

COST ESTIMATING METHODOLOGY AND APPLICATION

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I. INTRODUCTION

The Economic Modeling Working Group (EMWG) was created by Generation IV International Forum (GIF) early in 2003. The Group was charged with developing a methodology to assess the progress of the Generation IV systems in achieving the economic goals established by the GIF Policy Group. The objective was to establish a simplified cost estimating methodology appropriate for Generation IV systems in various stages of development and sufficiently rigorous to promote consistent application by the systems development groups. The EMWG is working with the System Steering Committees to provide training and assistance in the application of the methodology.

The GIF Cost Estimating Methodology has been developed and tested by the EMWG. It has been released for general use by the GIF System Steering Committees. The Policy Group, at the request of the EMWG, agreed to release the methodology to the general public to achieve more widespread experience with its application.

The Cost Estimating Methodology consists of (1) the Generation IV Cost Estimating Guidelines and (2) a software package, G4-ECONS, to facilitate the implementation of the Guidelines.

The EMWG monitors the application of the methodology and continues to assess

economic trends and experience which may have economic impacts on Generation IV systems.

II. GENERATION IV ECONOMIC GOALS

Early in the Generation IV process, the GIF Policy Group established a comprehensive set of goals to guide the development of Generation IV systems. Among the goals are two economic goals:

- to have a life cycle cost advantage over other energy sources (*i.e.*, to have a lower levelized unit cost of energy on average over their lifetime);
- to have a level of financial risk comparable to other energy projects (*i.e.*, to involve similar total capital investment costs and capital at risk).

III. GIF COST ESTIMATING GUIDELINES

The GIF Cost Estimating Guidelines provide a comprehensive approach for assessing the performance of Generation IV systems in achieving the established economic goals. The methodology may be used to assess if the Generation IV systems are indeed improved over Generation III or to improve the cost of Generation IV systems on a sub system level as the development proceeds. The Guidelines proceeded through several revisions as the methodology was developed and tested. Revision 4 is the current version and was released to GIF and the public in 2007.

The Guidelines provide detailed processes for developing the total capital investment cost and calculating the levelized unit electric cost. The overall structure of the cost estimating methodology is shown in Figure 1.

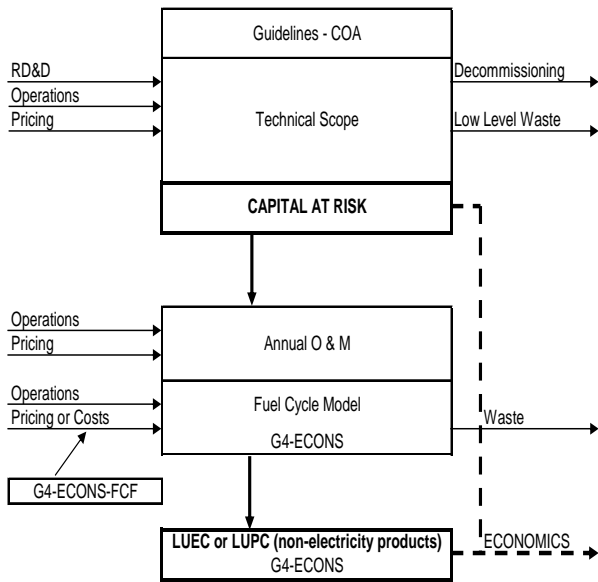


Figure 1: Structure of the GIF Cost Estimating Methodology

The central feature of the methodology is the comprehensive Code of Accounts. The Code of Accounts provides a disciplined structure for capturing and categorizing all appropriate costs in the development of consistent system cost estimates. An overview of the Code of Accounts is given in Chapter 1 of the Guidelines and a sample of a detailed Code of Accounts “dictionary” is provided in Appendix F.

Chapter 3 of the Guidelines provides a Code of Accounts for Research, Development and Demonstration costs that precede the actual system design. Such costs are usually not included in a system cost estimate but are important considerations for management in assessing the overall development cost for a given system. To date, this RD&D Code of Accounts has not been employed by any of the GIF system development groups.

Because the Generation IV systems will for some time be in varied states of development and maturity, two different approaches for cost estimation are included. Chapter 4 of the

Guidelines describes a “bottom up” approach appropriate for systems in an advanced state of development with some degree of design detail. The “bottom up” approach yields the most reliable and complete cost estimate and should be the ultimate outcome for a cost estimate on a mature system. Since most Generation IV systems will for some time be in a less mature state of development, Chapter 5 describes a “top down” method of cost estimation appropriate for use with evolving system development.

IV. G4-ECONS

To facilitate implementation of the Cost Estimating Guidelines, the EMWG developed an EXCEL based spreadsheet package, G4-ECONS. G4-ECONS 2.0 was released to GIF and the public in 2008. The software package facilitates the input of total capital cost at a high level to prevent the inadvertent disclosure of proprietary data. Levelized unit electric cost is also calculated. G4-ECONS 2.0 provides the capability for cost estimates of systems designed for other than electricity production, such as desalination or hydrogen production. Companion software, G4-ECONS-FCF, provides the capability to calculate cost of product from any fuel cycle facility. The basic structure of G4-ECONS is shown in Figure 2.

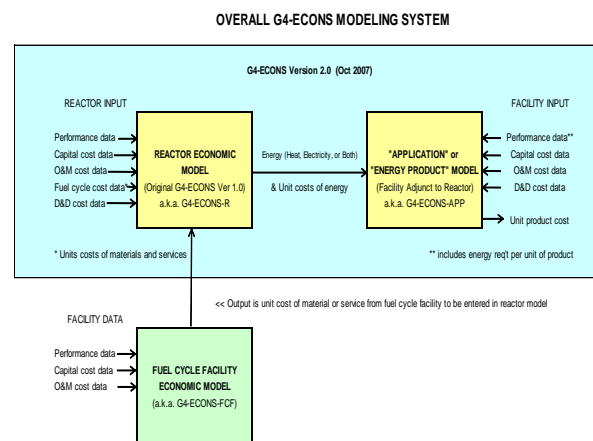


Figure 2: Structure of G4-ECONS

V. APPLICATIONS OF THE GIF COST ESTIMATING METHODOLOGY

During the development phase of the methodology, the EMWG performed analysis of

a Generation III CE System 80 + reactor to compare the results to published cost evaluations. The methodology, particularly the G4-ECONS software, compared well with published results. The levelized cost of electricity calculated by G4-ECONS was within 1% of the published figure. This test served as an initial validation of the software.

The first Generation IV trial application was performed by the Japanese members of the EMWG for the Japanese Sodium Fast Reactor (JSFR). These results were presented at the ANS meeting in Boston in June of 2007. Again the cost estimate comparisons were quite good thus providing a validation for Generation IV application. The G4-ECONS output for the JSFR is shown in Table 1.

case: JSFR Sample Calculation/ April 14,2006 (Closed cycle)			
Worksheet name: LUEC SUMMARY			
TOTAL REACTOR & FUEL CYCLE SYSTEM			
Summary of Model Results			
Case: JSFR Sample Calculation/ April 14,2006 (Closed cycle)			
Discount rate=		2.00%	
		Annualized Cost in \$M/yr	Mills/kwh or \$/MWh
Capital Cost incl Financing		\$77.4	6.51
Operations Cost		\$88.6	7.46
Fuel Cycle Cost		\$77.8	6.55
D&D Cost		\$5.1	0.43
Totals		\$249.0	20.95

Table 1: G4-ECONS Output Screen for JSFR Sample Calculation

The GIF System Steering Committees are preparing to apply the Cost Estimating Methodology to their projects as the designs become sufficiently complete to do so. The methodology is also being applied by other groups at the International Atomic Energy Agency and several Universities for both existing and advanced designs. Results of these applications are beginning to be published at various technical meetings and conferences.

The cost comparison with the Japanese cost estimating codes is shown in Table 2.

Mills/kWh or \$/MWh	G4-ECONS Code	FCC-EX*1	Final Report - FS Phase-2
Estimated year (year)	2005	2005	2005
Capital Cost incl. Financing	6.08	5.94	6.44
D&D Cost	0.43	0.43	0.43
Operations Cost	7.46	7.33	7.31
Front-end Fuel cycle	1.46	1.46	1.50
Back-end Fuel Cycle	5.09	5.09	2.99
Initial core fuel front-end Cost*2	0.43	0.23	0.41
Initial core back-end Cost*2	-	0.81	0.88
Totals	20.95	21.30	19.96

Table 2: G4-ECONS Comparison with Japanese Codes

The GIF Cost Estimating Methodology is available on a compact disk which includes the GIF Cost Estimating Guidelines, G4-ECONS Users Manual, G4-ECONS and G4-ECONS-FCF software. The disk may be obtained by emailing the Organization of Economic Cooperation and Development: webmaster@g4if.org.

The EMWG is tracking the distribution and monitoring the application of the methodology. Further improvements and revisions will be undertaken as experience indicates that such changes would be advantageous for specific GIF applications.

VI. CONCLUSION

The Generation IV Cost Estimating Methodology was developed to promote consistent evaluations of Generation IV Systems with respect to the economic goals set by the Policy Group. It has been tested against both Generation III and Generation IV systems and demonstrated to be a valid methodology for system cost estimation. The methodology is available to both GIF and non-GIF users. The EMWG will continue to track the application of the methodology and make improvements as the needs of GIF may indicate. Training and assistance in application of the methodology is provided as requested by the System Steering Committees.

Acknowledgements

This paper is presented on behalf of the GIF EMWG and represents the work done by its members.

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