in average kiln size	95
	c) Types of cement produced	96
	d) Captive power	96
	e) Energy conservation efforts by cement plants	97
	f) Energy use pattern	97
3.4	Concluding Remarks	100

CHAPTER IV SYSTEMS ANALYSIS OF PROGRAM PLAN ELEMENTS

4.1	Introduction	102
4.2	Program Planning	102
4.2.1	An Overview	102
4.2.2	Importance of Program Planning	104
4.2.3	Identification of Key Sub-element	106
4.3	Fuzzy set Theory (FST): An Introduction	106
4.4	Fuzzy Program Planning	107
4.4.1	Identification of Key Sub-elements in FPP	110
4.4.2	Interactions of the Key Sub-element	111
4.5	The Case of Indian Cement Industry	111
4.5.1	Program Planning Linkages	111
4.5.2	Identification of Key Sub-elements	112
4.5.3	Fuzzy Program Planning Linkages	115
4.5.4	Interactions of Key Sub-elements	118
4.6	Findings of the Study	118
4.6.1	Methodology Related	118
4.6.2	Key Sub-elements in FPP	129
4.7	Concluding Remarks	133

CHAPTER V HIERARCHY OF PROGRAM PLAN ELEMENTS USING INTERPRETIVE STRUCTURAL MODELING

5.1	Introduction	156
5.2	Interpretive Structural Modeling	157
5.3	Development of An Interpretive Structural Model	158
5.3.1	Structural Self-Interaction Matrix	158
5.3.2	Reachability Matrix	160

5.3.3	Lower-triangular Format Reachability Matrix	161
5.3.4	Minimum Edge Adjacency Matrix	161
5.3.5	Partitions in the Reachability Matrix	162
5.3.5.1	TT 1 (P x P), the relation partition	162
5.3.5.2	TT 2(P), the level partition	163
5.3.6	Digraphs for Interpretive Structural Model	164
5.3.7	Interpretive Structural Model	165
5.4	Fuzzy Interpretive Structural Modeling	165
5.5	Determining the Hierarchy amongst Program Plan Sub-elements	166
5.6	The case of Indian Cement Industry	167
5.6.1	The Contextural Relationships	167
5.6.2	Development of Interpretive Structural Models of Elements	168
5.6.3	Hierarchy of Sub-elements and Key Sub-elements	176
5.7	Finding of the Study	176
5.7.1	Methodology Related	176
5.7.2	Energy Conservation Related	190
5.8	Concluding Remarks	192
CHAPTER VI IMPACT OF INDIRECT RELATIONSHIPS IN CLASSIFICATION OF VARIABLES - A MICMAC ANALYSIS FOR ENERGY CONSERVATION		
6.1	Introduction	194
6.2	Indirect Relationships - MICMAC method	195
6.2.1	The MICMAC Principle	196
6.2.2	Fuzzy Indirect Relationship (FMICMAC)	198
6.2.3	Comparison of the Driver Power Ranks	203
6.2.3.1	Ranks in direct relationship vs fuzzy indirect relationship	203

6.2.3.2	Ranks in fuzzy direct relationship vs fuzzy indirect relationship	204
6.2.4	The Key Variables	204
6.2.5	Classification of System Variables	205
6.2.5.1	Classification of System Variables in direct and indirect relationship (MICMAC)	206
6.2.5.2	Classification of system variables in fuzzy direct and fuzzy indirect relationship (FMICMAC)	206
6.3	The case of Energy Conservation in Indian Cement Industry	207
6.3.1	The Indirect Relationship (MICMAC) Analysis	207
6.3.2	The Fuzzy Indirect Relationship (FMICMAC) Analysis	208
6.3.3	Comparison of Driver Power Ranks and Key Sub-elements	210
6.3.4	Classification of Sub-elements	210
6.4	Findings	229
6.4.1	Methodology related	229
6.4.2	Program related	233
6.5	Concluding Remarks	235
CHAPTER VII SCENARIO BUILDING		
7.1	Introduction	236
7.2	Scenario Building Methodology	237
7.2.1	Searching the Key Variables	237
7.2.2	Actors' Strategy : Alliances and Conflicts	237
7.2.3	Seeds of Change	238
7.3	The case of Energy Conservation in Indian Cement Industry	239
7.3.1	Actor's Strategy	239
7.3.1.1	The key objectives	239
7.3.1.2	The key activities	240

7.3.1.3	Alliances and Conflicts	240
7.3.2	Seeds of Change in Actors' Role	257
7.3.2.1	Coal Companies	257
7.3.2.2	Bureau of Indian Standards	257
7.3.2.3	Electricity Boards	258
7.3.2.4	National Council for Cement and Building Materials	258
7.3.2.5	Government	259
7.3.2.6	Other Actors	260
7.4	Concluding Remarks	260
CHAPTER VIII DEVELOPMENT OF ENERGY CONSERVATION POLICY FRAMEWORK		
8.1	Introduction	264
8.2	Methodology for Development of Policy Framework	265
8.2.1	Delphic Hierarchy Process	266
8.2.1.1	Delphi method	266
8.2.1.2	Analytic Hierarchy Process (AHP)	268
8.2.2	Fuzzy Set Methodology	270
8.3	The case of Indian Cement Industry - Energy Conservation Policy	273
i	Identification of Energy Conservation Options and Energy Performance Indicators through Delphi	274
ii	Determination of Eigen Vector Weights	279
iii	Eigen Vector weights of the EPis through Analytic Hierarchy Process	279
iv	The Position Matrices	280
v	Ranking of the Energy Conservation Options using Fuzzy Set Methodology	280

vi	Sensitivity Analysis for the Ranks of Energy Conservation Options	282
vii	Feedback on the Evolved Policy Framework	289
8.4	Concluding Remarks	293
CHAPTER IX STRATEGY PLANNING AND IMPLEMENTATION		
9.1	Introduction	294
9.2	Prerequisites of Strategy Planning - The Systems Analysis	294
9.2.1	Fuzzy Program Planning Based Program	295
9.2.2	Fuzzy Interpretive Structural Modeling Based Program	296
9.2.3	Fuzzy MICMAC Technique Based Program	297
9.2.4	Selection of Technique for Systems Analysis	298
9.3	Strategy Planning	300
9.3.1	Methodology	300
9.3.2	Implementation	301
9.4	Strategy Planning for Energy Conservation - The Case of Indian Cement Industry	301
9.4.1	Actors' Strategies	303
i	Strategy of NCB	303
ii	Coal Companies	307
iii	Cement Machinery Manufacturers	308
iv	Electricity Boards	308
v	Government	308
vi	Bureau of Indian Standards	309
vii	Railways	310
viii	Consultants	310
ix	Cement Plants	310
x	Industrial Development Bank of India	311

9.4.2	The Strategy Plan For Key Variables	311
i	Key Needs	311
	a) Development of energy efficient equipment/system	311
	b) Management of energy wastage	312
	c) Efficient operation and maintenance of plants	313
ii	The Key Constraint - Transport Bottle-necks	314
iii	The Key Alterable - Change in Technology	316
iv	Key Objective - To Develop Sound Energy Policy	317
v	The Key Activity - To Give Publicity for Energy Conservation Success Stories through Media	320
9.4.3	Strategy Implementation	321
i	Industry Level	321
ii	Plant Level	321
9.5	Concluding Remarks	323
CHAPTER X CONCLUSIONS		
10.1	Introduction	341
10.2	Summary of the Research	341
10.3	Critique of the Methodology Used	348
10.4	Significant Contributions of the Research	351
10.5	Limitations of the Research	356
10.6	Futuristic Considerations	358
10.7	Concluding Remarks	360
REFERENCES		361
APPENDICES		A1-A37