Research Division

Contractor: IFC Consulting Services

Contract # 07-348

FUNDING FISCAL YEAR		FY 07/08	FY 08/09	FY 09/10		
TERM		05/30/08-06/30/10	05/30/08-06/30/10	05/30/08-06/30/10		
PCA		72350	72350	72350		
LINE ITEM/OBJECT		418.20	418.20	418.20		TOTAL
DESCRIPTION	Tech Support					
Contract $		$ 140,000.00	$ 40,000.00	20,000.00	$	200,000.00
					$	-
					$	-
Total, Contract		$ 140,000.00	$ 40,000.00	$ 20,000.00	$	200,000.00

Payments to Contractor:

Inv. #	Inv. Date	Ser Per				C/S
2008-081300	10/8/2008	5/30-9/08	18,060.05		18,060.05	C080711
2008-088902	11/26/2008	OCT 08	7,074.00		7,074.00	C080711
2008-098624	12/8/2008	NOV 08	1,818.00		1,818.00	C080711
					-	
					-	
					-	
					-	
					-	
					-	
					-	
					-	
					-	
					-	
					-	
					-	
					-	
					-	
					-	
Total, Payments			$ 26,952.05	$ -	$ -	26,952.05
Balance Available to Pay Contractor			$ 113,047.95	$ 40,000.00	$ 20,000.00	$ 173,047.95
Balance Must Be Spent By:			*6/30/2010*	*6/30/2011*	*6/30/2012*	

(3)

Notes:

Contract Manager: D. Kennedy

46 & 21

Scan Sch C08711

C080711

RCVD APR 6 '09

ICF CONSULTING
9300 Lee Highway
Fairfax, VA 22031-1207

Telephone (703)934-3000 Fax (703)218-2547
Web http://www.icfconsulting.com

INVOICE

Air Resources Board
Attn: Accounting Section
P.O.Box 1436
Sacramento, CA 95812

Invoice Date: October 8, 2008
ICF Contract No.: 028211
ICF Invoice No.: 2008-081309
Invoice Period: ~~May-September 08~~
5/20/08
4-07-348

Description		Current Invoice Amount	Cumulative Invoice Amount
ICF Task Detail	0.00G		
Carb: GHG Reduction	18,060.05 7,074.00 1,818.00 003 26,952.05G	$20,066.72	$20,066.72
Subtotal: ICF Task(s)		$20,066.72	$20,066.72
TOTAL INVOICE AMOUNT DUE:		$20,066.72	
		less 10% withheld 2,006.67	
		Total Due $18,060.05	

Approved by:

Authorized Financial Representative

Payment Due Net 30

Payment Options:

Wire Transfer:
Citizens Bank of Pennsylvania
ABA #: 036076150
Account Name: ICF Consulting Group, Inc.
Account # : 6203219502
Taxpayer ID: 04-3647360

OR

Remit Payment To:
ICF Consulting Services, LLC
PO Box 7777 - W510501
Philadelphia, PA 19175-0501
Please reference our contract and invoice numbers on your check

Billing Questions: Call Samia El-Ferjani (703) 394-3698
or EMAIL sel-ferjani@ICFI.com

Contract Questions: Call Samuel Chambers (202) 862-1242
or EMAIL schambers@ICFConsulting.com

PAYMENT APPROVED:

BART E. CROES, P.E.
CHIEF, RESEARCH DIVISION
DATE 4/29/09

RCVD MAY 1 2009

RCVD APR 6 '09

ICF CONSULTING
9300 Lee Highway
Fairfax, VA 22031-1207

Telephone (703)934-3000 Fax (703)218-2547
Web http://www.icfconsulting.com

INVOICE

Invoice Date: November 26, 2008
ICF Contract No.: 028211
ICF Invoice No.: 2008-088982
Invoice Period: [redacted]

Air Resources Board
Attn: Accounting Section
P.O.Box 1436
Sacramento, CA 95812

[redacted] # 07-348

Description	Current Invoice Amount	Cumulative Invoice Amount
ICF Task Detail		
Carb: GHG Reduction	$7,860.00	$27,926.72
Subtotal: ICF Task(s)	$7,860.00	$27,926.72
TOTAL INVOICE AMOUNT DUE:	$7,860.00	
Less 10% withhold	786.00	
Total Due	$7,074.00	

Approved by:

Authorized Financial Representative

Payment Due Net 30

Payment Options:

Wire Transfer:
Citizens Bank of Pennsylvania
ABA #: 036076150
Account Name: ICF Consulting Group, Inc.
Account # : 6203219502
Taxpayer ID: 04-3647360

OR

Remit Payment To:
ICF Consulting Services, LLC
PO Box 7777 - W510501
Philadelphia, PA 19175-0501
Please reference our contract and invoice numbers on your check

Billing Questions: Call Samia El-Ferjani (703) 394-3698
or EMAIL sel-ferjani@ICFI.com

Contract Questions: Call Samuel Chambers (202) 862-1242
or EMAIL schambers@ICFConsulting.com

PAYMENT APPROVED:

for

BART E. CROES, P.E.
CHIEF, RESEARCH DIVISION
DATE 4/29/09

RECEIVED APR 1 2009

RCVD APR 6 '09

ICF CONSULTING 9300 Lee Highway
Fairfax, VA 22031-1207

Telephone (703)934-3000 Fax (703)218-2547
Web http://www.icfconsulting.com

INVOICE

Air Resources Board
Attn: Accounting Section
P.O.Box 1436
Sacramento, CA 95812

Invoice Date: December 8, 2008
ICF Contract No.: 028211
ICF Invoice No.: 2008-098624
Invoice Period: November-08

#01-34K

Description	Current Invoice Amount	Cumulative Invoice Amount
ICF Task Detail		
Carb: GHG Reduction	$2,020.00	$29,946.72
Subtotal: ICF Task(s)	$2,020.00	$29,946.72
TOTAL INVOICE AMOUNT DUE	$2,020.00	
less 10% withhold $ 202.00		
Total Due $1,818.00		

Approved by:

Authorized Financial Representative

Payment Due Net 30

Payment Options:

Wire Transfer:
Citizens Bank of Pennsylvania
ABA #: 036076150
Account Name: ICF Consulting Group, Inc.
Account # : 6203219502
Taxpayer ID: 04-3647360

OR

Remit Payment To:
ICF Consulting Services, LLC
PO Box 7777 - W510501
Philadelphia, PA 19175-0501
Please reference our contract and invoice numbers on your check

Billing Questions: Call Samia El-Ferjani (703) 394-5698
or EMAIL sel-ferjani@ICFI.com

Contract Questions: Call Samuel Chambers (202) 862-1242
or EMAIL schambers@ICFConsulting.com

PAYMENT APPROVED:

BART E. CROES, P.E.
CHIEF, RESEARCH DIVISION
DATE 4/29/09

RCVD MAY 1 2009

STATE OF CALIFORNIA – GENERAL SERVICES PROCUREMENT DIVISION

PURCHASING AUTHORITY PURCHASE ORDER

STD.65 (REV. 7/2003)
(PAM Version)

CONTRACT REGISTRATION NUMBER	AGENCY ORDER NUMBER	AMENDMENT NO.
n/a	07-348	
SUPPLIER: The numbers identified above MUST be shown on Invoice & Packing Slip.	DATE 06/20/08	PAGE 01 OF PAGE

SHIP TO
Air Resources Board
1001 I Street, 5th Floor, RD
Sacramento, CA 95814

BILL TO
Air Resources Board
Attn: Accounting Section
P.O. Box 1436
Sacramento, CA 95812

AGENCY BILLING CODE: 64300
PURCHASING AUTHORITY NUMBER: 9I-0908-ARB-HQ1
LEVERAGED PROCUREMENT AGREEMENT NO.

TO SUPPLIER ADDRESS (Type or Print Legibly)
ICF
9300 Lee Highway
Fairfax, VA 22031

INFORMATION TECHNOLOGY PROJECT IDECTIFICATION NUMBER

AGENCY OR BUYER INFORMATION

AGENCY TRACKING/REQUISTION NUMBER (OPTIONAL)

AGENCY NAME: Air Resources Board
CONTACT NAME: Dory Kramer
CONTACT E-MAIL ADDRESS: dkramer@arb.ca.gov
CONTACT PHONE NUMBER: 916 / 445-4444
CONTACT FAX NUMBER: 916 / 327-2940

SUPPLIER CONTACT NAME	SUPPLIER PHONE NUMBER	SUPPLIER FAX NUMBER	SUPPLIER E-MAIL ADDRESS
Nakia C. Adams FEIN: 04-3647360	703-934-3646	703-218-2547	nadams@icfi.com

PAYMENT TERMS	CERTIFICATION NUMBER	CERTIFIED	CERTIFIED	EXPIRATION DATE	CERTIFIED	EXPIRATION DATE
NET 45	n/a	☐ SMALL	☐ MICROBUSINESS		☐ DVBE	

REQUIRED DELIVERY DATE	SHIPPING INSTRUCTIONS	☐F.O.B. Destination FRT. PPD	☐ F.O.B. Destination FRT. PPD/ADD Freight not to exceed cost stated on P.O.	☐F.O.B. ORIGIN	CITY OF ORIGIN	STATE	ZIP CODE

ITEM NUMBER	QUANTITY	UNIT	COMMODITY CODE or PRODUCT CODE or SERVICES ID NUMBER	RECYCLED PRODUCT	PRODUCT OR SERVICES DESCRIPTION	UNIT PRICE	EXTENSION TOTAL
1	1				Exhibit A, Scope of Work (2 pages)		
2	1				Exhibit A, Attach 1, Labor Rates (pages 12-13)		$190,000.00
3	1				Exhibit A, Attach 1, Other/Direct Costs (page 12)		$10,000.00
4	1				Exhibit A, Attach 1, Specifications ((74 pages)		
5	1				Exhibit B, (Payment Provisions) (1 page)		
6	1				Exhibit C – IT GPs (referenced below)		
7	1				Exhibit D–Special Terms and Conditions (2pages)		
8	1				Exhibit E – Additional Provisions (8 pages)		
9	1				Exhibit F-Final Report Format (6 pages)		

TERMS AND CONDITIONS

A-1 ☒ General Provisions are incorporated herein by reference to:
☐ Form GSPD-401 Non-IT Commodities (revised date_____) OR ☐ Form GSPD-401IT(revised date 4/12/2007)
☒ATTACHED OR ☒ Published at website www.dgs.ca.gov/pd

A-2 ☒ This order is issued under a Department of General Services (DGS) Leveraged Procurement Agreement (LPA). Terms and Conditions set forth in that agreement (LPA number referenced in the block titled Leveraged Procurement Agreement No.) are incorporated herein by references as if set forth in full text.

B ☐ Agency Special Provisions are attached and titled _____.

C ☒ Any other attachments, such as specifications or Statement of Work, or Information Technology Model Language Modules, are identified in the product or service description area or on continuation pages.

*NOTE: If there are variable charges for Installation, Shipping of Freight, or Other Non-Taxable Services, detail per line item and enter total here.

TAXABLE SUBTOTAL	$200,000.00
TAX RATE SALES TAX	
*INSTALLATION	
*SHIPPING/ FREIGHT	
*OTHER NON-TAXABLE	
GRAND TOTAL	$200,000.00

PROCUREMENT METHOD ☐ COMPETITIVE: Solicitation Number (if applicable) _____
☒LEVERAGED ☐DVBE/SMALL BUSINESS [GC 14838.5(a)] ☐ NON-COMPETITIVELY BID ☐ EXEMPT

PROGRAM/CATEGORY (Code and Title)	FUND TITLE	VERIFIED NO STATE SURPLUS AVAILABLE ☒ Yes ☐ NO	PAID BY CAL-CARD ☐ Yes ☒ NO

ITEM	CHAPTER	STATUTE	FISCAL YEAR	OBJECT OF EXPENDITURE (Code And Title)	☐ O.E. ☐ EQ.

CERTIFICATION AND APPROVAL OF EXECUTIVE OFFICER

I HEREBY CERTIFY, on personal knowledge, that this order for purchasing the items specified above is issued in accordance with the procedure prescribed by law governing the purchase of such items for the State of California, and that all such legal requirements have been fully complied with.

AUTHORIZING NAME (Print or Type): Socorro Watkins
TITLE: Chief, Business Services Branch
AUTHORIZING SIGNATURE: for Sharon Abney, Manager, Contract Services Section 6/20/08

UNENCUMBERED REMAINDER AFTER POSTING THIS ORDER TO ALLOTMENT EXPENDITUE LEDGE	
ADJUSTMENT INCREASING ENCUMBRANCES	
ADJUSTMENT DECREASING ENCUMBRANCES	
CERTIFIED CORRECT (SIGNATURE) See STD 215 for encumbrance & signature.	

DISTRIBUTION: Original – Supplier; Copy 1 – DGS Procurement; Copy 2 – Packing Slip

SCPRS 3900090833127

SUPPLIER INSTRUCTIONS

1. **INVOICES:** Unless otherwise specified, original invoices shall be sent to the "Bill To" address on the face of this document. Invoices shall be submitted in triplicate and shall include:

   - Contract registration number *(if applicable)*,
   - Agency order number,
   - Item number,
   - Services or Product ID number,
   - Unit price,
   - Extended item price, and
   - Invoice total amount.

   State sales tax, installation cost, shipping/freight costs, and/or other non-taxable costs shall be itemized separately and added to each invoice as applicable.

2. **REQUIRED PAYMENT DATE:** Payment will be made in accordance with the provisions of the California Prompt Payment Act, Government Code Section 927 et seq. Unless expressly exempted by statute, the Act requires state agencies to pay properly submitted, undisputed invoices not more than 45 days after (a) the date of acceptance of goods or performance of services; or (b) receipt of an undisputed invoice—whichever is later.

3. **SHIPPING INSTRUCTIONS:** When the Purchase Order or contract allows prepaid/add transportation charges, submit original receipted expense bills if freight charges are over $50.00. All shipments shall be F.O.B. Destination Freight Prepaid unless otherwise specified. All orders **MUST** include a copy of the packing slip inside the carton **AND** a copy securely attached to the **OUTSIDE** of the shipping carton.

EXHIBIT A
Standard Agreement

SCOPE OF WORK

1. Contractor agrees to provide to Air Resources Board (ARB) services as described herein:
2. The project representatives during the term of this agreement will be:

State Agency: Air Resources Board		Contractor: ICF Consulting Services, LLC	
Name:	Emma Plasencia	Name:	Laurence M. Rose
Address:	1001 I Street, 5th floor Sacramento, CA 95814	Address:	9300 Lee Highway, Fairfax, VA 22031
E-Mail:	eplasenc@arb.ca.gov	E-Mail:	LRose@icfi.com
Phone:	(916) 323-1524	Phone:	(703) 934-3557
Fax:	(916) 322-4357	Fax:	(703) 218-254

Direct all administrative inquiries to:

State Agency:	Air Resources Board	Contractor:	Mark Wagner
Section/Unit:	Research Division	Section/Unit:	Sr Vice President
Attention:	Dory Kramer	Attention:	
Address:	1001 I Street, 5th floor	Address:	9300 Lee Highway, Fairfax, VA 22031
E-Mail:	dkramer@arb.ca.gov	E-Mail:	mwagner@icf.com
Phone:	(916) 445-4444	Phone:	(202) 862-1155
Fax:	(916) 327-2940	Fax:	

3. **Description of Services:**

A. **Scope and Description** – *The ARB has committed to using the Energy 2020 Model for analysis of the AB 32 Scoping plan. ENERGY 2020 is an integrated multi-region energy model that provides complete and detailed, all-fuel demand and supply sector simulations. The ENERGY 2020 model runs under the PROMULA simulation system. The ARB is reasonably proficient in the use of this model but will require additional assistance if it is to meet the deadlines set for the completion of the economic analysis required for the AB 32 Scoping plan development.*

B. **Contractor Tasks and Responsibilities** – *The contractor will provide further training in the use of the Energy 2020 model, assistance in designing and coding policy scenarios using the PROMULA language and assistance in the interpretation of model results*

C. **Deliverables** – *The primary deliverables will be PROMULA code designed to run specific ARB policies in the Energy 2020 model. On an as needed basis, the ARB will provide the contractors with descriptions of policies and the contractor assist ARB in writing the PROMULA code necessary to implement the policy in Energy2020. The code must be well documented and accurately reflect the policy scenario being modeled. The contractor will also provide an explanation of the results generated by running the policy scenarios in Energy 2020.*

EXHIBIT A
Standard Agreement

D. **Acceptance Criteria** – *It shall be the State's sole determination as to whether a deliverable has been successfully completed and acceptable to the State. There must be a signed acceptance document for each deliverable before invoices can be processed for payment."*

Acceptance criteria shall consist of the following:

1. *Deliverables are completed as specified and approved.*
2. *All deliverables must be in a format that can be used by the State.*
3. *If a deliverable is not accepted, the State shall provide the rationale in writing within 5 days of receipt of the deliverable or upon completion of acceptance testing period.*

E. **Other Reporting Requirements**

1. *On a (monthly) basis, each contractor staff person shall complete and submit to ARB a monthly invoice for actual hours expended by person and labor category.*
2. *The contractor will develop and provide ad hoc reports as deemed appropriate and necessary by the State.*

F. **State Responsibilities**

Provide access to business and technical documents as necessary for the contractor to complete the tasks identified in the department's purchase document.

ICF's proposal will remain in effect for a period of ninety (90) days from the date of submission. ICF retains the right to review its submission and to extend its offer or to revise its proposal based on the facts known to us at the end of the ninety-day period.

Cost Justifications

The staff selected for this project have extensive experience related to the application of ENERGY 2020. The level of effort (LOE) indicated for each staff member and labor category has been carefully considered to provide CARB with cost-effective services. Junior staff members will provide research and other project support, while ICF's and SSI's senior modeling experts will oversee the research efforts, contributing their expertise and ensuring a high quality project. The rates proposed for each staff member are competitive with the environmental consulting industry overall.

Additional Information

- DUNS Number – 06-524-6527
- CAGE Code – 3AV32
- Federal Tax Identification Number – 04-3647360
- Size Status – Large Business
- ICF has prepared this submission based on a Time and Materials contract
- Invoices will be submitted on a monthly basis

Remittance Address

Electronic funds transfer address:

Account Name:	ICF Consulting Group, Inc. Fairfax, Virginia
Bank:	Citizens Bank 1 Citizens Drive Riverside, RI 02915
ABA Number:	036076150
Account Name:	ICF Consulting Group, Inc.
Account Number:	6203219502

Lockbox Address:
ICF Consulting Services, L.L.C.
P.O. Box 7777 – W510501
Philadelphia, PA 19175-0501

ICF INTERNATIONAL

Our proposed rates are shown in the table below:

	Year 1			Year 2			Project Summary	
Labor Category	Hours	Rate Per Hour	Total	Hours	Rate Per Hour	Total	Hours	Total
Principal Consultant 5		$302.00			$317.10			
Principal Consultant 4		$260.00			$273.00			
Principal Consultant 3		$225.00			$236.25			
Principal Consultant 2	80	$220.00	$17,600	40	$231.00	$9,240	120	$26,840.00
Principal Consultant 1	10	$190.00	$1,900	5	$199.50	$998	15	$2,897.50
Senior Consultant 5		$200.00			$210.00			
Senior Consultant 4		$170.00			$178.50			
Senior Consultant 3		$160.00			$168.00			
Senior Consultant 2		$140.00			$147.00			
Senior Consultant 1		$120.00			$126.00			
Junior Consultant 2		$80.00			$84.00			
Junior Consultant 1		$60.00			$63.00			
Associate Consultant 7	100	$155.00	$15,500	50	$162.75	$8,138	150	$23,637.50
Associate Consultant 6	50	$130.00	$6,500	25	$136.50	$3,413	75	$9,912.50
Associate Consultant 5	100	$115.00	$11,500	50	$120.75	$6,038	150	$17,537.50
Associate Consultant 4	80	$108.00	$8,640	40	$113.40	$4,536	120	$13,176.00
Associate Consultant 3	48	$100.00	$4,800	24	$105.00	$2,520	72	$7,320.00
Associate Consultant 2		$85.00			$89.25			
Associate Consultant 1		$75.00			$78.75			
Research Analyst 2		$72.00			$75.60			
Research Analyst 1		$60.00			$63.00			
Clerical Support 2		$80.00			$84.00			
Clerical Support 1		$60.00			$63.00			
SSI Senior Modeler	110	$290.00	$31,900	55	$304.50	$16,748	165	$48,647.50
SSI - Senior Associates	150	$175.00	$26,250	75	$183.75	$13,781	225	$40,031.25
Total Labor	728		$124,590	364		$65,410	1,092	$190,000
Other Direct Costs								
Travel Costs			$4,241			$4,245		$8,486
Other Direct Costs			$144					$144
G&A			$696			$674		$1,370
Total			$5,081			$4,919		$10,000
Total Year 1			$129,671	Total Year 2		$70,329	Total	$200,000

Direct Labor Rates

ICF has proposed hourly rates based on labor categories. The labor category rates are derived from actual labor rate information as of May, 2008.

Allocation of Hours

ICFs estimate is based on our experience in performing similar work for other clients, and reflects the results of our detailed analysis of the activities to be performed as specified in the RFO. Our distribution of hours across the labor categories also reflects the staffing mix that ICF believes will be most cost-effective in completing this work. The table below depicts the total cost to complete the project.

Allocation of Other Direct Costs (ODCs)

It is ICF's disclosed accounting practice to recover contract specific other direct costs as a direct charge to any specific contract. Such other direct cost elements include but are not limited to courier/messenger, computer related, material/supplies, postage/express mail, printing, reproduction, telephone and travel. It is also our accounting practice to apply G&A to all other direct costs at a rate of 15.88%.

Period of Performance

The proposed period of performance is:

Year 1 – date of award to May 31, 2009
Year 2 – June 2, 2009 – May 31, 2010

ARB/ICF
Agreement No. 07-348
Exhibit A, Attachment No. 1
Technical & Cost Proposal

Energy2020 Modeling Assistance to Support the Implementation of AB 32

(RFP #07-348)

May 15 2008

Submitted to:

California Air Resources Board
Dory E. Kramer
P.O. Box 2815
Sacramento, CA 95812
Phone: 916-445-4444
Email: dkramer@arb.ca.gov

Submitted by:
ICF Consulting Services, LLC
9300 Lee Highway
Fairfax, VA
22031

This proposal includes data that shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed—in whole or in part—for any purpose other than to evaluate this proposal. If, however, a contract is awarded to this offeror as a result of—or in conjunction with—the submission of these data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the resulting contract. This restriction does not limit the Government's right to use information contained in these data if it is obtained from another source without restriction. The data subject to this restriction are contained in this volume and its appendices and attachments.

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1 Introduction

Governments all over the world are taking action to reduce greenhouse gas (GHG) emissions, in recognition that without such action, the impacts of climate change are likely to be dramatic and costly. In taking this step to evaluate GHG emission reduction opportunities from key sectors, the Air Resources Board (ARB) is positioning itself as a leader in this area, paving the way for the emergence of cost effective strategies to reduce GHG emissions.

ICF International (ICF) and Systematic Solutions, Inc. (SSI) are pleased to submit this proposal to support the ARB in assessing the cost effectiveness of alternative GHG emission reduction strategies. ENERGY 2020 is an integrated multi-region energy model that provides complete and detailed, all-fuel demand and supply sector simulations. ICF and SSI have developed ARB's modeling framework, and this contract would supplement the existing work by providing assistance with further training in the use of the Energy 2020 model, assistance in designing and coding policy scenarios using the PROMULA language and assistance in the interpretation of model results. To facilitate the ability of the ARB to use the model and integration framework, we propose to work collaboratively with the ARB staff throughout this project so that they are knowledgeable regarding the sources of data used in the model and the manner in which the data are input.

The ICF Team embodies an ideal synergy of expertise for supporting the ARB's mission. ICF has established a reputation in the field of climate change consulting for its analytical rigor, in-depth expertise, and technical integrity through scores of GHG emissions related assignments. ICF has one of the world's largest consulting staff dedicated to global climate change policy analysis. SSI has designed, developed and implemented energy, environmental and macroeconomic models for national and regional policies since 1985. SSI has performed forecasting, simulation, and policy analysis for the public and private sector entities in over 30 states and provinces in North America. The ICF Team has managerial and administrative structures to ensure that effective project management, cost, and quality assurance controls are in place for the duration of any given project.

The ICF Team proposes to provide the staff and expertise required to deliver the modeling capabilities that meet the ARB's requirements. We look forward to working closely with the ARB staff to help the ARB fulfill its legislative mandate under the California Global Warming Solutions Act (AB 32).

Section 2 of this proposal provides business information for the ICF/SSI team. The remainder of this proposal is organized according to the guidelines in the RFP entitled "RFO response content." Section 3 provides our "Specification of Work" responding to the State's Specification of Work in Attachment A of the RFP. Section 4 provides our cost information, organized according to the RFP's "Cost Worksheet, Attachment B." Appendix A provides an overview of ENERGY 2020, and Appendix B provides resumes for key staff.

2 ICF Team Business Information

Prime Contractor:	ICF Consulting Services, LLC
Corporate Headquarters:	9300 Lee Highway Fairfax, VA 22031
Authorized Binding Official:	Lawrence Rose (703) 934-3557
Authorized Technical Official:	Ralph Torrie 416- 341-0392
Branch office:	ICF Consulting Services, LLC 14724 Ventura Blvd., Suite 1001 Los Angeles, CA 91403
Subcontractor:	Systematic Solutions, Inc. 4420 Snypp Road Yellow Springs, Ohio 45387
Authorized Contact:	Jeff Amlin 937-767-1873

The proposed ICF Team is available to begin work for the ARB immediately, upon contract award.

3 Specification of Work

Climate change is at the forefront of the challenges facing California and the world. ICF International is pleased to submit this proposal to provide the California Air Resources Board (the ARB) with modeling capabilities to assess greenhouse gas (GHG) emission reduction strategies across all sectors of the California economy. We offer a comprehensive approach, combining our multi-sector expertise with the industry's premier multi-sector modeling platform, ENERGY 2020.

ICF is joined in this proposal by Systematic Solutions Incorporated (SSI), the exclusive developer and owner of ENERGY 2020. The combined strengths of the ICF Team enable us to offer the ARB a proven modeling framework with unparalleled depth and breadth of coverage of all relevant sectors, including: residential, commercial, industrial, power, fuel, renewable, energy efficiency and distributed generation. ICF and SSI have worked together to model and evaluate multi-sector GHG emission reduction policies in California, Canada, Illinois, and other locations. We propose to apply this experience to provide the ARB with the modeling capabilities it requires to fulfill it legislative mandates under *The Global Warming Solutions Act of 2006* (AB 32).

The remainder of this section is organized as follows:

- Section 3.1 presents our understanding of the ARB's objective for this project.
- Section 3.2 presents an overview of our approach to executing the project.
- Section 3.3 presents an overview of ENERGY 2020. A more detailed description of the model is in Appendix A.
- Section 3.4 presents our proposed workplan and schedule.
- Section 3.5 provides an organization chart.

3.1 Objective

The objective of this project is to provide the ARB with the modeling capability to analyze policy options for reducing GHG emissions across all sectors of the California economy. As mentioned above, this capability is required for the ARB to fulfill its legislative mandate under AB 32, which requires that the ARB implement a program that reduces the State's GHG emissions to 1990 levels by 2020. The California Energy Commission's (CEC) recent analysis estimates that the State will need to reduce GHG emissions by 174 million tons from baseline levels to achieve this target in 2020.[1]

This legislation is one of a series of initiatives that has been undertaken in recent years to reduce GHG emissions statewide (see text box below). Consequently, the ARB's analysis must be capable of considering a broad range of emission reduction policies and activities that are already in place or are under consideration, including: vehicle climate change standards (AB 1493); energy efficiency investments; building and appliance standards, renewable portfolio standards; electric power generation emission performance standards (SB 1368); low carbon

[1] See Appendix F in: California Energy Commission, *Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004*, Staff Final Report, December 2006, CEC-600-2006-013-SF.

fuel standards; regulatory emissions reductions from specific sources (such as HFC and PFC emissions); and carbon sequestration options (particularly in the forest sector).

Of particular importance to the ARB is the ability to model and evaluate market-based regulatory approaches for reducing GHG emissions, including a cap and trade system. As directed by the Governor, the Market Advisory Committee (MAC) is examining alternative designs for a cap and trade program. The ARB must be capable of modeling and evaluating alternative designs identified by the MAC as part of the assessment of market-based policies required under AB 32. Although the MAC report is not yet available (a draft report is expected at the end of May), we can anticipate several of the key program design issues that will need to be examined:

Milestones in the Development of California's Climate Policy

- California Climate Action Registry (2000)
- Vehicle emissions law (AB 1493, 2002) and regulations (2004)
- Renewable Portfolio Standard – SB 1078 (2002)
- Emission Targets in Executive Order (2005)
- Climate Action Team Report (2006)
- Climate Legislation – AB 32 (2006)
- Accelerated RPS – SB 107 (2006)
- Power Plant Performance Standard legislation, SB 1368 (2006), and regulations (2007)
- California Solar Initiative, CPUC program and subsequent legislation – SB 1 (2006)
- Market Mechanisms Executive Order (2006)
- Fuel Standard Executive Order (2007)

- *Scope:* The scope of an emissions cap defines the sectors included under the cap and the points at which the cap is enforced (i.e., the "points of regulation"). An upstream cap on fossil fuels would place a limit on the carbon content of fuels introduced into California. All fuels could be included, and the point of regulation could be the entity that brings the fuel into the state. Midstream and downstream caps may also be considered, including capping emissions from electric utilities as Load Serving Entities (LSEs) or capping emissions at individual power generation facilities and other large users of fossil fuels.

- *Allowance Distribution:* Emission allowances are expected to be the regulatory instrument for implementing the cap. A critical question to be analyzed is how best to distribute allowances to the regulated community. Previous cap and trade programs have given the allowances to affected facilities based on various methods. Also under consideration by the MAC are options for auctioning allowances. Recent analyses of the European Union Emissions Trading Scheme (ETS) experience indicate that auctioning may be preferred. In the Northeast states GHG program (the Regional Greenhouse Gas Initiative, RGGI), there is currently increased discussion and interest in auctioning allowances.

- *Offsets*: Whether and to what extent emission offsets will be eligible to be used is an important policy question under consideration. The ARB will need to assess the implications off allowing or limiting offsets by sector and location. Under RGGI, for example, the eligibility of certain types of offsets is triggered by observed allowance prices.

- *Other Issues*: There are a variety of other program design issues that will require examination. For example, the impacts of allowance banking will need to be assessed. Similarly, the implications of defining a maximum allowance price as an "off ramp" or "safety valve" should be examined.

In order to analyze these aspects of a cap and trade program in conjunction with a broad range of related emission reduction policies, the ARB's modeling system will include: (1) the model provided under this project (ENERGY 2020); (2) a detailed electric sector modeling capability (maintained at the California Pubic Utilities Commission, CPUC); and (3) a macroeconomic modeling capability (EDRAM) maintained at the ARB.

As an important component of this three-part framework, the modeling capability provided under this project – ENERGY 2020 – is capable of:

- simulating the California economy, including economic output and growth, energy production and consumption, GHG emissions, and related measures;
- representing a broad range of emission reduction programs in specific sectors under consideration;
- imposing an emissions cap on all sectors or selected sectors;
- considering technical options for reducing GHG emissions in multiple sectors simultaneously in an integrated manner, for example through the use of Marginal Abatement Cost Curves (MACCs); and
- estimating the responses of each of the sectors of the economy to the full range of policies and emission cap program designs.

The overall modeling framework must also be capable of considering multi-state analyses, particularly sets of states that may join with California to create an integrated GHG emission reduction program.

As described in the following section, our overall approach to this project is to provide assistance to ARB in applying ENERGY 2020 to fulfill these requirements.

3.2 Approach Overview

The ICF Team proposes a comprehensive and proven approach for providing the multi-sector modeling capability required by the ARB. First, we will continue to work with the ARB to customize ENERGY 2020 to reflect California-specific conditions and the broad range of policies under consideration:

- *ENERGY 2020:* ENERGY 2020 provides the capacity to model the energy, technology, and policy interactions that the ARB wishes to explore with this project, as well as broader impacts on and interactions with the environment and the economy. By relying on an established model with proven capabilities, the ARB can be assured of obtaining the functional and analytical capabilities required to achieve its objectives.
- *California-Specific Data:* The ICF Team proposes to obtain, review, and provide up-to-date California-specific data for use in ENERGY 2020. Working with the ARB staff, we propose to identify the most appropriate data sets and ensure that they are represented in the model properly to reflect California economic sectors, energy production and consumption, and GHG emissions.
- *Model Parameters:* The ICF Team proposes to provide the ARB with up-to-date model parameters that consider the latest thinking on how sectors react to GHG emission

reduction policies, including how changing prices affect output and energy demand by sector.

- *Marginal Abatement Cost Curves:* The ICF Team proposes to assemble available data on the technologies and costs for reducing GHG emissions in key sectors. These emission reduction opportunities have been represented as Marginal Abatement Cost Curves (MACCs) in previous studies. Working with the ARB staff, we will assemble these data and represent them in the model.

As noted in the RFP, the ENERGY 2020 model runs under the PROMULA simulation system. The PROMULA language provides the following basic capabilities: data management, data analysis, modeling, and report generation.

The ICF/SSI team will provide additional services to ARB as policies are analyzed and refined, including:

- Translating policies into ENERGY 2020 scenarios
- Writing PROMULA code for the scenarios
- Updating of model data as new data is accumulated or as more suitable sources of data are identified
- Additional model support as identified by ARB.

ICF and SSI will develop all necessary services as outlined in Background and Purpose for the State to evaluate with the purpose of determining that ICF's response meets the requirements to perform the tasks and activities defined by the State's Scope of Work, attachment A of the RFO No. 07-348 as herein under the following tasks:

- **Training**– ICF/SSI will provide further training in the use of the ENERGY 2020 model.
- **Assistance** – ICF/SSI will assist in the designing and coding policy scenarios using PROMULA language. The PROMULA code will be designed to run specific ARB policies in the Energy 2020 model. The ARB will on a needed basis, provide ICF International with descriptions of policies and ICF International will assist ARB in writing the PROMULA code necessary to implement the policy in ENERGY 2020.
- **Interpretation** – ICF/SSI will assist in the interpretation of model results. The code will be well documented and accurately reflect the policy scenario being modeled. ICF and SSI will also provide an explanation of the results generated by running the policy scenarios in ENERGY 2020.

Using this overall approach, the ICF Team is confident in our ability to deliver the modeling capability required by the ARB. The next section provides an overview of ENERGY 2020.

3.3 ENERGY 2020

ENERGY 2020 is an integrated multi-region energy model that provides complete and detailed, all-fuel demand and supply sector simulations. These simulations can be linked to a model such as EDRAM to capture macroeconomic interactions to determine the benefits or costs to the local, or national, economy of new facilities, emission policies, or changing energy prices. The model portrays the interaction of market competitors in a realistic, as opposed to an idealized, fashion. GHG emissions and costs, including allowances and trading, are

endogenously determined, thereby allowing assessment of environmental risk and co-benefit impacts.

ENERGY 2020 is a policy planning model: it contains hundreds of "standard" policy options and literally thousands of policy variables to create new policies. For climate change efforts some generic policy categories include tax incentives/disincentives, exogenous additions to delivered energy prices, new regulations/market structures, grants and rebates, efficiency standards, consumer awareness, allowance trading and consumer behaviors and their responsiveness to various options.

ENERGY 2020 Highlights

- ENERGY 2020 model can be used to model energy using technologies and processes for 25 years or more. Projects currently being conducted for Environment Canada routinely model results to 2050.
- Explicit coverage of key sectors including, but not limited to, fossil-fuel fired electricity generation, upstream oil and gas, downstream petroleum, base metal smelters, iron and steel, cement, forest products, and chemicals production. Electricity generation will be calibrated to the power sector model results. The North American Industrial Classification System (NAICS) will be used to define those sectors.
- Fourteen commercial and thirty four industrial sectors are modeled by ENERGY 2020. For the electricity sector, utility and industry generation are each modeled as well as steam production. All of the sectors listed in the RFP are modeled explicitly in ENERGY 2020.
- Inter-industry and inter-fuel allocations of resources respond to changes in relative prices as well as to demand levels. Prices can affect both the level of demand for a service, the efficiency of the process or device as well as the type of fuel selected.
- The model can be used to analyze various options with regard to compliance strategies and costs, fiscal incentives, trading schemes and technologies as well as policies aimed at demand reduction or demand side management.

The model is descriptive. It simulates the physical and economic flows of energy users and suppliers. It simulates how they make decisions and how those decisions causally translate to energy-use and emissions. In ENERGY 2020, those decisions include process/shell efficiency and costs decisions, device efficiency and cost decisions, new investment market-share decisions, and utilization decisions. Weather and economic conditions affect utilization as much as energy price conditions. The model accumulates both process (facility) and device capital stocks, and simulates their retirements. It calculates both marginal and average costs and efficiencies. Process efficiency (how much energy service the household or factory needs to produce its output) determines the number of joules that must come out of the furnaces, hot water heaters, refrigerators, lights, and other equipment. For example, heating needs (and efficiency) define the devices needed. The devices define the primary energy needed.

The simulation covers three classes of residential, one class of commercial (up to 13 buildings type have been defined) and 23 industrial categories. Each class has six to eight end-uses (process heat, space heat, cooling, lighting, cooking, and others).

Process costs (endogenously based on energy decisions) and device costs (the marginal costs of using energy from the device) determine the energy choices. These choices maximize the utility of using the energy as determined by the Qualitative Choice Theory (QCT). One important aspect of QCT is that it considers both price and preferences. It includes the extent to which market participants know of or have access to the choice. For example, some people only want large safe cars and efficiency is secondary. Some people live in rural areas and do not have access to natural gas. There may be a new heat pump technology that works well in northern climates but if it is not fully marketed/advertised, few know to select it. All the decisions

(their components and information flows) that are relevant to consumer energy choice are endogenously simulated.

Additionally each demand sector has a self-generation sub-sector. These sectors can simulate cogeneration and distributed generation including fuel cells and micro-turbines. Lastly, each demand sector includes a demand for energy feedstocks (solvents, reactants, lubricants, asphalt, and others).

Emissions are modeled in ENERGY 2020 based on a detailed representation of economic activity and demand for services, process and device efficiencies, fuel mixes, emission factors, control technologies, and existing regulations. Results from ENERGY 2020 can be input into a macroeconomic model such as EDRAM to provide an integrated simulation of the economic implications of changes in energy and emissions policies. Combined, the models can be used to determine the outcomes of emissions regulations, trading schemes, including domestic and international trading and other policies. The detailed structure of these models provides a rich picture of policy impacts on output, prices and employment by sector.

ENERGY 2020 is capable of capturing adequately the impact in terms of trade, technology investments, capital stock turnover, and various measures of economic impacts. Investments are, in part, driven by stock turnover though they may also be initiated in response to policies or incentives. Capital investments in new technology are modeled at both the process and device level so that these investments in turn affect the efficiency with which energy is used and the resulting GHG emissions. Of particular interest is that ENERGY 2020 calculates criteria air pollution emissions. This capability enables the model to examine the co-benefits of GHG emission reduction policies in terms of reductions in criteria air pollutant emissions.

A more detailed description of ENERGY 2020 is provided in Appendix A. The ICF Team is pleased to provide additional information on the model as needed by the ARB to evaluate this proposal.

3.4 Work Plan, Schedule, and Deliverables

This section outlines the specific steps that the ICF Team proposes to undertake to ensure the success of this project.

The expected start date for the additional services is May 2008, and the estimated timeframe for this project work will be twenty-four (24) months. Thus, in Section 4 of this proposal, ICF has provided T&M rates for both year 1 and year 2.

All schedules will be specified by ARB in technical directives. ICF will respond by email to these technical directives, acknowledging receipt and providing a brief outline of our plan to respond.

As specified in the RFP, the primary deliverables will be ENERGY 2020 policy files (in PROMULA code) designed to run specific ARB policies in the ENERGY 2020 model, along with documentation and interpretation of model outputs. On an as needed basis, the ARB will provide the ICF/SSI team with descriptions of policies and we will assist ARB in writing the PROMULA code necessary to implement the policy in ENERGY 2020. The code will be well-documented, will accurately reflect the policy scenario being modeled, and will be accompanied, where appropriate, with an explanation of the results. ICF agrees to a signed acceptance document for each deliverable as specified in the RFP.

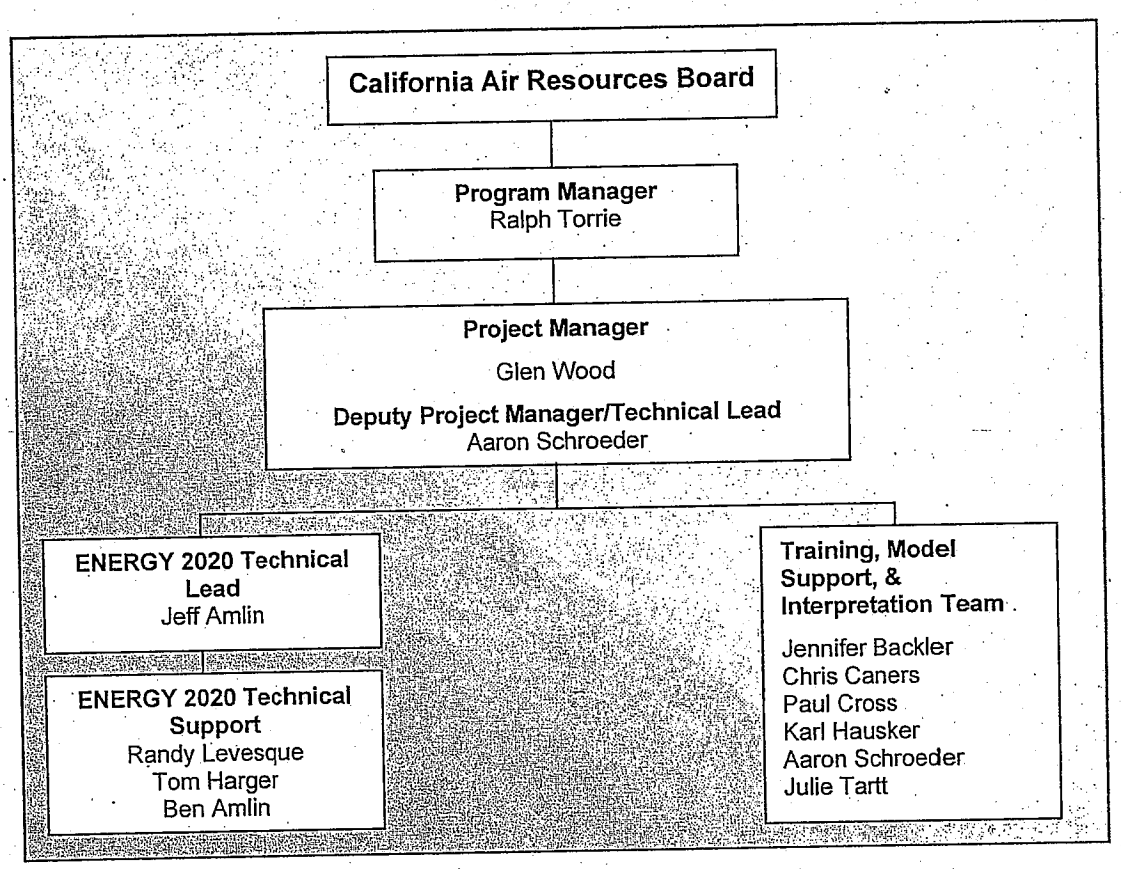
3.5 Project Organizational Structure and Personnel

The ICF Team proposes a focused organizational structure with well defined roles and responsibilities. The project organizational chart (Exhibit 1) presents the lead staff from both

ICF International and Systematic Solutions, Inc., and their roles. The Program Manager has overall responsibility for this work and ensuring client satisifcation; the Project Manager and Deputy Project Manager/Technical Lead will be the key day-to-day contacts for purposes of the technical communications between CARB staff and the project team.

In addition to the staff in the exhibit, the ICF Team proposes additional support staff as presented in the project budget. We can also draw on additional staff for support if needed. SSI and ICF have worked together on similar projects, and will deliver seamless support to the ARB throughout this effort.

Exhibit 1: ICF Team Organizational Structure



Resumes for selected team members are provided in Appendix B.

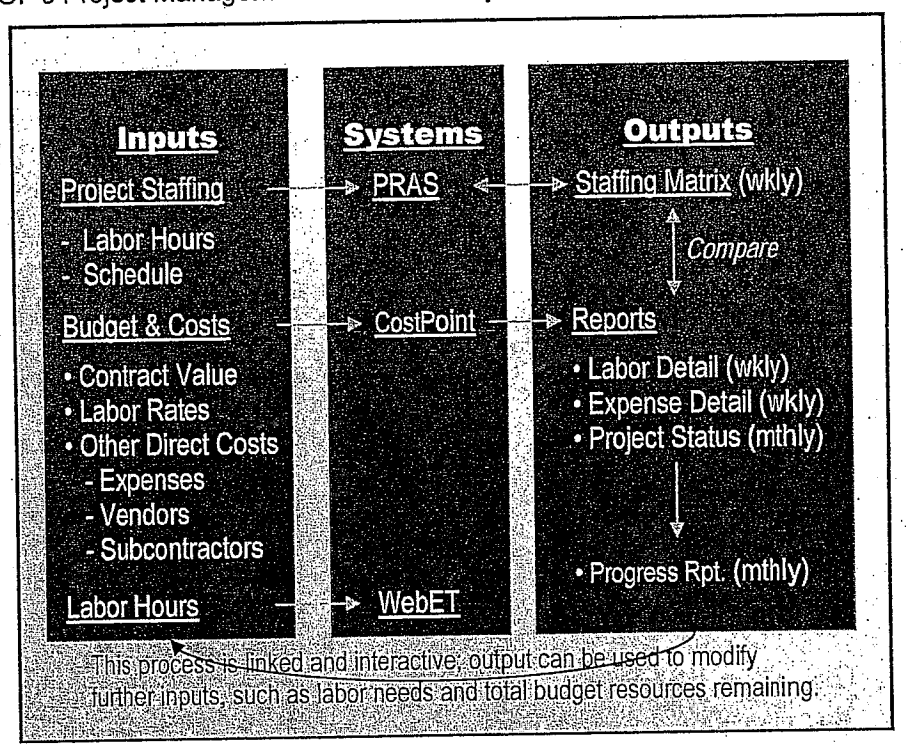
4 Cost Proposal

This section describes the methods for cost management, as well as the time and materials rates that we propose for both the first and second years of the project. We will use the systems described in section 4.1 to send monthly invoices for actual hours expended. We will not provide actual timesheets, but instead will provide a tabulation of hours by person and labor category.

4.1 Cost Management

Cost management is critical to successful project execution. This section describes our project management information system for tracking labor hours and costs, generating tracking reports, and preparing detailed financial status reports that allow the ARB Project Manager to evaluate our contract performance.

Exhibit 2: ICF's Project Management Information System



ICF's state-of-the-art cost tracking capabilities are facilitated by Web-based electronic timekeeping (WebET) and the Deltek CostPoint system (see Exhibit). These tools allow project managers to generate weekly project cost reports at the task level. These reports enable expenditure tracking to be linked closely with progress made on the work plan. Using these tools, ICF's management team will ensure that the ARB project is managed within budget and on schedule.

4.1.1 Monitoring Costs by Tracking Labor Hours: WebET

ICF uses an Internet-accessible electronic timekeeping system, WebET, to track labor hours on a daily basis. This system allows managers to track labor hours on the contract by category and task levels. All ICF employees enter time daily into WebET and sign their timesheet for the week by close of business on Sunday. Reports from the system are available by the Tuesday afternoon following the close of the week the previous Sunday.

On a weekly basis, the management team will receive reports that show the labor hours spent on their tasks and subtasks from the beginning of the project to the previous week. These reports will allow our managers to keep a careful watch over the rate at which labor is being

used. They also facilitate the comparison of hours expended and the progress on the project in terms of deliverables and budget.

4.1.2 Monitoring Costs by Tracking Labor and Other Costs: CostPoint

ICF utilizes the Deltek CostPoint integrated financial and accounting system. CostPoint is a flexible and scalable Windows-based enterprise resource management system centered on a project accounting system. The CostPoint system was developed specifically for, and approved by, government agencies to support their cost accounting and reporting requirements. This robust system handles an unlimited number of contracts and task orders, incorporates subcontractor cost data, and generates numerous tracking reports that project managers can access online.

The information in ICF's CostPoint tracking system is typically assembled from the following categories of basic inputs and sources:

- **Project data** comes directly from client source documents (e.g., the contract, task orders) and includes information such as the contract number, task order number, anticipated labor hours, period of performance, and amount and source of funding.

- **Personnel information** includes the name, employee number, labor category, and hourly labor rate.

- **Labor hours** by person are entered into WebET (discussed above), which is a linked part of CostPoint. The information needed to track and report labor hours and the associated costs are incorporated in the project accounting system and reports.

- **Travel and other direct costs** (ODCs) are recorded in CostPoint on a daily basis as internal and vendor costs are received. Each cost is also entered into CostPoint with a general ledger code that identifies the cost category (e.g., subcontractor, travel, reproduction, delivery, long distance telephone) and with a vendor name, vendor number, and invoice number that facilitates retrieval of more detailed invoice information, if required. In addition, the vendor number and the project code can be used in combination to aggregate and report costs by vendor, region, site, etc. to meet the Directorate's needs.

- **Subcontractor costs** are recorded as they are received from our Team members. The same project accounting codes are used to collect the information with the required attributes. Subcontractor labor hours are thus tracked and incorporated into the overall project labor and cost plans and reports.

4.2 Time and Materials (T&M) Rates

We are proposing labor categories and corresponding rates. The rates are escalated by 5 percent in year 2 to reflect expected increases in salaries for the individuals within the labor categories.

We propose a total budget for this project of $200,000. We understand that this project is scalable, and are willing to negotiate on the budget ceiling.

Our proposed rates are shown in the table below:

	Year 1			Year 2			Project Summary	
Labor Category	Hours	Rate Per Hour	Total	Hours	Rate Per Hour	Total	Hours	Total
Principal Consultant 5		$302.00			$317.10			
Principal Consultant 4		$260.00			$273.00			
Principal Consultant 3		$225.00			$236.25			
Principal Consultant 2	80	$220.00	$17,600	40	$231.00	$9,240	120	$26,840.00
Principal Consultant 1	10	$190.00	$1,900	5	$199.50	$998	15	$2,897.50
Senior Consultant 5		$200.00			$210.00			
Senior Consultant 4		$170.00			$178.50			
Senior Consultant 3		$160.00			$168.00			
Senior Consultant 2		$140.00			$147.00			
Senior Consultant 1		$120.00			$126.00			
Junior Consultant 2		$80.00			$84.00			
Junior Consultant 1		$60.00			$63.00			
Associate Consultant 7	100	$155.00	$15,500	50	$162.75	$8,138	150	$23,637.50
Associate Consultant 6	50	$130.00	$6,500	25	$136.50	$3,413	75	$9,912.50
Associate Consultant 5	100	$115.00	$11,500	50	$120.75	$6,038	150	$17,537.50
Associate Consultant 4	80	$108.00	$8,640	40	$113.40	$4,536	120	$13,176.00
Associate Consultant 3	48	$100.00	$4,800	24	$105.00	$2,520	72	$7,320.00
Associate Consultant 2		$85.00			$89.25			
Associate Consultant 1		$75.00			$78.75			
Research Analyst 2		$72.00			$75.60			
Research Analyst 1		$60.00			$63.00			
Clerical Support 2		$80.00			$84.00			
Clerical Support 1		$60.00			$63.00			
SSI Senior Modeler	110	$290.00	$31,900	55	$304.50	$16,748	165	$48,647.50
SSI - Senior Associates	150	$175.00	$26,250	75	$183.75	$13,781	225	$40,031.25
Total Labor	728		$124,590	364		$65,410	1,092	$190,000
Other Direct Costs								
Travel Costs			$4,241			$4,245		$8,486
Other Direct Costs			$144					$144
G&A			$696			$674		$1,370
Total			$5,081			$4,919		$10,000
Total Year 1			$129,671	Total Year 2		$70,329	Total	$200,000

Direct Labor Rates

ICF has proposed hourly rates based on labor categories. The labor category rates are derived from actual labor rate information as of May, 2008.

Allocation of Hours

ICFs estimate is based on our experience in performing similar work for other clients, and reflects the results of our detailed analysis of the activities to be performed as specified in the RFO. Our distribution of hours across the labor categories also reflects the staffing mix that ICF believes will be most cost-effective in completing this work. The table below depicts the total cost to complete the project.

Allocation of Other Direct Costs (ODCs)

It is ICF's disclosed accounting practice to recover contract specific other direct costs as a direct charge to any specific contract. Such other direct cost elements include but are not limited to courier/messenger, computer related, material/supplies, postage/express mail, printing, reproduction, telephone and travel. It is also our accounting practice to apply G&A to all other direct costs at a rate of 15.88%.

Period of Performance

The proposed period of performance is:

Year 1 – date of award to May 31, 2009
Year 2 – June 2, 2009 – May 31, 2010

ICF's proposal will remain in effect for a period of ninety (90) days from the date of submission. ICF retains the right to review its submission and to extend its offer or to revise its proposal based on the facts known to us at the end of the ninety-day period.

Cost Justifications

The staff selected for this project have extensive experience related to the application of ENERGY 2020. The level of effort (LOE) indicated for each staff member and labor category has been carefully considered to provide CARB with cost-effective services. Junior staff members will provide research and other project support, while ICF's and SSI's senior modeling experts will oversee the research efforts, contributing their expertise and ensuring a high quality project. The rates proposed for each staff member are competitive with the environmental consulting industry overall.

Additional Information

- DUNS Number – 06-524-6527
- CAGE Code – 3AV32
- Federal Tax Identification Number – 04-3647360
- Size Status – Large Business
- ICF has prepared this submission based on a Time and Materials contract
- Invoices will be submitted on a monthly basis

Remittance Address

Electronic funds transfer address:

Account Name:	ICF Consulting Group, Inc. Fairfax, Virginia
Bank:	Citizens Bank 1 Citizens Drive Riverside, RI 02915
ABA Number:	036076150
Account Name:	ICF Consulting Group, Inc.
Account Number:	6203219502

Lockbox Address:
ICF Consulting Services, L.L.C.
P.O. Box 7777 – W510501
Philadelphia, PA 19175-0501

Appendix A: The Model – ENERGY 2020

ENERGY 2020 is an integrated multi-region, multi-sector energy analysis system that simulates the supply, price and demand for all fuels. It is a causal and descriptive model, which dynamically describes the behavior of both energy suppliers and consumers for all fuels and for all end-uses. It simulates the physical and economic flows of energy users and suppliers. It simulates how they make decisions and how those decisions causally translate to energy-use and emissions.

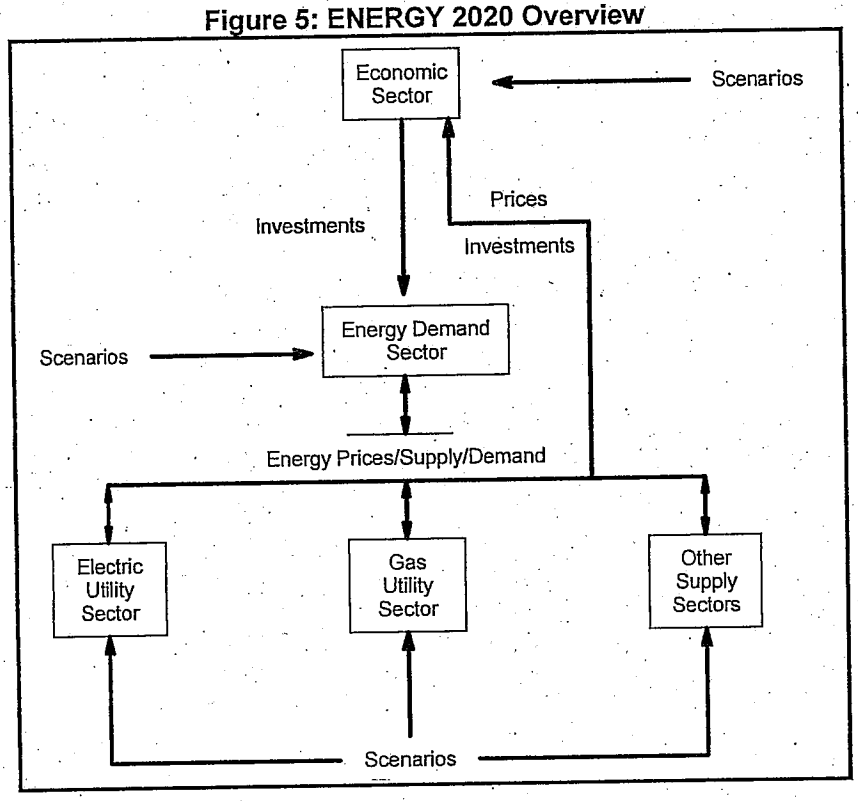
ENERGY 2020 is an outgrowth of the FOSSIL2/IDEAS model developed for the US Department of Energy (DOE) and used for all national energy policy since the Carter administration.[2] This early version of ENERGY 2020 was developed in 1978 at Dartmouth College for the DOE's Office of Policy Planning and Analysis. It has been refined through its use over more than 25 years to model a variety of energy and air emissions policies ranging from power industry deregulation to emissions trading to climate change policies affecting all sectors of the economy.

Model Overview:

The basic structure of ENERGY 2020 is provided in Figure 5. Energy Demand sector interacts with the Energy Supply sector to determine equilibrium levels of demand and energy prices. Energy Demand is driven by the Economy sector, which in turn provides inputs to the Economy sector in terms of investments in energy using equipment and processes and energy prices. The model has a simplified Economy sector to capture the linkages between the energy system and the macro-economy. However, the model is best run with full integration with a macroeconomic model such as REMI. Given the modular nature of ENERGY 2020, additional sectors or modules from other, non-ENERGY 2020 related, models (macroeconomic, supply such as oil, gas, renewables etc.) can be incorporated directly into the ENERGY 2020 framework.

[2] FOSSIL2 was the original version but was renamed to IDEAS a few years ago to reflect its evolutionary development since its original construction

Figure 5: ENERGY 2020 Overview



Energy Demand:

The demand sector of the model represents the geographic area by disaggregating the four economic sectors into subsectors based on energy services. As many or as few subsectors can be incorporated. Multiple technologies, multiple end-uses and multiple fuels are detailed. The level of detail that can be incorporated is of course subject to the data availability. The four economic sectors are:

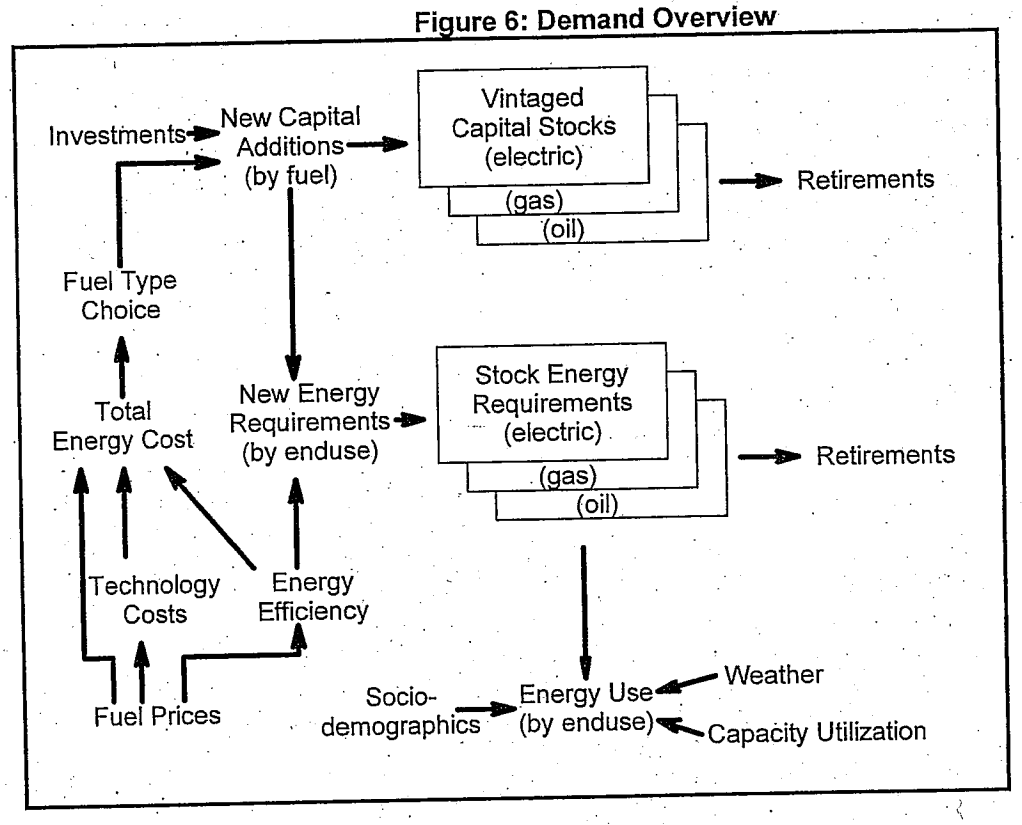
- Residential sector which includes three classes, single family, multifamily and rural/agricultural with 8 end-uses including space heating, water heating, lighting, cooling, refrigeration, other substitutable, and other non-substitutable.
- Commercial sector which is aggregated into one class and deals with 7 (?) end-uses including space heating, water heating, cooling, lighting, other substitutable, other non-substitutable.
- Industrial sector which includes 10 (23 for US) 2-digit SIC categories and process heat, motors, lighting, miscellaneous as the end uses.
- Transportation sector which includes several modes of transportation including automobile, truck, bus, train, plane, marine and electric vehicles. Also, each of the residential, commercial and industrial sectors have separate transportation demands.

For each of the end-uses, up to six fuels are modeled, for example, the residential space heating has the choice of a gas, oil, coal, electric, solar and biomass space heating

technologies. Added end-uses, technologies and modes can be added as data allow. For all end-uses and fuels, the model is parameterized based on historical locale-specific data. The load duration curves are dynamically built up from the individual end-uses to capture changing condition under consumer choice and combined gas/electric programs.

A few basic concepts are crucial to an understanding of how the model simulates the energy system. These concepts including, the capital stock driver, the modeling of energy efficiency through trade-off curves, the fuel market share calculation, utilization multipliers and the cogeneration module are discussed below in abbreviated form. Figure 6 (Demand Overview) illustrates the demand sector interactions.

Figure 6: Demand Overview



Energy Demand as a Function of Capital Stock:

The model assumes that energy demand is a consequence of using capital stock in the production of output. For example, the industrial sector produces goods in factories, which require energy for production; the commercial sector requires buildings to provide services; and the residential sector needs housing to provide sustained labor services. The occupants of these buildings require energy for heating, cooling, and electromechanical (appliance) uses.

The amount of energy used in any end-use is based on the concept of energy efficiencies. For example, the energy efficiency of a house along with the conversion efficiency of the furnace determines how much energy the house uses to provide the desired warmth. The energy efficiency of the house is called the capital stock energy or process efficiency. This efficiency is primarily technological (e.g. insulation levels) but can also be associated with control or life-style changes (e.g. less household energy use because both spouses work outside the home.) The

furnace efficiency is called the device or thermal efficiency. Thermal efficiency is associated with air conditioning, electromotive devices, furnaces and appliances.

The model simulates investment in energy using capital (buildings and equipment) from installation to retirement through three age classes or vintages. This capital represents embodied energy requirements that will result in a specified energy demand as the capital is utilized, until it is retired or modified.

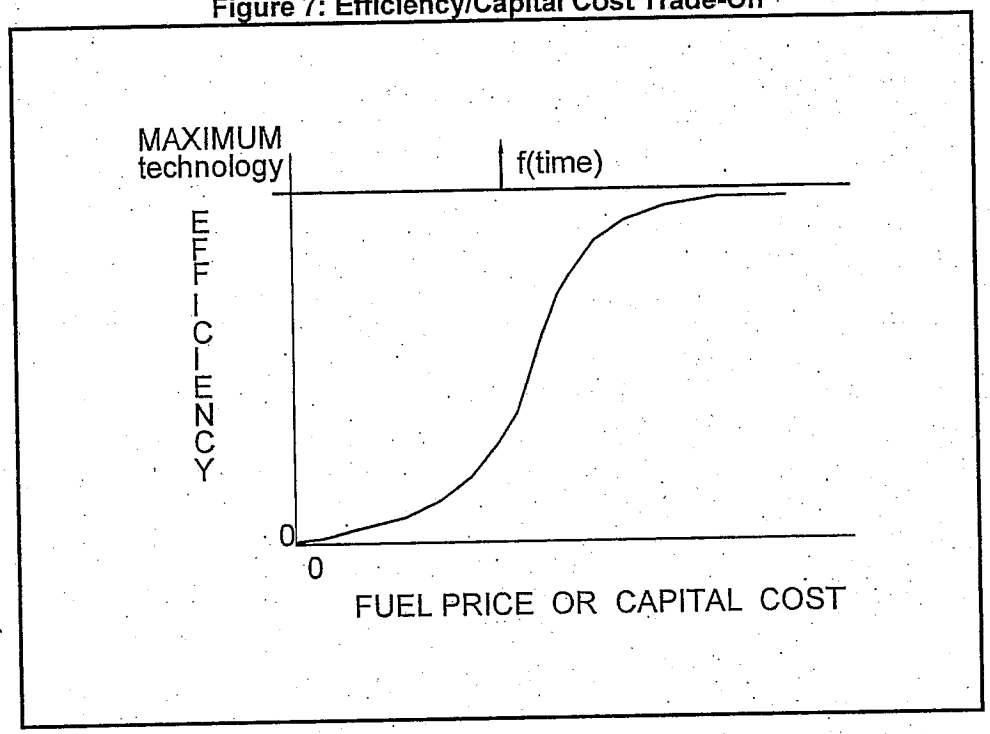
The size and efficiency of the capital stock, and hence energy demands, change over time as consumers make new investments and retire old equipment. Consumers determine which fuel and technology to use for new investments based on perceptions of cost and utility. Marginal trade-offs between changing fuel costs and efficiency determine the capital cost of the chosen technology. These trade-offs are dependent on perceived energy prices, capital costs, operating costs, risk, access to capital, regulations and other imperfect information.

The model formulates the energy demand equation causally. Rather than using price elasticities to determine how demand reacts to changes in price, the model explicitly identifies the multiple ways price changes influence the relative economics of alternative technologies and behaviors, which in turn determine consumers' demand. In this sense, price elasticities are outputs, not inputs, of the model. The model accurately recognizes that price responses vary over time, and depend upon factors such as the rate of investment, age and efficiency of the capital stock, and the relative prices of alternative technologies.

Device and Process Energy Efficiency:

The energy requirement embodied in the capital stock can be changed only by new investments, retirements, or by retrofitting. The efficiency with which the capital uses energy has a limit determined by technological or physical constraints. The trade-off between efficiency and other factors (such as capital costs) is depicted in Figure 7 (Efficiency/Capital Cost Trade-Off). The efficiency of the new capital purchased depends on the consumer's perception of this trade-off. For example, as fuel prices increase, the efficiency consumers choose for a new furnace is increased despite higher capital costs. The amount of the increase in efficiency depends on the perceived price increase and its relevance to the consumer's cash flow.

Figure 7: Efficiency/Capital Cost Trade-Off



The standard the model efficiency trade-off curves are called consumer-preference curves because they are estimated using cross-sectional (historical) data showing the decisions consumers made based on their perception of a choice's value. Many planners are now interested in measure-by-measure or least-cost curves which use engineering calculations and discount rates to show how consumers should respond to changing energy prices. Another analysis focuses on the technical/price differences in alternative technologies and the incentives needed to increase the market-share or market penetration of a specific technology. This perspective on the choice process uses market share curves. The model allows the user to select any of these three types of curves to represent the way consumers make their choices. Shared savings, rebate, subsidy programs, etc. can be tested using any of the curves.

Cumulative investments determine the average "embodied" efficiency. The efficiency of new investments versus the average efficiency of existing equipment is one measure of the gap between realized and potential conservation savings.

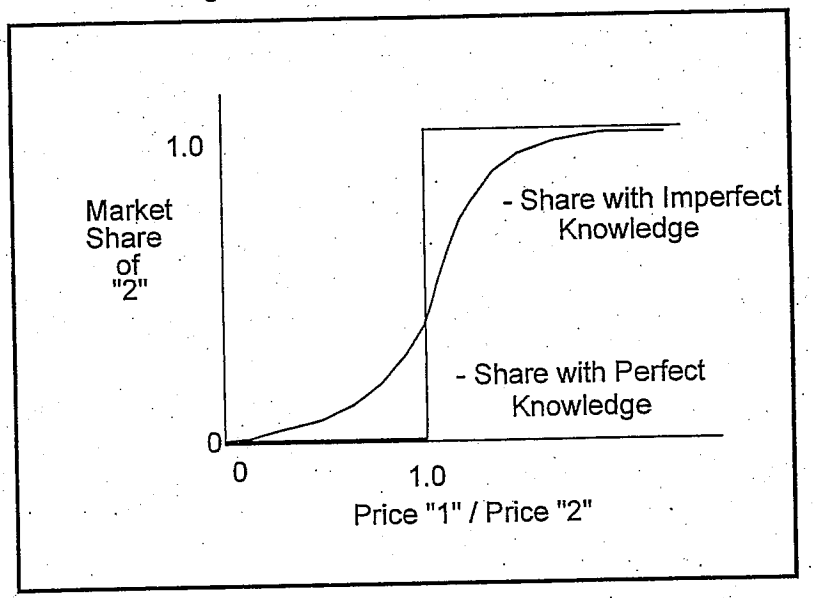
The model uses saturation rates for devices to represent the amount of energy services necessary to produce a given level of output. Saturation rates may change over time to reflect changes in standard of living or technological improvements. For example, air conditioning has historically increased with rising disposable incomes. These rates can be specified exogenously or can be defined in relation to other variables within the model (such as disposable income).

The Market Share Calculation:

Not all investment funds are allocated to the least expensive energy option. Uncertainty, regional variations, and limited knowledge make the perceived price a distribution. The investments allocated to any technology are then proportional to the fraction of times one

technology is perceived as less expensive (has a higher perceived value) than all others. This process is shown graphically in Figure 8 (Market Share Dynamics).

Figure 8: Market Share Dynamics



Short Term Budget Responses:

A short-term, temporary response to budget constraints is included in the model. Customers reduce usage of energy if they notice a significant increase in their energy bills. The customers' budgets are limited and energy use must be reduced to keep expenditures within those limits. These cutbacks are temporary behavioral reactions to changes in price, and will phase out as budgets adjust and efficiency improvements (true conservation) are implemented. This causes the initial response to changing prices to be more exaggerated than the long-term response, a phenomenon called "take-back" in studies of consumer behavior.

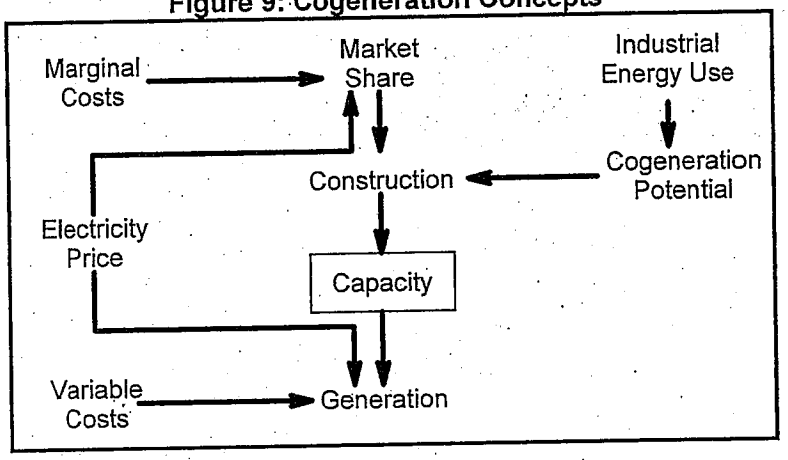
Accounting for Fungible Demand:

Some furnaces and processes can use multiple fuels. That is, they can switch almost instantaneously between, for example, gas and oil or coal and biomass as prices or the market dictates. Energy demand that is affected by this short-term fuel switching phenomena is called fungible demand. The model explicitly simulates this market share behavior.

Modeling Cogeneration:

Most energy users meet their electricity requirements through purchases from a utility. Some users (industrial and commercial) can, however, convert some of their own waste heat into usable electricity when economics warrant such action. Other users (residential and commercial) can purchase self-generation energy sources such as gas turbines, diesel-generators or fuel cells. Figure 9 shows a simplified overview of the cogeneration structure.

Figure 9: Cogeneration Concepts



In the model all energy used for heating is a candidate for cogeneration. The cost of cogeneration is the fixed capital cost of the investment plus the variable fuel costs (net of efficiency gains). This cogeneration cost is estimated for all technologies and compared to the price of electricity. The marginal market share for each cogeneration technology is based on this comparison.

Cogeneration is restricted to consumers who directly produce part of their own electricity requirement. Companies which generate power primarily for resale to the electric utility, are considered independent power producers and are model in the electric supply model.

Energy Supply:

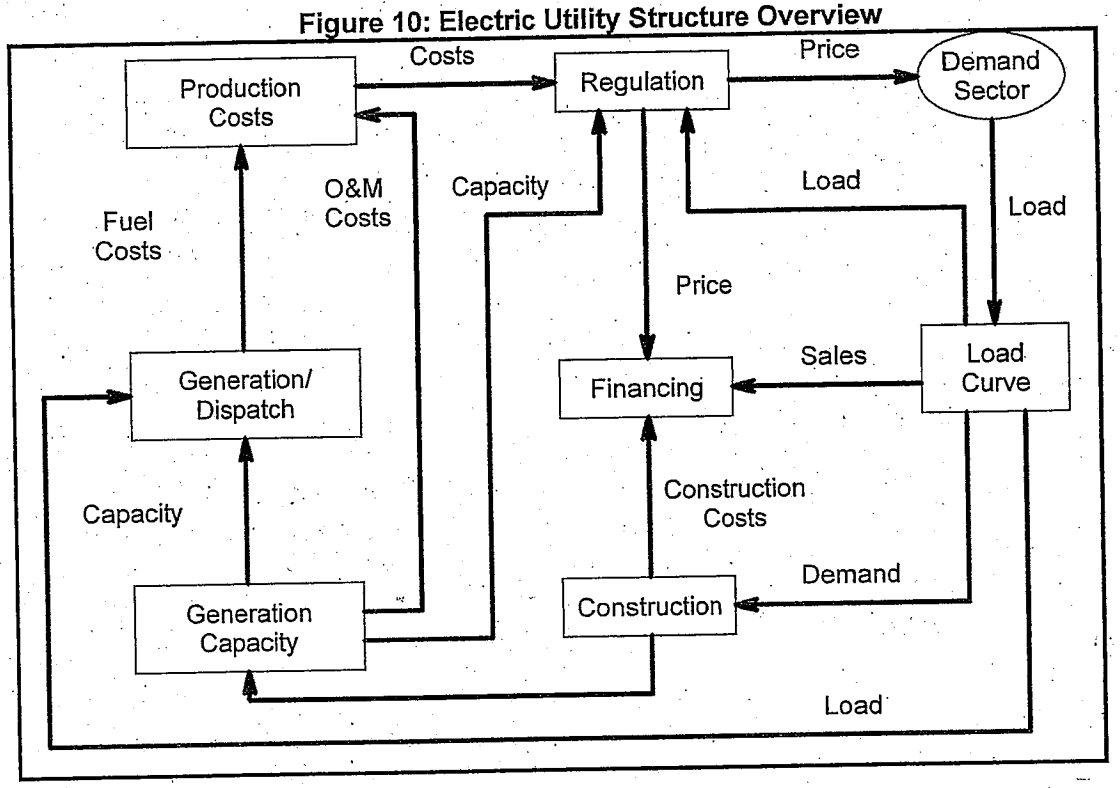
For electric and gas utilities (separate or combined), ENERGY 2020 internally and self-consistently simulates sales, load (by end-use, time-of-use, and class), production (across thirty-six dispatch types), demand-side management (by technology), forecasting, capacity expansion (new generation, independent power producers, purchases, and DSM), all important financial variables, and rates (by class, end-use, and time-of-use.)

The version currently used in this analysis only has the electricity utility sector (a full fledged natural gas utility sector for Canada is currently unavailable in the model, only a simplified natural gas supply function is used to calculate the supply price response).

With the inclusion of the electric utility sector, the generic supply model turns over the calculation of electricity prices to that sector. The model endogenously simulates the forecasting of capacity needs, as well as the planning, construction, operation and retirement of generating plants and transmission facilities. Each step is financed in the model by revenues, debt, and the sale of stock. The simulated utility, like its real world counterpart, pays taxes and generates a complete set of accounting books. In ENERGY 2020, the regulatory function is modeled as a part of the utility sector. The regulator sets the allowed rate of return, divides revenue responsibility among customer classes, approves rate base, revenues and expenses, and sets fuel adjustment charges.

The interactions in the electric utility sector are summarized in Figure 10.

Figure 10: Electric Utility Structure Overview



Expansion Planning:

The utility sector endogenously forecasts future demand for electricity. From the forecast it projects the future capacity required meeting future demand by taking into account retirements and plants already under construction. If future electricity requirements, including reserves, are forecasted to exceed available capacity (using seasonal ratings), then construction of additional capacity is initiated.

If additional capacity is needed to meet forecasted needs, the basic capacity expansion module in ENERGY 2020 determines whether base or peaking capacity is required. The model determines the maximum number of hours that new peaking capacity can be economically operated, before it would be less expensive to construct and operate base load capacity instead. If the forecasted peaking capacity would operate more than that economic maximum, base loads units are initiated, otherwise peaking units are initiated. Any plant type including geothermal, wind, biomass and storage can be considered.

New plants, of a pre-specified minimum size, are initiated when the reserve margin would be violated if the plants were not built or if base load capacity is inadequate to serve base load energy needs at the end of the forecast period. The model does allow the minimum reserve margin to be temporarily violated at the peak if new base load capacity is scheduled to be available within the year. Peaking units are allowed to serve more than the "maximum economical" number of hours until base load capacity comes on-line.

Minimum plant size is exogenous. The mix of new base load plants (i.e. alternative coal technologies, hydro, or nuclear) is user-specified in the standard ENERGY 2020 configuration. The model also evaluates the financial implications of new construction, including total construction costs, cost schedules, and AFUDC/CWIP. The gross rate on AFUDC equals the

weighted average cost of capital. The actual construction progress and financial impacts are simulated on a year by year basis.

ENERGY 2020 can also be configured to consider intermediate load units, firm purchases contracts, external sales, independent power producers, and demand-side options. These options can be "optionally" selected based on endogenous least-cost analysis or can be chosen by user-specified criteria to meet. A detailed automatic Integrated Resource Planning module that would endogenously choose (with user control) from DSM measures utility and non-utility generation and purchase alternatives using linear programming techniques is now being offered as an enhancement.

Financing:
The ENERGY 2020 utility finance subsector simulates the activities of a utility's finance department. It forecasts funding requirements and follows corporate policies for obtaining new funds. The model simulates borrowing and issuing of stock, and can repurchase stock or make investments if it has excess cash. Cash flows are explicitly modeled, as are any decision that affects them. Coverage ratios, intermediate- and long-term debt limits, capitalization, rates of return, new stock issues, bond financing, and short-term investments are endogenously calculated. The model keeps track of gross, net, and tax assets. It also calculates the depreciation values used for the income statement and tax obligations. ENERGY 2020 produces a complete set of utility financial reports.

Regulation:
The utility sector sets electricity prices according to regulatory requirements. The regulatory procedures use allowed rate-of-return and test year cost and demands to determine allowed revenues. Electricity prices are calculated from peak-demand fractions by allocation of costs. Any other allocation scheme can also be considered. The regulatory subsector of ENERGY 2020 automatically factors in a wide variety of regulatory policies and options. More importantly, the model can be readily modified to consider a wide spectrum of scenarios.

The regulatory process revolves around a test year, usually one year forward, when proposed rates will go into effect. The utility sector forecasts test year sales and peak demands by season and customer class, just as it does to determine capacity needs. These test year demand estimates are used to allocate responsibility for system peak, and therefore, generation capacity costs.

Fuel costs for the test year are estimated by dispatching the plants that will be available in the test year, using the dispatching routine explained below. Fuel costs and operating and maintenance costs are adjusted for expected inflation, and these costs are factored into the electricity rates using forecasted sales.

ENERGY 2020 calculates the utility rate-base according to a detailed conventional rate making formula. The model allows the user to adjust allowable costs, and has been used extensively to evaluate alternative rate-base scenarios for individual plants, including allowing return of, but no return on investment, and partial disallowment of construction and interest costs.

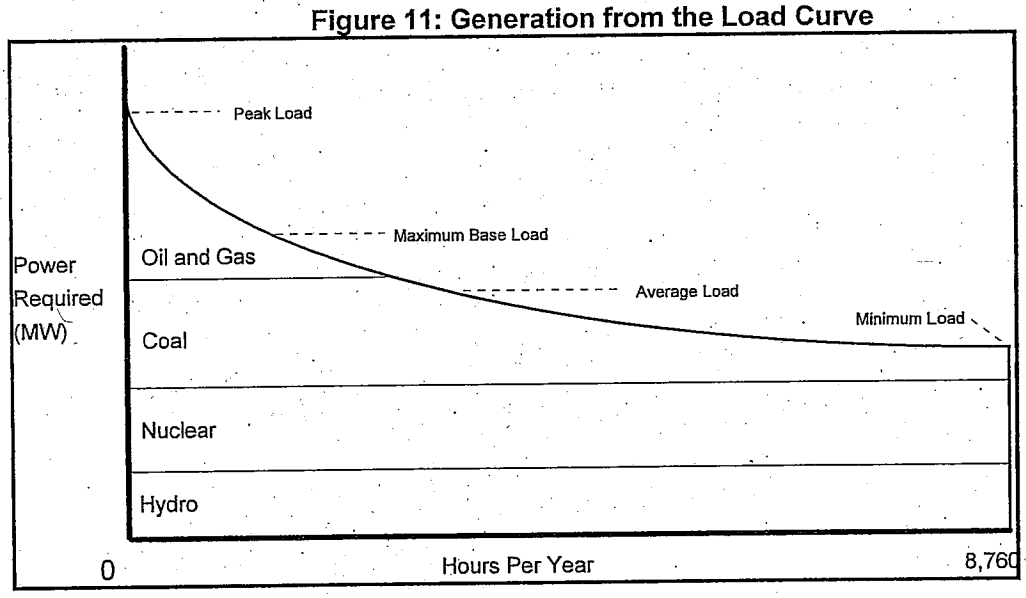
The ENERGY 2020 system also includes estimation of avoided costs, which determines when the utility may be required to purchase third party power. Environmental constraints, such as air pollution restrictions, can also be included in the model. If ENERGY 2020 is configured as a regional or statewide system, municipal utilities, with their unique tax and rate structures, are incorporated. Similarly, regional or power pool interchange is also recognized by ENERGY 2020. As with the other sectors of ENERGY 2020, the regulatory subsector is flexible enough to accommodate any existing or hypothetical circumstance.

Operations:

Each end-use in ENERGY 2020 has a related set of load shape factors. Typically, these factors define the relationship between peak, minimum and average load for each season. These factors when combined with the weather-adjusted energy demand by end-use and corrected for cogeneration, resale, and load management programs, form the basis of the approximated system load duration curve. Alternatively, unit hourly loads for each end-use for three days per month (average weekday, weekend and peak weekday) are used.

The standard ENERGY 2020 production subsector uses an advanced de-rating or chronological method to estimate the seasonal or hourly dispatch of plants. It purchases power externally when economic or necessary. Plant availability and generation for coal, nuclear, hydroelectric, oil and gas are currently considered, as well as pumped storage, firm purchases, interruptible load, and fuel switching and qualified facilities. Figure 11 also shows a typical plant dispatch schedule.

Figure 11: Generation from the Load Curve



The ENERGY 2020 system estimates conventional fuel costs based on the unit dispatch, heat rates, and fuel prices (from the supply sector.) Nuclear fuel costs are capitalized and depreciated throughout the refueling cycle. Nuclear fuel expenses also include fuel disposal costs.

ENERGY 2020 explicitly models the costs of maintaining the transmission and distribution (T&D) system. New facility investments are scheduled and incurred endogenously. In addition, the user can specify the decision rules that dictate T&D expenditures. ENERGY 2020 also explicitly models both fixed and variable operation and maintenance costs, power pool interchanges, nuclear decommissioning costs, plant capital additions, plant cancellations, and general administration costs.

Model Applications:

The structure of the model is well tested and has been used to simulate not only US and the Canada energy and environmental dynamics but also those of several countries in Western,

Central and Eastern Europe. The US EPA used ENERGY 2020 to perform regional (energy, environmental and macroeconomic) impact evaluations of proposed Kyoto initiatives at the 50-state level. Further, the model has been used successfully for deregulation analyses in over 50 energy suppliers and in all the US states and Canadian provinces. Several US and Canadian energy suppliers used the model for the analysis of combined electricity and gas deregulation dynamics.[3] The model contains confidence and validity packages that allow it to determine how to take maximal advantage of RTO rules. The ISO NE used the model to find "gaps" in its rules and to develop more efficient market conditions. The model was used for the CAPX/ISO to model to show, before the fact, many of the "games" played in the California market.

ENERGY 2020 has recently been used to model a low GHG emission (60% below 1990) scenario for Canada, conduct climate change modeling for the province of Ontario, model both GHG and CAC emission strategies for Environment Canada. It has recently been used to provide climate change and other energy and emissions modeling in Massachusetts, Michigan, Vermont, and Hawaii, and is currently being applied to support Climate Change modeling in the State of Illinois.

[3] Energy 2020 is the only model known to have simulated and predicted the dynamics that occurred in the UK electric deregulation. These include gaming, market consolidation and re-regulation dynamics.

Appendix B: Resumes

JEFF AMLIN
President

Systematic Solutions, Inc.

EDUCATION:
M.S., System Simulation and Policy Design, Dartmouth College, Hanover, New Hampshire, 1980.
B.S., Systems Analysis, Magnum Cum Laude, Miami University, Oxford, Ohio, 1976.

PROFESSIONAL EXPERIENCE:

1985-Present President: Systematic Solutions, Inc.
Mr. Amlin is responsible for marketing, management, and execution of modeling, analysis, and simulation projects. Clients include electric utility load forecasters, corporate planning staffs, and state and national energy and environmental planners.
Mr. Amlin is an author and principle developer of ENERGY 2020, an energy demand and energy supply simulation model. He has been the principal investigator for load forecasting projects and comprehensive long-term energy planning and policy analysis studies for investor owned utilities, state, provincial, and national governments. Mr. Amlin combined the ENERGY 2020 and the REMI service-area macroeconomic model to simulate the feedback between the nation's energy and economic sectors. He developed integrated capacity-expansion simulation package to evaluate construction, firm purchase, futures contracts, DSM, cogeneration, and qualified facility options and led development and implementation of ENERGY 2020 and HYPERSENS, a sensitivity testing and confidence analysis software package.
Mr. Amlin has led several studies evaluating the energy and economic impacts of pollution policies including carbon taxes and the Kyoto Protocols. He designed software to estimate emissions coefficients for Greenhouse Gases, CACs, and other pollutants. Mr. Amlin worked directly with the Canadian stakeholders to evaluate the raw data, the energy and emissions forecast, and the policy options and parameters needed to meet the Kyoto Protocol. He designed a system to transfer the energy and emissions data to the Informetrica macroeconomic model and to feed back the economic data to the ENERGY 2020 energy model.
Mr. Amlin enhanced ENERGY 2020 to simulate the restructuring of the electric utility industry and to test deregulation policies and rules. Using ENERGY 2020, he has analyzed the existence of market power, simulated the impact of proposed legislation, forecasted wholesale clearing price, determined the value of existing and proposed electric generating plants, and evaluated the value of potential mergers. He developed the structure and algorithms for dispatching the electric system using generation company bids and subject to transmission constraints. He designed the data management system which creates energy demand and supply models for any user specified market in the US or Canada.
Mr. Amlin has co-developed a workshop that uses ENERGY 2020 to allow utilities and government agencies to experience a competitive electric industry. Mr. Amlin has led these workshops for utility executives, utility staff, and governmental employees.
Mr. Amlin directed development of FARSIGHT, a short-term hourly load forecasting model, which produces accurate seven-day forecasts of hourly loads.
1984-1985 Director of Modeling Applications: PROMULA Development Corporation.
Mr. Amlin was responsible for all phases of contract software projects: proposal writing, system design, system implementation, database design, programming, documentation, and client interface. Applications include electric utility strategic planning models, statistical sensitivity analysis software, accounting systems, and electric utility demand forecasting systems using simulation. He co-developed one of the first integrated utility models to run on a microcomputer.
1982-1984 Principal Analyst: Advance Modeling/Simulation Group, Control Data Corporation.
Mr. Amlin was project manager for system dynamics modeling projects with external clients. He developed strategic planning and policy analysis models for electric utilities. Clients included electric utility companies and state energy offices. Mr. Amlin developed HYPERSENS sensitivity analysis software for simulation models. Other projects included manufacturing assembly line simulation, head demand-side analyst for the U.S. DOE National

Energy Plan IV energy projections, and technical/consulting support to electric utilities in the area of energy demand forecasting.
1979-1982 Research Scientist: Modeling Systems and Applications Group, Battelle-Columbus Laboratories.
Mr. Amlin conducted contract research and development in modeling and database applications, using FORTRAN, NUCLEUS, and DYNAMO as support systems. He designed demographic, economic, and energy system simulation models. Mr. Amlin's responsibilities included documentation of modeling systems, training, and direct interaction with clients. He participated in the TEAM-UP project, sponsored by the Electric Power Research Institute. The purpose of this project was to transfer energy analysis and environmental assessment models to the electric utility industry. Mr. Amlin co-developed the ELFOR electric load forecasting model used by the New England Power Pool and its member utilities and assisted multiple utilities in the enhancement of this highly disaggregated end-use model.
1978-1979 Research Assistant: Thayer School of Engineering, Dartmouth College.
Mr. Amlin participated in research activities funded by the U.S. Department of Energy to simulate energy policy impacts. He analyzed the legal, economic, and institutional barriers to the expanded use of small-scale hydropower as an alternative energy source for New England and was a contributor to The Global 2000 Report to the President (Carter) in the areas of demographics and agriculture.
1977-1978 Programmer/Analyst: Medical Datamation.
Mr. Amlin designed and implemented a mathematical model of health risks and life expectancy using FORTRAN. He developed a structured FORTRAN precompiler for an Interdata 8/32 computer.

SELECTED PAPERS AND PUBLICATIONS

LFO/HFO Sulphur Tax Analysis, for Environment Canada, Ottawa, Ontario, September 3, 2003.
Economic Impact of the Pacific Northwest Port Shutdown, with Randy Levesque, for the Bonneville Power Administration, Portland, Oregon, May 21, 2003.
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"ENERGY 2020 Users' Training," for The Bonneville Power Administration, Portland, Oregon, June 25-27, 2002.
Impacts of BPA Options on the Economy of the Pacific Northwest, with Sue Kleemann, for The Bonneville Power Administration, July 2001.
"Utilities 21: Utility Restructuring Workshop," for ENECO, Diest, Netherlands, November 2-3, 2000.
"CIGMOD: Competitive Industry Gaming Model," CIGMOD Workshop, hosted by Light - Serviços De Eletricidade S.A., Rio de Janeiro, Brazil, November 22-26, 1999.
"Utilities 21: Utility Restructuring Workshop", for Andersen Consulting, Barcelona, Spain, September 20-21, 1999.
"Introduction to ENERGY 2020," *ENERGY 2020 Training Workshop for the Silesian Power Distribution Company (GZE)*, Gliwice, Poland, September 13-16, 1999.
"Introduction to Causal Demand Simulation," *ENERGY 2020 Training Workshop for the Silesian Power Distribution Company (GZE)*, Gliwice, Poland, September 13-16, 1999.
The Feasibility of Combining the Table Models Into a Single Integrated System, with Sue Kleemann, for The Bonneville Power Administration, April 19, 1999.
"CIGMOD: Competitive Industry Gaming Model," CIGMOD Workshop, hosted by Duke Power, Tampa, Florida, March 4-5, 1999.
"Introduction to ENERGY 2020," *ENERGY 2020 Training Workshop for the Zaklad Energetyczny Torun SA*, Torun, Poland, February 8-12, 1999.
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"ENERGY 2020 Training Workshop," for Natural Resources Canada, Ottawa, Ontario, October 25-29, 1998.
"ENERGY 2020 Training Workshop," for Minnesota Department of Public Service, Minneapolis, Minnesota, October 4-7, 1998.
"Introduction to ENERGY 2020," *ENERGY 2020 Meeting for Environment Canada*, Ottawa, Ontario, August 30-September 1,1998.

"Conversion of ENERGY 2020 to C++ from PROMULA," for Sandia National Laboratories, Albuquerque, New Mexico, August 9 – 21, 1998.
"ERM Training Workshop," for Cinergy, Covington, Kentucky, July 12-17, 1998.
"ERM West Coast Training Workshop," for Bonneville Power Administration, Portland, Oregon, April 7-10, 1998.
"ENERGY 2020 Training Workshop," for Nationalna Elektricheska Kompania, Sofia, Bulgaria, March 14-21, 1998.
"Greenhouse Gas Training," for Department of Business, Economic Development and Tourism, State of Hawaii, Honolulu, Hawaii, February 8-13, 1998.
"REMI Training," for Department of Business, Economic Development and Tourism, State of Hawaii, Honolulu, Hawaii, February 8-13, 1998.
"ENERGY 2020 Training Workshop," for Latvenergo and DC Baltija, Riga, Latvia, October 14-17, 1997.
"ENERGY 2020 Training Workshop," for Lithuanian State Power System, Kaunas, Lithuania, October 18-20, 1997.
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"CIGMOD Training Workshop," for Ohio Edison, Akron, Ohio, April 4-2, 1997.
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"Interactive Sensitivity/Confidence Analysis of Large-scale Simulation Models on Microcomputers," with G. Backus, *1985 Summer Computer Simulation Conference*, Chicago, Illinois, July 22-26, 1985.
"Comprehensive Corporate Policy Planning using Large-scale Simulation on Microcomputers," with G. Backus, *1985 Summer Computer Simulation Conference*, Chicago, Illinois, July 22-26, 1985.
"A Practical Approach to Sensitivity Testing for System Dynamics Models," with G. Backus and A. Ford, *1983 International System Dynamics Conference*, Chestnut Hill, Massachusetts, July 27-30, 1983.
"Integrated Utility Planning and Consumer Response Model," with G. Backus. *National Regulatory Research Institute*, Columbus, Ohio, September 14-16, 1983.
"A Practical Approach to Sensitivity Analysis," with L. Clemens *National Regulatory Research Institute*, Columbus, Ohio, September 14-16, 1983.
"HYPERSENS: Sensitivity Analysis Using Latin-Hypercube Sampling," *Forecasting Demand and Energy Requirements Seminar*, University of Wisconsin Extension, Madison, Wisconsin, October 25-27, 1982.
"Computer Model for Small-Scale Hydropower Policy Analysis," co-authored with P. H. Kirshen, *Journal of Water Resources Planning and Management Division*, ACSE, Volume 107, No. R1, Proc. Paper 16093, March 1981.
Ohio Waste Wood for Energy, Co-authored with E. H. Hall, J. E. Burch, S. S. Goret, and W. T. Lawhorn, Jr., Battelle-Columbus Laboratories Report, June 1981.
"ELFOR, A Model for Long-Range Forecasting of Electric Energy (KWH) and Demand (KW) and for Load Management Simulation," Co-authored with G. E. Juras, Battelle-Columbus Laboratories Report, October 1980.
Factors Hindering the Development of Small-Scale Municipal Hydropower: A Case Study of the Black River Project in Springfield, Vermont, Co-authored with E. Peters, G. Berger, and D.
Meadows, DSD #144, Thayer School of Engineering, Dartmouth College, Hanover, New Hampshire, March 1979.
Economic and Technical Determinants of Small-Scale Hydropower Development in New England, M.S. Thesis, Thayer School of Engineering, Dartmouth College, Hanover, New Hampshire, June 1979.

LITIGATION & WORKING PAPERS

Testimony in behalf of the Illinois Department of Energy and Natural Resources, Docket 90-79, *The Illinois State Gas Utility Plan Recommendations*, Illinois Commerce Commission, Springfield, Illinois, 1990.
Testimony in behalf of Illinois Department of Energy and Natural Resources, Docket 89-152, *The Illinois Statewide Electric Utility Plan Recommendations*, Illinois Commerce Commission, Springfield, Illinois, 1989.

Ben Amlin
Sr. Analyst
Telephone: (614) 767-0291

Systematic Solutions, Inc.
4853 Wallington Drive
Hilliard, Ohio 43026

5 Education:

B.B.A., Management Information Systems, Ohio University, Athens, Ohio, 1999.

6 Professional Experience:

2006-Present Sr. Analyst: Systematic Solutions, Inc.

Mr. Amlin assists in the execution of modeling, analysis, and simulation projects. This includes data updates to the ENERGY 2020 model, changes to supporting programs, testing, installation, and trouble shooting. Clients include electric utility load forecasters, corporate planning staffs, and state and national energy and environmental planners.

2000-2006 Senior Traffic Engineer Qwest Communications

Mr. Amlin provided weekly and monthly reporting to assist other engineers in making cost effect decisions on adding, changing or removing network capacity. Mr. Amlin designed and helped to implement a new method of routing some Qwest long distance traffic to different carries to reduce cost or satisfy larger business commitments.

Mr. Amlin worked with several departments within Qwest to facilitate the installation of a new software package to update the Qwest network with new cost effective traffic routes in a near real time basis. He helped to translate the technical details of the Qwest network to the third party vendor and assumed a project management role when needed.

1999-2000 Traffic Engineer Qwest Communications

Mr. Amlin monitored various portions of the Qwest long distance phone network. He maintained an appropriate level of network capacity, addressed problem circuits, and assisted with several cost savings projects.

Jennifer Backler
Senior Associate

EDUCATION

M.A. (Economics), University of Alberta, Canada, 2004

B.A. (Economics), Trent University, Canada, 1997

EXPERIENCE OVERVIEW

Ms. Backler joined ICF International as a Senior Associate in early 2008. She brings over 10 years of provincial government experience in economic analysis and project management in energy, climate change, and natural resources. Jennifer holds a Master of Arts in Economics from the University of Alberta, where she examined focused on the study of applied micro-economic and completed a thesis examining trends in the revenues and expenditures of provincial governments.

During her tenure with the Ontario Ministry of the Environment, Ms. Backler was a key player in the management and successful completion of the Ontario Climate Change Plan, released in the fall of 2007. During this process, she coordinated a large scale effort to compile emissions analyses from 13 Government of Ontario ministries. Ms. Backler has also been responsible for briefing high-level government officials. In addition to her graduate degree, Jennifer holds a Bachelor of Arts from Trent University in Peterborough, Ontario.

PROJECT EXPERIENCE

Energy, Economic and Emissions Modeling, Province of Ontario, September 2007

Managed and input into the energy, economic, and emissions modeling required for the release of the Ontario Climate Change Plan, including analyzing potential policy elements within the plan as well as forecasting the macro-economic implications of proposed emission reduction targets. The Ontario Climate Change Plan was released in September 2007.

Review of Emissions Trading Regime and Climate Change Initiatives, Province of Ontario

Provided the emissions and economic analysis to support and enable the review of Ontario's emissions trading regime for potential regulatory amendments, and lead a team that analyzed possible climate change initiatives with respect to emission avoidance/reduction, required funding, and for suitability to the Ontario plan.

Development of Provincial Parks and Conservation Reserves Act

Led the end-to-end policy development related to the new Provincial Parks and Conservation Reserves Act including submissions development, process management, government consultations, approvals, facilitation of the EBR posting, preparation of and support for the legislative package for First Reading in the House. Having been adopted, this legislation will guide the management and operation of several hundred provincial parks and conservation reserves with an annual budget of over $60M

EMPLOYMENT HISTORY

ICF International	Senior Associate	2008 -
Ontario Ministry of the Environment	Senior Economist	2006 - 2008
Ontario Ministry of Natural Resources	Program Liaison Officer	2004 - 2006
Ontario Ministry of Natural Resources	Senior Economist	2000 - 2004
Alberta Department of Energy	Economist	1998 – 2000

Chris Caners, P. Eng. ICF INTERNATIONAL

Associate

EDUCATION

2005 M.Sc. (Eng.) Mechanical Engineering. Queen's University, Canada

2002 B.A.Sc. Mechanical Engineering (Mechatronics). University of Toronto, Canada

EXPERIENCE OVERVIEW

Chris Caners joined ICF International's Climate Change Strategy team in July 2007. He holds a Master of Science in Mechanical Engineering from Queen's University, where he investigated energy technologies at the Fuel Cell Research Centre, a cutting-edge Canadian scientific institution. Chris focuses primarily on operational sustainability, energy and environmental regulation, policy and analysis and climate change strategy. In particular, Mr. Caners has expertise in developing GHG emissions inventories, performing environmental assessments, developing multi-stakeholder sustainability plans and evaluating the effectiveness of climate change strategies. He has also worked on various energy and economy related research projects, evaluating sector-specific trends and performing project-level feasibility studies.

Recently, Chris co-authored an analysis paper for Environment Canada on provincial and territorial climate change plans, examining the interaction between those policies and federal policy. Chris also co-authored a backgrounder on per-passenger aviation emissions, outlining the complexities and assumptions intrinsic to such a calculation. At Queen's, Chris was recognized twice for his work as a member of the Auto21 Network of Centres of Excellence, where he evaluated the performance of a novel fuel processing system. In addition to his graduate degree, Chris also holds a Bachelor of Applied Science in Mechanical Engineering from the University of Toronto, and is a licensed professional engineer in the Province of Ontario.

PROJECT EXPERIENCE

Development of Electricity Emissions Factors for Wind Power Development, Canadian Wind Energy Association, January 2008 to present

CanWEA hired ICF International to provide an analysis of the mechanisms available with which to determine the emissions intensity of grid-supplied electricity. Chris is responsible for several technical aspects of the work. In addition, Chris is the client liaison for this project, and is the lead author for the final report.

Climate Change Strategy and Modelling, State of Wisconsin, November 2007 to present

ICF was awarded a contract by the State of Wisconsin to provide policy modeling and analysis that was instrumental in assisting the stakeholder group supply recommendations to the governor's office. Chris analysed model outputs, and designed spreadsheet tools for this purpose. He also reviewed the Energy Independence and

Security Act in order to implement it into the ENERGY 2020 model, and is currently researching a number of different policy options, which will be modelled relative to the Reference Case.

Cap and Trade Working Group, Multiple Clients, November 2007 to present

A group of large Canadian utilities with significant annual greenhouse gas emissions hired ICF to evaluate the impacts of new federal Canadian policies on their operations. Chris helped to develop a database of energy and emissions information for each utility, subsequently providing data analysis and scenario development.

Provincial Policy Assessment, Spectra Energy, November 2007 to present

Chris undertook a comprehensive review of the regulations and policies of the province of British Columbia to determine their impact on the operations of a large natural gas supplier.

Greenhouse Gas Inventory Review, Invista, November 2007 to January 2008

Chris was the main reviewer for the Invista's global greenhouse gas inventory. He was responsible for examining the inventory, evaluating it against accepted industry standards and recommending improvements. Chris authored the final report that was delivered to the client.

Industry Provincial Offsets Group, Multi-client, November 2007 to present

Chris acted as the interim secretariat for this group of industry, non-governmental and governmental representatives, whose aim is to assist in the development of a cap and trade mechanism to curb greenhouse gas emissions. Chris organized meetings, took minutes, compiled, wrote and edited reports and presentations on behalf of the members.

Modeling Air Emissions in Canada's Electricity Sector, Environment Canada, November 2007 to present

ICF was awarded a contract to investigate the effect that provincial and federal policies would have on emissions using the multi-sectoral model, ENERGY 2020. Chris analysed the data and generated several spreadsheet analysis tools for this purpose. Chris also co-authored the final report and presentation.

Provincial and Federal Energy and Emissions Modelling, Environment Canada, November 2007 to January 2008

Environment Canada, a federal agency, contracted ICF to evaluate the climate change plans of the Canadian provinces and territories. This analysis investigated the effectiveness of the various plans, and identified overlapping federal and provincial/territorial policies. Chris was the lead author on the final report. Each policy was rated according to the

Energy Efficiency, Productivity and Competitiveness, Natural Resources Canada, October 2007

Natural Resources Canada retained ICF to supply a white paper analysis on the interaction between energy productivity and competitiveness in Canada and abroad. Chris was responsible for the evaluation and analysis of the relevant data.

Climate Change Strategy and Modelling, State of Illinois, July 2007 to October 2007

The government of Illinois set an ambitious target to reduce greenhouse gas emissions from the state to 1990 levels by the year 2020. ICF, in partnership with two other subcontractors provided policy modeling and analysis that was instrumental in assisting the stakeholder advisory group supply recommendations to the governor's office. ICF modeled and provided analysis for over twenty different policies. Chris provided analytical support and co-authored the final report.

Per-Passenger Air Travel Emissions Calculator, International Civil Aviation Organization, August 2007 to October 2007

ICF was contracted by the International Civil Aviation Organization (ICAO) to develop and provide a framework tool to assist their members and the general public in calculating greenhouse gas emissions from passenger air travel. ICF worked with the client and other stakeholders to provide the optimum methodology for their needs. Chris provided research assistance and co-authored a report on the subject of air travel emissions on behalf of ICAO.

EMPLOYMENT EXPERIENCE

ICF International	Associate	July 2007 – present
University of Toronto Sustainability Office	Project Manager	July 2005 – June 2007
Queen's University	Teaching Assistant	September 2002 – May 2005
DuPont Canada	Research Intern	May 2000 – August 2001
Magna International	Research Student	May 1999 - August 1999

LANGUAGES

English	Fluent
French	Basic

Paul M. Cross, MBA
Senior Associate

ICF INTERNATIONAL

EDUCATION

M.B.A. Management, Wright State University, Fairborn, Ohio 1991
B.S., Agronomy, Ohio State University, Columbus, Ohio 1980

EXPERIENCE OVERVIEW

Mr. Cross joined ICF International's Climate and Energy policy team in April 2008 after an 18 year career developing and implementing the ENERGY 2020 multi-sector model at Systematic Solutions, Inc.

While at Systematic Solutions, Inc., Mr. Cross was responsible for programming, data research and development, calibration, and testing of the ENERGY 2020. Clients included electric utility load forecasters, corporate planning staffs, and state, national, and international energy and environmental planners.

Mr. Cross prepared client forecasts customized to client needs. He evaluated client-specified policies and scenarios for accuracy and realism, produced client-specific reports and presentations and presented results to senior staff. He provided support for ENERGY 2020 clients on a wide range of energy and environmental issues including model development, operation, parameterization, and policy analysis. Some of the policy types include end-use pricing, DSM programs, and pollution loadings.

Mr. Cross was the lead analyst/project manager for numerous state and multi-state projects. He conducted group and individual client training sessions both on and off site. Mr. Cross conducted client-training workshops at the annual ENERGY 2020 users' conferences. He has co-authored numerous enhancements to the ENERGY 2020 simulation model code. He has participated in several studies evaluating the impact of pollution policies including carbon taxes and the Kyoto Protocols.

Mr. Cross co-developed a workshop that uses ENERGY 2020 to allow utilities and government agencies to experience a competitive electric industry in a realistic simulated environment. He has led numerous workshops for senior utility executives, utility staff, governmental employees, and international clients.

PROJECT EXPERIENCE

Climate Change Strategy and Modelling, State of Wisconsin, April 2008 to present

ICF was awarded a contract by the State of Wisconsin to provide policy modeling and analysis that was instrumental in assisting the stakeholder group supply recommendations to the governor's office. Paul is currently researching a number of different policy options, which will be modelled relative to the Reference Case.

Western Governor's Association Western Climate Initiative April 2008 to present

ICF was selected to provide modeling support to the Western Governor's Association's Western Climate Initiative. Using ENERGY 2020, ICF has developed a model of energy use and emissions covering all of Western North America in order to model GHG reduction policies under consideration by the WCI partners. Paul has joined this project to provide analytical and modeling support; translating policies proposed by the WCI partners into modeling terms and running the model to produce outputs for presentation to the Economic Modeling Team and WCI partners.

Environment Canada (2004-2005)

Systematic Solutions, Inc. (SSI) was selected to analyze of the impact of various policies to reduce Greenhouse Gases including hybrid vehicles, combined heat and power systems, renewable electric generation (wind, biomass, small hydro), CO2 permits, sinks, sequestering, energy efficiency improvements, and the targeted measures. Paul provided analytical and modeling support for this effort.

Environment Canada (2004-2005)

SSI was awarded this project to forecast CAC emissions by fuel for each of the provinces in Canada, estimated and incorporated CAC reduction curves for several major industries, developed the model structure needed to simulate CAC reduction policies, and tested the ability of these policies to reduce CAC emissions. Paul assisted in policy analysis and implementation.

Saskatchewan Energy and Mines (2004-2005)

SSI provided support in the use of ENERGY 2020 for the analysis of climate change policy and impacts along with electricity and gas market assessment. Paul was the primary contact with SEM and provided support and training.

Saskatchewan Energy and Mines (2001)

SSI assisted the client in the analysis of climate change policy and impacts along with electricity and gas market assessment. Paul was the primary liaison with the client.

Duke Energy Brazil (2001)

SSI was chosen to provide computer simulation and workshops to assess the dynamics of deregulation in Brazil and market strategies and opportunities. Paul was part of the team which led the workshops on site.

Vermont Department of Public Service (2001-2003)

SSI provided regional planning and assessment for electricity and gas as well as climate change policy. Paul was the lead analyst. He trained VTDPS staff as well as provided modeling and policy implementation support.

Massachusetts Executive Department of Energy Resources (1999)

SSI was chosen to analyze the impact of deregulation in New England and Eastern Canada on Massachusetts's economy and energy picture. Paul implemented the simulation model as well as provided client support.

Vermont Department of Public Service (1999-2001)

SSI was chosen to analyze the deregulation impacts in New England and Eastern Canada on Vermont. Paul implemented the simulation model as well as provided client support.

Western Resources (1998)

SSI was awarded the contract to provided gas and electric load forecasting for all the Western Resource service areas. Paul analyzed model data inputs as well as model forecasts.

Latvenergo, Latvia (1995-1997)

SSI was chosen to develop industrial, commercial, and residential enduse demand and energy forecasts for Latvenergo of Latvia using ENERGY 2020. Paul provided extensive training on the use of ENERGY 2020 on site.

Eesti Energia, Estonia (1995-1997)

SSI was chosen to develop industrial, commercial, and residential enduse demand and energy forecasts for Eesti Energia of Estonia using ENERGY 2020. Paul provided extensive training on the use of ENERGY 2020 on site.

Lithuanian State Power (1995-1997)

SSI was chosen to develop industrial, commercial, and residential enduse demand and energy forecasts for Lithuanian State Power System and DC Baltija using ENERGY 2020. Paul provided extensive training on the use of ENERGY 2020 on site.

Massachusetts Executive Office of Energy Resources (1986-1997)

SSI co-developed the SAFER model (State Annual Forecast of Energy Resources) used since 1986 for state planning/forecasting of all-fuel prices, supply and demand through the year 2001. Residential, Commercial, Industrial, and Transportation sectors are detailed by end-use. Electric Utility, Natural Gas Utility, and Qualified Facility sectors are detailed by technology. The integrated planning model also includes a macroeconomic model to simulate the impacts of energy policy on the economy. Paul was the lead analyst for the majority of this project. This entailed client training, model modification, and policy analysis.

Vermont Department of Public Service (1987-1996)

SSI co-developed an integrated utility model (supply and demand) for long-term analysis of demand-side and supply-side policy alternatives. Paul was the lead analyst for the majority of this project. This entailed client training, model modification, and policy analysis.

EMPLOYMENT EXPERIENCE

ICF Consulting	Senior Associate	April 2008 – present
McKinley Hall, Inc	Coordinator of IT and Compliance	September 2005 – April 2008
Systematic Solutions, Inc	Senior Analyst	September 1986 – January 2005

Thomas A. Harger
Senior Analyst
Telephone (937) 767-1873

Systematic Solutions, Inc.
4420 Snypp Road
Yellow Springs, Ohio 45387

6.1.1 Education:

B.S., Management Science, Wright State University, Dayton, Ohio, 1988.

6.1.2 Professional Experience:

1989-Present Senior Analyst: Systematic Solutions, Inc.

Mr. Harger is responsible for programming, data development, calibration, and testing for the ENERGY 2020 Model. He prepares and evaluates client forecasts and policy scenarios and provides support for clients regarding model development, operations, parameterization, data input, and policy analysis. Mr. Harger has been a project manager for several projects and was responsible for completing projects on time and under budget. Specific projects include developing a statewide model for Illinois and assisting with on-site training and providing on-site ENERGY 2020 training for an overseas client. The training included data development, calibration, and preparing and evaluating forecasts as well as providing information about how ENERGY 2020 simulates energy markets. Mr. Harger helped develop a statewide model for Hawaii to analyze the feasibility of reducing dependence on oil with renewable energy and he assisted with on site training and presentation of results to the client including providing documentation of data and spreadsheets. He participated in the model development for a nationwide evaluation of the impact of utility deregulation commissioned by a consortium of eight utilities

Mr. Harger has assisted with the design and programming for the Windows version of ENERGY 2020. He is responsible for designing and programming an interface between ENERGY 2020 and Visual Basic. He assisted with the system design and programming for the competitive industry gaming model (CIGMOD) used in our training workshops. Mr. Harger has extensive experience working with and converting raw data into usable form. He assisted in the collection and modification of electric data for all electric companies (including Municipals, G&Ts, and Distributions) in the United States and Canada for ENERGY 2020.

Mr. Harger supported data development and report generation for the several studies evaluating the impact of pollution policies including carbon taxes and the Kyoto Protocols.

Other projects worked on by Mr. Harger include the development of electricity least cost technology curves, the incorporation of enduse and rate class load data into a long range electricity demand forecasting model, and the development of a user friendly interface with ENERGY 2020 for a regional economic model. He has taught group sessions and provided individual training at the ENERGY 2020 conferences and has been the ENERGY 2020 Conference coordinator.

6.1.3 Professional Affiliations:

Alpha Iota Delta, Honorary Society for the Decision Sciences

6.1.4 Computer Experience:

Hardware: IBM PC, IBM 3700, VAX.
Operating Systems: MSDOS.
Languages: FORTRAN, PASCAL, COBOL, BASIC, SLAM II, PROMULA, SAS, Visual Basic.

6.1.5 Publicly Available Papers:

"ERM Training Workshop," for Cinergy, Covington, Kentucky, July 12-17, 1998.

"CIGMOD Training Workshop," for Ohio Edison, Akron, Ohio, April 4-2, 1997.

"CIGMOD ERM Training Workshop," for KN Energy, Denver, Colorado, August 8-12, 1997.

"Using ENERGY 2020 Features, Part 1," *1993 International ENERGY 2020 User's Conference*, June 23-25, 1993, Ottawa, Ontario.

"Using ENERGY 2020 Features, Part 2," *1993 International ENERGY 2020 User's Conference*, June 23-25, 1993, Ottawa, Ontario.

"Feedback effects between the REMI Model and ENERGY 2020," *1992 REMI User's Conference*, October 15-17, 1992, Killington, Vermont.

"REMI Interface with ENERGY 2020," *1992 ENERGY 2020 Conference*, September 23-25, 1992, Atlanta, Georgia.

Karl Hausker, Ph.D. ICF International

Vice President

EXPERIENCE OVERVIEW

Dr. Hausker has over 20 years of experience in economic and public policy analysis in the areas of climate change, environment, and energy. He led EPA's climate change programs for 3 years and most recently served as Deputy Director of the Center for Climate Strategies, a leading NGO working with states. He has conducted and directed policy research and analysis across a broad range of issues including: multi-sectoral analysis of climate change mitigation options, emissions trading, vehicle pollution, electricity regulation, and energy security. He has managed organizations, large and small. He has worked at multiple levels of governance: international, national, state, and local. He is knowledgeable in the field of offsets, both international and domestic.

PROJECT EXPERIENCE

Climate Change Action Plans for Multiple U.S. States, 2005-2007. Before joining ICF in August 2007, Dr. Hausker served for 2 years as Deputy Director of the Center for Climate Strategies. He co-founded this non-profit group in 2005, and it quickly grew to be the premiere advisor to U.S. states developing climate action plans. Dr. Hausker managed stakeholder processes and the development of plans in Arizona, New Mexico, North Carolina, Vermont, Colorado, and Montana, and led analysis in the transportation and land use sectors. Each state project began with an inventory and forecast of a state's GHG emissions, conforming to national and international protocols.

Climate Change Developments in US and Canada, Mitsubishi Research Institute (MRI), 2000-2003. While working for PA Consulting Group, Dr. Hausker provided information and analysis to the MRI on developments in climate change science, economics, and policy in the U.S. and Canada through biweekly reports and phone calls. He traveled annually to Japan for presentations and hosts visits by MRI staff to the U.S.

WRI/WBCSD GHG Protocol Project, 2002-2003. Dr. Hausker participated in this project on behalf of MRI. His work focused on the issues of baselines and additionality.

Climate Change Initiative - Ukraine, USAID, 2000-2002. Dr. Hausker performed a comprehensive revision and updating of training materials for this climate change capacity-building project for USAID/Ukraine. He performed research and analysis and applied his broad background in climate science, technology, economics, mitigation, and adaptation, and his intimate knowledge of the UNFCCC, Kyoto Protocol, and the emerging greenhouse gas trading market. He made presentations at a July 2002 conference in Kiev.

Climate Change Outreach and Awareness (India), 2000. Dr. Hausker worked collaboratively with PA Consulting (then Hagler Bailly) on this project throughout his year in India at the Tata Energy Research Institute (see below). When he joined Hagler Bailly in 2000, he put his experience in India to work in the

closing months of this project by developing a tracking system for mitigation projects and providing technical assistance to project developers. He helped debrief the USAID India Mission and prepare final deliverables. This project brought about a remarkable change in the Indian government's stance toward the Clean Development Mechanism in the Kyoto Protocol.

Climate Change Responsibilities at U.S. EPA, 1993-1995 While serving U.S. EPA Deputy Assistant Administrator, Dr. Hausker led the Agency's climate change efforts, both domestic and international, integrating the work of the Policy Office and the Office of Air and Radiation. He represented the Agency on the White House Climate Change Task Force and in the formulation of the President's Climate Change Action Plan in 1993. He represented EPA at COP-1 in Berlin in 1995 and in other international fora; and he testified numerous times on climate change before Congress.

Support for US-AEP's Environmental and Energy/Climate Change Strategy (Asia), USAID, 1998-1999. Dr. Hausker lived and worked in India for over a year as an independent consultant to USAEP and as a Senior Visiting Fellow at the Tata Energy Research Institute in New Delhi. Dr. Hausker collaborated extensively with Hagler Bailly on USAID's Climate Change Outreach and Awareness project described above. His contribution was pivotal in bringing about a remarkable change in the Indian government's position on the Clean Development Mechanism. He also assisted USAID field staff in: developing country strategies and priorities; developing country and regional workplans; identifying potential activities and partnerships; conducting workshops and training; and building networks of urban and industrial managers. For example, Dr. Hausker initiated a public/private partnership among the Society of Indian Automotive Manufacturers (SIAM) and the city of New Delhi that resulted in a series of innovative inspection and maintenance (I&M) camps for two-wheel vehicles operating in that city. He also examined and promoted alternative sewerage treatment options for the city of Varanasi

Clean Air Act Amendments of 1990. While working for the U.S. Senate Energy and Natural Resources Committee, Dr. Hausker led Committee efforts to design a more efficient allowance auction system as part of the SO2 cap-and-trade provisions of Title IV. His design was incorporated into the Senate version of the legislation (but did not prevail in the final law). The Senate version gave EPA authority to auction multi-year streams of allowances to better serve the emerging IPP market and sell more allowances in the early years of the program when liquidity and market thinness concerns were greatest.

EDUCATION

Ph.D., Public Policy, University of California, Berkeley, California,1985

Master of Public Policy, University of California, Berkeley, California,1981

Bachelor of Arts, Economics, Cornell University, Ithaca, New York, 1979

SELECTED PAPERS AND PUBLICATIONS

Reinventing Environmental Regulation: The Only Path to a Sustainable Future, Environmental Law Reporter, 29(3): 10148-10157. March 1999.

The Politics and Economics of Auction Design in the Market for Sulfur Dioxide Pollution, Journal of Policy

Analysis and Management, 11(14): 553-572, Fall 1992.

Automobile Fuel Efficiency Stalls in the 102nd Congress, Journal of Energy and Development, 16(2):175-194, Spring 1991.

Residential Energy Consumption: Models of Consumer Behavior and Their Implications for Rate Design, (co-authored with Lee Friedman), Journal of Consumer Policy, 11:287-313, 1988.

EMPLOYMENT HISTORY

ICF International Vice President 2007-present

Center for Climate Strategies Deputy Director 2005-2007

Independent Consultant 2004

PA Consulting Group Principal 2000-2003

Tata Energy Research Institute Visiting Fellow (and independent consultant)

1999

Center for Strategic & International Studies Senior Fellow 1995-1998

U.S. Environmental Protection Agency Deputy Assistant Administrator 1993-1995

U.S. Senate Energy and Natural Resources Committee

Chief Economist 1987-1992

Putnam, Hayes & Bartlett Associate 1985-1987

RANDY BELL LEVESQUE
Senior Analyst

Systematic Solutions, Inc.

EDUCATION
M.S. Quality Management and Productivity, May 1989. University of Iowa, Iowa City, Iowa.
B.A. Mathematics and Philosophy, May 1987. Beloit College, Beloit, Wisconsin.

PROFESSIONAL EXPERIENCE
1999-Present Senior Analyst: Systematic Solutions, Inc.
Ms. Levesque helps to develop forecasts and analyze policy scenarios using the ENERGY 2020 Model. Her responsibilities include data development, data analysis, model enhancement, programming, and writing.
Ms. Levesque is a member of the team that designed, developed and now maintains the Windows-based interface to the ENERGY 2020 Model (using Visual Basic). She further helped to develop and maintain a web-based interface used with European clients (using HTML, VB Script, JAVA Script, ASP, and COM). Ms. Levesque co-wrote and edited the User's Guide to the Visual Basic interface.
Ms. Levesque developed a modeling system to interface between ENERGY 2020 and both the REMI macroeconomic model (for the US) and the Informetrica macroeconomic model (for Canada). These modeling systems enabled data to be passed between the models and, in the case of the REMI model, the execution of the economic and the energy models.
1994 – 1999 Analyst: Systematic Solutions, Inc.
Ms. Levesque developed utility financial, load, and end use data as input to the ENERGY 2020 Model. She was responsible for documenting data development and analysis techniques. Ms. Levesque aided in designing and integrating enhancements, such as a linear programming component, into the model.
1993 – 1994 Evaluation Research Specialist: Central Maine Power Co.
Ms. Levesque conducted studies of the Company's energy management programs. She was responsible for scheduling studies, designing sampling plans, collecting, and analyzing data. Ms. Levesque's responsibilities included writing reports and presenting information gathered during studies.
1992-1993 Quality Improvement Lead Facilitator: Central Maine Power Co.
Ms. Levesque consulted internally on total quality management (TQM) techniques, specializing in statistical analysis. She provided corporate training of TQM principles and techniques, as well as to groups outside the company. Ms. Levesque assisted teams in problem solving and group dynamics.
1991 Economist: Central Maine Power Co.
Ms. Levesque lead the completion of the Company's short-term residential, industrial, and commercial sales forecasts. Ms. Levesque was responsible for tracking and reporting monthly sales trends to senior management.
1990-1992 Load Research Analyst: Central Maine Power Co.
Ms. Levesque was responsible for the statistical sample design, planning, data collection, analysis and presentation of customer data usage studies. She coordinated uses of load research data throughout the Company. Ms. Levesque provided consultation to other departments on statistical analysis techniques and data usage.
1989-1990 Integrated Resource Planning Trainee: Central Maine Power Co.
Ms. Levesque studied and applied integration of demand-side and supply-side management techniques, such as linear programming and cost-benefit analyses, during rotation through departments of Supply Planning, Financial Planning and Market Research & Forecasting.

SELECTED PAPERS & PUBLICATIONS
"User's Guide to ENERGY 2020 Hawaii Version", September 2002.
"User's Guide to ENERGY", August 2002.
"User's Guide to ENERGY 2020," Systematic Solutions, Inc. July 2002.
"User's Guide to ENERGY 2020 (the Windows Version)," with Susan Kleemann, Systematic Solutions, Inc. July 2000.
"ERM Training Workshop," for Cinergy, Covington, Kentucky, July 12-17, 1998.
"Electric Lifeline Program High Use Visits: 1992 Impact Evaluation," with Patricia Hart, Central Maine Power Company. March 1994.
"CMP Load Shape Uses: Reference Manual," Central Maine Power Company. March 1992.

"Impact Study of Residential Time-Of-Use Rates," Central Maine Power Company. December 1990.
"1989 Concurrent Load Research Report," Central Maine Power Company. Spring 1990.

Aaron Schroeder
Associate

ICF International

EDUCATION

B. E., Electrical Engineering. University of Saskatchewan, Saskatoon, Canada, 2003

CERTIFICATIONS AND TRAINING

Microsoft Excel Expert Certification, 2006

EXPERIENCE OVERVIEW

Aaron joined ICF International as an associate in ICF's Energy and Environment Practice in July 2007. He brings to ICF four years of experience working with large volume electricity portfolios in both the public and private sectors. Mr. Schroeder began his professional career in the Department of Infrastructure and Transportation with the Government of Alberta. During his employment there, Aaron worked collaboratively to analyze and disseminate internal energy consumption and demand information. Additionally, he completed cost analysis of potential and existing energy efficiency projects and developed business cases in support of corporate initiatives.

More recently, Mr. Schroeder worked with an Ontario based electricity and natural gas portfolio consultant where he was responsible for overseeing electricity and natural gas operations including procurement, nomination and settlement on behalf of large volume clients.

PROJECT EXPERIENCE

Greenhouse Gas Inventorying ICF has developed software tools for the purpose of facilitating GHG inventorying, also more commonly known as developing a carbon footprint. Aaron led the development team for the development of GHGID, ICF's proprietary inventory tool. He coordinated the software development including research and design, project management and client customization. To date, GHGID has been specifically tailored to suit the requirements of real estate management firms, freight and delivery companies, an international engineering consultancy and government property management clients.

Climate Change Strategy Modeling – California Air Resources Board; State of Wisconsin; Western Climate Initiative; Environment Canada Several jurisdictions are engaging modeling exercises to quantify the economic, energy and emission implications of proposed GHG mitigation policies. Aaron has been supporting the modeling team in these efforts by researching and preparing data for the models' basecase development. Specifically, Aaron's efforts have been focused in the electric generation and oil sands sectors. Several policy cases were developed for each project and the resulting changes in emissions and economic implications were analysed.

Canadian Carbon Market Analysis ICF conducted multi-client backed study of the forthcoming Canadian Carbon Market, centered around the Canadian Regulatory Framework for Air Emissions. The study utilized the Energy 2020 model, a multi-sector, multi-fuel, economy, energy and emissions simulation model to determine the effects of the implementation of emissions regulation in Canada. Aaron worked with the project team to research and implement the model under various policy scenarios. Further, Aaron led the effort to develop a dynamic supply demand analysis tool, the *Canadian Carbon Pricing Tool,* which determines supply/demand balance given user estimates on carbon offset supply availability.

Natural Resources Canada – Minimum Efficiency Performance Standards (MEPS) for Lighting ICF was retained to provide analytical and technical support to Natural Resources Canada in their effort to establish MEPS for general service lighting. Aaron led a technical research team assigned to establish the current performance level of lamps available in Canada, establish benchmarks for energy and cost analysis and develop technical guidance for products that require exemption from regulation.

Quantification of Greenhouse Gas Attributes of Renewable Energy Credits (RECs) Electricity generation from renewable sources is eligible for "Eco-Logo" certification where it is deemed to offset fossil fuel generation. In Alberta, electricity is predominantly generated from coal and natural gas. Aaron participated in the methodology development and analysis of the greenhouse gases deemed to be offset from two renewable generators in Alberta for the period of 2003 through 2006. This quantification was used to provide an expert opinion on the actual offsets attributable to the RECs associated with these generators.

NO and SO_2 Emissions Reduction Verification, 2007 Aaron completed a verification of the emissions reduction claim of an Ontario retail chain under the Ontario Emissions Trading Regulation. The verification included a review of the client's Emission Reduction Report and an on-site verification of the database and associated calculations. Based on the findings of the review, ICF issued an opinion letter on the validity of the emissions reduction claim.

Deficient Power Factor Analysis, Peace River Correctional Centre, 2006 (while employed with Alberta Infrastructure and Transportation). Aaron completed an investigation of deficient power factor at the provincial correctional centre in Peace River, Alberta. The project included historical utility analysis, on-site measurement, and recommending further action in the final report. Aaron utilized his knowledge in electrical distribution systems to determine the root cause of the problem and recommend action which will result in improved efficiency and cost savings.

AB 32
My involvement in the CA ARB project was on the data collection and reference case development team. This group was responsible for collating historical reference case data including electrical generating fleet characteristics, national and state level economic values and weather degree day data. The team worked to develop a standardized approach to collecting, processing and storing historical data as it was prepared for entry into the Energy 2020 model.

PROFESSIONAL AFFILIATIONS
Institute of Electrical and Electronics Engineers (IEEE)
IEEE Power Engineering Society (PES)

EMPLOYMENT HISTORY

ICF International	Associate	2007 – 2008
Aegent Energy Advisors Inc.	Business Operations Manager	2006 – 2007
Alberta Infrastructure and Transportation	Coordinator, Utilities Portfolio	2003 – 2006

ICF Consulting

Julie Tartt
Senior Associate

EDUCATION

Honours Bachelor of Science Degree in Environmental Sciences (awarded *with honours*) majoring in Environmental Protection with an area of emphasis in Environmental Degradation, Guelph, Ontario, Canada, 1997

CERTIFICATIONS AND TRAINING

Business Writing for Professionals, Ryerson University Continuing Education, 2005
Project Management Overview / MS Project 2003, New Horizons Computer Learning Centre, 2005
Certificate in Implementing and Auditing a Health and Safety Management System, BSI Management Systems, 24-hour Training Course, 2004
Project Management Seminar, University of Toronto Professional Development Centre, 21-hour Training Course, 2004
European Environmental Due Diligence 16-hour Training Course, Italy, 2002
LANTRA Professional 4-Wheel Drive 16-hour Training Course, UK, 2002
Environmental Auditing Foundations 40-hour Training Course, UK, 2001
Ontario Ministry of the Environment Health and Safety Basics 24-hour Training Course, 2000
Ontario Ministry of the Environment 'Field notes to Courtroom' 8-hour Training Course, 2000

EXPERIENCE OVERVIEW

Ms. Tartt has been with ICF International since 2003 in the Canadian energy practice. She has over seven years of experience as a consultant in the environmental and energy fields, holds extensive experience in administering and managing projects and is skilled with various research methods and tools for acquiring and analyzing data. Over the past year, Julie has been developing a multi-client outlook on the impacts of the Canadian Regulatory Framework for Air Emissions on regulated sectors. This has involved forecasting of a likely carbon market in Canada and a number of pricing scenarios. Throughout this extensive and vital work, Ms. Tartt has interfaced with and presented to clients, while developing the necessary products to inform over fifteen oil and gas industry and power sector clients in steps to develop new business and carbon strategies. Ms. Tartt has also worked on several other assignments including modeling of the Canadian Power Sector including aspects such as generation, capacity, financial and emissions profiles as well as policy papers and a strategic positioning paper for federal government agencies. Ms. Tartt has implemented and audited an occupational health & safety management system and coordinated of all aspects of a complex stakeholder consultation process. Julie has also provided consultative services for clients in emissions reduction strategies, emissions inventories and emissions trading opportunities. Ms. Tartt is providing current support to CARB on AB32 analysis.

Prior to joining ICF, Ms. Tartt specialized in environmental impact assessments with a particular emphasis on biological sciences. Julie has international professional experience preparing environmental impact assessment documents and environmental management at construction / development sites including managing teams of ecologists and archaeologists as well as the construction workforce. She also has considerable experience auditing construction (of gas pipelines) and limited experience conducting ecological surveys. Other aspects of her international work involve environmental due diligence inspections (Phase 1 inspections) and report production for property acquisition projects. Prior to working in the UK, Ms. Tartt worked as a consultant for the Ontario Ministry of the Environment coordinating all aspects of their biosolids programs at the District level.

PROJECT EXPERIENCE
Energy Markets and Modeling

Canadian Regulatory Framework Assessment and Carbon Market Outlook, Multi Client, 2007. On April 26 2007, the Government of Canada released its Regulatory Framework for Air Emissions, which is intended to mandate

greenhouse gas reductions. The Framework sets short term targets, based on emissions intensity that ratchet-down throughout the compliance period (2010 to 2020). The industry sectors regulated by the document include: electricity production produced by combustion, oil and gas and other large final emitters. In order to meet the GHG reduction targets, regulated firms will have several compliance mechanism options available to them including: internal reductions, contribution to a Technology Fund, Credit for Early Action, purchase of CDM credits, purchase of domestic offset credits, and domestic trading. In response to this Framework document, ICF has completed a project that modeled the future price of carbon in a Canadian emissions trading market using Energy 2020, a powerful multi-sector, multi-fuel, economy, energy and emissions simulation model. The study provided subscribers with analysis of the proposed Framework, its impact on future greenhouse gas emissions and costs to industry as well as an excel-based Canadian Carbon Pricing Tool. The tool enables users to quantify their potential compliance costs (economic risk) based upon user-defined choice of variables such as: eligible offset project types, transaction costs and volume of offset credits available for each offset project type. Julie was a core member of the development and research team that completed this assessment of the future Canadian carbon market.

Scenario Analysis: Air Emissions Under the Canadian Regulatory Framework, Canadian Electricity Association, 2007. ICF was employed by the CEA and its members, including all major generating utilities across Canada, to aggregate and analyse electricity sector futures outlooks. The project was taken on to develop a comprehensive database of current and forecasted electric generating fleet operations and inform the development of alternative approaches to regulating the sector in terms of GHGs and air pollutants. Ms. Tartt and her colleagues assessed the changes in compliance flexibility, fuel switching, new and emerging technology development and credit purchasing across a broad range of regulatory scenarios. The analysis also investigated the opportunities and barriers for capital stock turnover, culminating in a lower emitting national power sector and the relevant and realistic timeframes in which this may be feasible.

Canada-Wide Electricity Sector Modelling, Canadian Electricity Association, 2004-Present. This study for the Canadian Electricity Association (CEA) focused on the Canada-wide power generation system. ICF employed our nation-wide electricity sector model (IPM) to quantify the CEA's contribution to greenhouse gas reductions and support their negotiations with the federal government. Ms. Tartt and her colleagues synthesized confidential, facility-specific data provided by CEA members as well as publicly researched data to ensure the modeling results (capacity, generation, emissions, etc.) and analysis would provide meaningful detailed outputs. The CEA was provided with a basecase as well as company-level results including capacity, generation and emissions (including greenhouse gases) for each participating member company. Julie also completed a further facility-level analysis of CO_2 emissions for the CEA member companies.

Sole Source Procurement Advice, Power Generation Company, 2004. In this two-phase project, contracting scenarios were analyzed to evaluate scheduling impacts to a proposed power generation development project, taking into account the facilitation of environmental assessment approval requirements. Recommendations for assuring value in a sole source procurement scenario were provided as well as communications strategies for this important renewable energy development project in a public forum.

Assessment and Strategic Advice on the Structure and Regulation of Gas Supply, Gas Storage and Upstream Gas Transportation with Respect to the Ontario Natural Gas Industry, Ontario Energy Board, 2004. In this project the client required advice on the structure and regulation of Ontario's Natural Gas Industry considering and incorporating the input of all the major stakeholders in the industry. Ms. Tartt co-coordinated all aspects of the stakeholder consultation process. She also participated in each meeting and/or interview and producing comprehensive notes for internal use in the composition of the policy advice papers and produced weekly synopsis reports for the client.

Electric Markets in Canada: Identifying Carbon Impact and Cost Effective Generation for Regional Hydrogen Production, Natural Resources Canada, 2003-2004. In this three-phase project, the client is interested in investigating the capacity of the power generation sector to support a hydrogen economy in transportation - the impacts of such changes are analyzed. Active member of the IPM (Integrated Planning Model) team that modeled nine Canadian provinces for this effort. Co-authored the final report for Phase II, and also prepared presentations to be delivered to the client.

National Implementation of Integrated Planning Model (IPM), Environment Canada, 2003-2005. This project involves joint coordination between Environment Canada and U.S. Environmental Protection Agency to build, using the IPM, a North American model of the power generation sector. Ms. Tartt worked on the Canadian portion of the model and was involved in research into various aspects of the Canadian system including, generation capacity, financial and emissions profiles. Julie was also an active member of the team responsible for running the IPM model, de-bugging runs, parsing run results for detailed checking purposes as well as analyzing results.

Feasibility Study for Sir Adam Beck 3 Expansion, Klohn Crippen, 2003-2004. The Sir Adam Beck hydro-electric power generation facility has an option to expand with a third generating facility and increased hydro flow. Issues identified were: technical feasibility, impact on power market, impact on environmental market and financial feasibility. Part of the team that worked closely with the hydro engineers to model the SAB effects using the IPM.

Energy Efficiency

Opportunity Analysis for CDM Programs in Ontario – 2008-2010, Ontario Power Authority, 2007. Building on past assessments of CDM potential in Ontario and a review of current OPA initiatives, ICF developed a portfolio map to identify opportunities for future Conservation and Demand Management (CDM) initiatives. These opportunities were screened based on criteria established by the OPA. Examples of exemplary "best practice" programs were identified for each of the program areas identified, and illustrative costs and potential savings for each program type were developed for the Ontario market. As a result of this assessment a number of potential programs were recommended for the OPA's consideration for introduction in the 2008-2010 timeframe. Ms. Tartt contributed to the research and analysis effort, as well as authoring sections for the final report.

Electricity Demand in Ontario – a Retrospective Analysis, Ontario Power Authority, 2005. In this project, ICF provided the OPA with a retrospective analysis of Ontario's electricity demand over the period from 1990 to 2004. Electricity demand patterns post-1990 were analyzed separately for residential, commercial and industrial sectors with further disaggregation of electricity use by subsectors (end use, housing type, appliance type, etc.). Through the analysis, ICF estimated and quantified the extent to which the decoupling of electricity growth and economic growth occurred due to improvements in the efficiency of electricity use. Ms. Tartt updated the Ontario electricity data and assisted in the production of the final report.

Long Term Energy and Climate Change Strategy – Background Research on Energy Use and Demand Issues, National Round Table on the Environment and the Economy, 2005. ICF is required to analyze Canada's GHG emissions over a long time frame for this project (to 2050). The target to be achieved is a 50% reduction of current GHG levels by 2050. It is recognized that the level and pattern of the nation's GHG emissions are largely determined by the level and pattern of energy use. Understanding the factors that affect energy use patterns is therefore critical to understanding the possibilities for a future in which GHG emissions are greatly reduced from current levels. This project began with a retrospective analysis of energy demand including an assessment of energy use trends in the residential, commercial, industrial and transportation sectors. Ms. Tartt supported data analysis and reporting of these trends. In the background research phase of the project, ICF will be providing the NRTEE with a high level analysis of relationships between population, economic activity (GDP), energy use and electricity use. The information compilation and analysis is being done on a sectoral basis, preceded by a high level treatment of energy use of national and provincial economies. Ms. Tartt has contributed to the research and data analysis effort, as well as authoring sections for the final report.

Long Term Energy and Climate Change Strategy – Modelling and Analytical Support, National Round Table on the Environment and the Economy, 2005. This was the second part of the assignment to analyze Canada's GHG emissions with the aim of cutting current GHG levels in half by 2050. ICF employed the Energy 2020 model as a forecasting tool and Socolow's stabilization wedge methodology to analyze and quantify the effects of various measures (i.e. technologies) in contributing to achieving the required GHG reduction target. Julie was involved in creating the initial list of wedges to be developed and has also researched and formulated several of those wedges.

Emissions Inventory

Gap Analysis /Inventory Assessment – ATCO Power, 2005.

This project offered ATCO Power the assurance that emissions quantification methodologies (employed in the 2004 submission) would meet the government's requirements for rigor and result in an accurate, consistent, transparent and complete inventory. Julie performed the analysis and verification of ATCO's co-generation facilities, interfaced with the client and authored the final report.

Emissions Inventory Assessment, JD Irving, 2005. In this project, ICF assisted JD Irving (JDI) in updating their emissions inventories of GHGs, NO_x and SO_2 for the four mills in their Forest Products division (manufacturing pulp, paper, tissue and corrugated medium) as well as GHGs for their sawmills. The overall objective of this project was to ensure that the data being collected (particularly GHG data) continues to be comprehensive and accurate so that Irving's Forest Products division will be able to accurately report to the federal Government under the proposed GHG Regulations for Large Final Emitters. Another objective was to ensure that past (for GHGs) and future emission abatement projects implemented at the Forest Products mills and the sawmills would yield GHG, NO_x and SO_2 emission "assets" marketable upon the implementation of a provincial, national or international emissions trading scheme. Worked with JDI staff to ensure their GHG, NO_x and SO_2 inventories for the Forest Products division and sawmills were complete by calculating emissions for 2002-2004. Also authored a final report summing up the inventory findings.

Science and Policy

Strategic Planning Session for the Board of APPrO, Association of Power Producers of Ontario, 2005. Coordinated telephone interviews with all members of the APPrO Board of Directors and participated in a day-long strategic planning session with the Board. Incorporated the ideas, views and suggestions that arose from the interviews and the planning session into a Strategic Roadmap report for APPrO.

Wind Incentives, Natural Resources Canada, 2004. Ms. Tartt was part of the team that performed qualitative assessment of economic, financial, fiscal and regulatory incentives used worldwide to support a wind power sector development. Five international countries were researched and studied (Denmark, Germany, Spain, United States and India). The incentives were assessed and from this, lessons and learned and recommendations particular to Canada's needs were developed.

Biotechnology Science Framework, Canadian Food Inspection Agency, 2004. This project provided a Canadian Federal Agency with a framework for biotechnology science including specific recommendations on actions, which will enable the Agency to remain current in its knowledge and application of biotechnology science and ensure effective deployment within the organization and with partner organizations. Researched foresight mechanisms in biotechnology science as well as government policies in science and biotechnology to gain a thorough understanding of government expectations of science-based agencies before formulating and authoring this framework document.

Strategy Development, Canadian Food Inspection Agency, 2003-2004. Researched and co-authored a strategic positioning paper discussing the role of science in government, the Government of Canada's approach to biotechnology and how these relate to a Canadian Federal Agency.

Climate Change and Emissions Trading

International Carbon Market Pricing Tool, Multi-client, 2005. ICF is developing an international outlook for carbon prices in an emissions trading market. The first version is an interactive tool which will allow users to test scenarios and see impacts of different variables. ICF is also developing a reference case and writing both a user's manual as well as a discussion of key variables and outcomes for the reference case. Julie was involved in background research in order to populate the tool with international carbon market data (country baselines, targets, etc.) and quality assurance/quality control of the tool and the user's manual.

Emissions Trading Opportunities, Magna, 2005. In this project, ICF produced a strategic advice document to advise a large international auto parts manufacturer/distributor on opportunities for emissions trading in both domestic and international markets. Julie was involved in the research and co-authored the document in which the concept of international emissions trading was introduced and CDM/JI opportunities for Magna were discussed.

Proposal Development for Pilot Emissions Removals, Reductions and Learning Initiative (PERRL) for Environment Canada, Alberta-Pacific Forest Industries, 2004. This project involved preparing a project proposal for a forest product company in Alberta in response to the Canadian federal government's interest in purchasing carbon removals from forestry sink projects under the Pilot Emission Removals, Reductions and Learnings (PERRL) Initiative. Upon entering into a contract with the government, the forest product company and the settlement will undertake an avoided deforestation project by reducing the width of seismic lines cut through their forests, causing the reduction of deforestation in Alberta's boreal forests, thus creating a net greenhouse gas removal. Quantified the carbon removals from the avoided deforestation project and developed the Project Description, Baseline, Project and Emission Reduction Templates in conformance with the quantification and reporting standards required by PERRL.

Energy Star Presentation, Natural Resources Canada, 2004. Reviewed consumer surveys from the past several years on environmental awareness/understanding of the Kyoto protocol and global warming and also awareness and comprehension of Energy Star products and labels. This research was used to ascertain the mindset of the Canadian consumer and offer suggestions to a Canadian Federal Agency on how to improve their energy efficiency program.

Quantitative Assessment of Uncertainty of Canada's Greenhouse Gas Inventory, Environment Canada, 2004. ICF was chosen to provide the statistical analysis of Canada's Greenhouse Gas Inventory as part of the UNFCC recommended Good Practice. Ms. Tartt conducted expert elicitation interviews and assisted in the preparation of the report.

Transportation

Transportation Security Requirements and Competitiveness: A Review of Foreign Evidence, Transport Canada, 2005. The goal of the assignment was to gather data that would provide an overview of foreign experiences in transportation security on a national level and present results from the review of this data. The research spanned several transportation modes (air, sea, road, rail, transit and multi-modal) and several countries (US, Australia, China, Japan, UK). In this assignment, Ms. Tartt participated in the research and data collection which included interviews and a literature review as well as analysis of the results production of the report.

Transportation Sector Emissions Trading Options. US Environmental Protection Agency, 2005. Ms. Tartt provided research and support towards the development of a series of White Papers examining the potential for a greenhouse gas emissions trading system to provide incentives for emission reductions in the transportation sector. In addition to providing a summary of current literature and prevailing policy relating to the issue, this series of papers contains an analysis of the incentives for economic agents to undertake a broad range of activities that reduce emissions of carbon dioxide from combustion of fossil fuels. The first paper in the series explores three alternative approaches to including transportation in an emissions trading system—a system based on vehicle registrations, a system that engages vehicle insurers, and a system that entails the participation of financial institutions that provide financing for new vehicles.

Management Systems Implementation and Auditing

Occupational Health and Safety and Environmental Management System Audit, Ontario Power Generation, Hydroelectric, 2005. Part of a team of internal auditors assigned to conducting a combined 14001 EMS and 18001 OHSMS audit for all facilities affiliated to the Niagara Plant Group.

OHSAS 18001 Implementation, Tembec Inc., 2004. On-going project to support the development and implementation of an OHSAS 18001 compliant Occupational Health & Safety Management System (OHSAS).

The scope includes assisting the local team of individuals assigned to the project with the risk assessment process, the development of all system procedures and operational controls, conducting internal audits and management review and developing corrective actions.

Environmental Auditing

Farningham Pipeline, Phase I, Transco, 2001-2002. While employed at RSK ENSR Group conducted environmental auditing of construction including weekly inspections and monthly environmental audits.

Farningham Pipeline, Phase II, Transco, 2002. While employed at RSK ENSR Group completed stakeholder consultations, planning application search, vantage point survey of site and also conducted ecological survey.

South-West Uprating Project, Transco, 2001-2002. While employed at RSK ENSR Group conducted environmental auditing of construction including weekly inspections and monthly environmental audits.

Newbury Pipeline, McConnell Dowell/Transco, 2001-2002. While employed at RSK ENSR Group conducted environmental auditing of construction including weekly inspections and monthly environmental audits.

Cricklade Pipeline, Transco, 2001-2002. While employed at RSK ENSR Group prepared environmental review including production of constraints map, incorporation of ecological and archaeological assessments and summary of impacts and proposed mitigation measures. After planning permission was granted and construction commenced, undertook environmental auditing of construction.

Salcombe Pipeline, Transco, 2001-2002. While employed at RSK ENSR Group prepared environmental review including production of constraints map, incorporation of ecological and archaeological assessments and summary of impacts and proposed mitigation measures. After planning permission was granted and construction commenced, undertook environmental auditing of construction.

Redruth Pipeline, Transco, 2001-2002. While employed at RSK ENSR Group prepared environmental review including production of constraints map, incorporation of ecological and archaeological assessments and summary of impacts and proposed mitigation measures. After planning permission was granted and construction commenced, undertook environmental auditing of construction.

Environmental Due Diligence

Project Hamilton Environmental Due Diligence, General Electric, 2001-2002. While employed at RSK ENSR Group was responsible for carrying out a series of environmental due diligence site inspections (Phase 1 inspections) on approximately 15 individual sites in a real estate portfolio for a major property acquisition project. Sites inspected included office buildings, commercial and retail establishments and apartment buildings. Utilized the inspection and interviewing of personnel to author the site description sections of the final reports to the client.

Phase 1 Environmental Assessments, Various Private Sector Clients, 2003. While employed at AiMS Environmental conducted approximately ten Phase 1 environmental site assessments for several commercial and residential properties in the Toronto area following the Canadian Standards Association (CSA) Standard Z-768-01 as a guide.

Environmental Impact Assessment (EIA)

Cambridge to Matching Green Pipeline, Transco, 2001-2002. While employed at RSK ENSR Group managed day-to-day undertakings of the EIA project for the project manager. Completed comprehensive stakeholder consultations with statutory and non-statutory consultees, performed planning application search, prepared constraints map, reviewed all relevant planning policies from local plans and prepared impact and proposed mitigation measures table. Authored planning, introduction, project description and socio-economic chapters for the Environmental Statement and ensured planning permission for the 45km pipeline was granted.

Isle of Grain LNG Storage Facility and Pipeline, Transco, 2001-2002. While employed at RSK ENSR Group prepared key issues report with project manager. Completed comprehensive stakeholder consultations with statutory and non-statutory consultees, performed planning application search, prepared constraints map, reviewed all relevant planning policies from local plans and prepared impact and proposed mitigation measures table. Authored planning and project description chapters for the Environmental Statement.

Poole Pipeline, Transco, 2002. While employed at RSK ENSR Group managed Poole Pipeline environmental review project, submitted proposal for work, commissioned and managed ecological and archaeological surveys, completed stakeholder consultations, planning application search and vantage point survey of site, prepared constraints map, authored environmental review and obtained planning permission.

Sturminster Pressure Reduction Station (PRS), Transco, 2002. While employed at RSK ENSR Group managed PRS environmental review project, submitted proposal for work, commissioned and managed ecological and archaeological surveys, completed stakeholder consultations, planning application search and vantage point survey of site, prepared constraints map, authored environmental review and obtained planning permission.

West Moors PRS, Transco, 2002. While employed at RSK ENSR Group managed PRS environmental review project, submitted proposal for work, commissioned and managed ecological and archaeological surveys, completed stakeholder consultations, planning application search and vantage point survey of site, prepared constraints map, authored environmental review and obtained planning permission.

Greatham PRS, Transco, 2002. While employed at RSK ENSR Group managed PRS environmental review project, submitted proposal for work, commissioned and managed ecological and archaeological surveys, completed stakeholder consultations, planning application search and vantage point survey of site, prepared constraints map, authored environmental review and obtained planning permission.

Calne to Compton Bassett Pipeline, Transco, 2002. While employed at RSK ENSR Group managed pipeline environmental review project, submitted proposal for work, commissioned and managed ecological and archaeological surveys, completed vantage point survey of site and assisted colleague in authoring environmental review to obtain planning permission.

Castle Cary Pipeline, Transco, 2002. While employed at RSK ENSR Group managed pipeline environmental review project, submitted proposal for work, commissioned and managed ecological and archaeological surveys, completed vantage point survey of site and assisted colleague in authoring environmental review to obtain planning permission.

Almondsbury Pipeline, Transco, 2002. While employed at RSK ENSR Group submitted proposal for environmental review work, commissioned and managed ecological and archaeological surveys, completed stakeholder consultations, planning application search and vantage point survey of site, prepared constraints map, authored environmental review and obtained planning permission.

Portbury Pipeline, Transco, 2002. While employed at RSK ENSR Group submitted proposal for environmental review work, commissioned and managed ecological and archaeological surveys, completed stakeholder consultations, planning application search and vantage point survey of site, prepared constraints map, authored environmental review and obtained planning permission.

EMPLOYMENT HISTORY

ICF Consulting	Senior Associate	January 2006 – present
ICF Consulting	Associate	November 2003 – December 2005
AiMS Environmental	Environmental Scientist	October 2003 – November 2003
RSK ENSR Group	Environmental Consultant	June 2001 – October 2002
Enerco Ltd.	Research Associate	December 2000 – May 2001
R.J. Burnside & Associates on contract to	Biosolids Coordinator	August 1999 – August 2000

the Ontario Ministry of the Environment	Field Technician	Summer 1999
Ontario Ministry of the Environment	Dispute Management	February 1998 – July 1999
IBM Canada Inc.		

RALPH D. TORRIE

Vice President

ICF International

EDUCATION

Honours B.Sc. (Physics Major), University of Waterloo

EXPERIENCE

Ralph Torrie is an expert in the field of energy and environment and has over 25 years of entrepreneurial and consulting experience that includes hundreds of initiatives in research, business development, and advocacy. He is known for combining visionary thinking with rigorous analysis and has made original and important contributions in the field of sustainable development. He is an expert on Canadian energy demand patterns, including in the industrial sector, and has led or contributed to numerous analyses of the technological and economic potential for energy efficiency. The methods and software he has invented for the quantification of energy savings and the development of greenhouse gas and air emission reduction strategies are used throughout the world. He has worked throughout Canada and in many other countries, has numerous publications, and in 2002 received the Canadian Environment Silver Award for his work on climate change.

In the mid-1980's he served as the assistant coordinator of the Energy Research Group of the United Nations University and the International Development Research Centre and in the late 1980's he was part of a group of environmental analysts and advocates that helped define the sustainable development agenda that has become the focus of national and international policy. He represented peace, environment and international development NGO's before the hearings of the Brundtland Commission, and his testimony on the connections between environment, poverty and security is quoted in the Commission's final report, Our Common Future.

Mr. Torrie has been involved in the climate change issue since 1988 when he organized the energy workshop at the Toronto Conference on the Changing Atmosphere. Throughout the 1990's her served as the principal consultant to the Cities for Climate Protection program of the International Council for Local Environmental Initiatives. He is the co-inventor of environmental planning software that has been translated into several languages and is used by more than 300 municipalities, companies and institutions on five Continents. He recently led a US EPA-sponsored design team to develop a strategic software tool to support harmonized strategies for reducing both greenhouse gas emissions and criteria air pollutants.

SOME SELECTED ACTIVITIES AND ACCOMPLISHMENTS

Project manager in the development of energy and greenhouse gas emission scenarios to support the National Round Table on the Environment and the Economy's mandate to explore energy and climate policies for Canada in the post-Kyoto period. (Client: National Round Table on the Environment and the Economy, 2005)

Project manager for an analysis of electricity demand patterns in Ontario and an assessment of the potential for conservation and demand management. (Client: Ontario Power Authority, 2005)

Lead consultant for developing the method and approach for Toronto's first harmonized inventory and strategy for the joint reduction of greenhouse gases and common air contaminants. (Client: Toronto Atmospheric Fund, City of Toronto, 2005)

Technical assessment of the opportunities for reducing emissions of both air contaminants and greenhouse gases from Ontario school buses. (Client: Ontario Public Health Association, 2004)

Team Leader in the Review of the Need for and Alternatives To Manitoba Hydro's Proposed Wuskwatim Generating Station in the Clean Environment Commission Hearings. (Client: Resource Conservation Manitoba and TREE 2003-2004)

Invited speaker at numerous environmental educational and professional conferences (recently including Queen's University, National Institute for Environmental Studies, New Brunswick Lung Association, March 2004 "Sustainable Energy Futures for Central Ontario" in Toronto, "National Extended Producer Responsibility" in Halifax, "Climate Change Symposium of the Thames Valley District School Board" in London Ontario; "Conference of the Reducers" in Toronto 2004, "Sustainable Technologies and Services Summit" in Ottawa, November 2004.

Developer of the U.K. Councils for Climate Protection Greenhouse Gas Software which has been used by over 25 cities in England. (2001-present)

Developer of CCP Greenhouse Gas Software for the U.S., Canada and Australia national programs and USAID funded software for Mexico, Thailand, Philippines, South Africa, Indonesia, India and a Spanish Latin American version for CIDA. (1995-present)

Head of an international design team developing a strategic planning software tool for analyzing and quantifying harmonized strategies for reducing both greenhouse gas and air pollutant emissions. (Client: STAPPA/ALAPCO, ICLEI, US EPA, 2001-2002).

Planned and coordinated an international "Best Practices Exchange" in Toronto to bring together an elite group of municipal staff and elected officials from the world's leading environmental cities to address the policy and implementation challenges facing environmentally advanced cities. (Client: Toronto Atmospheric Fund, 2001).

Strategic planning consulting and facilitation to one of Canada's leading suppliers of outdoor clothing and recreational equipment. (Client: Mountain Equipment Coop, 2001-2002)

Consultant and software provision for the "Clean Air Cool Planet" initiative in the U.S. Northeast, a program for engaging small and medium sized businesses and institutions in strategic energy conservation and emission reduction activities.

Overseeing the updating and consolidation of the energy consumption and emissions inventory for the City of Toronto, and the development of possible energy conservation and emission reduction strategies for the city. (Client: with Environs RIS for the Toronto Atmospheric Fund).

Development of energy conservation and emission reduction strategies for the City of Ottawa. (Client: City of Ottawa, various contracts, 1996-2001).

Invited participant and guest speaker at a planning retreat for environmental managers in the Government of Canada. (Client: Public Works and Government Services Canada, 2001).

Invited principal author, Foundation Paper, Municipalities Table, Canada's National Climate Action Strategy. (CLIENT: Municipalities Table Secretariat, Environment Canada, 1998)

Review of Municipalities Table Options Paper assumptions with respect to greenhouse gas emissions under direct and indirect control of local governments in Canada, the development of a business-as-usual projection of those emissions, and review of the treatment of landfill gas recovery options and greenhouse gas impacts of waste reduction and recoiling programs. (Environment Canada, 1999-2000).

Invited lecturer, International City/County Management Association workshop for US A.I.D. managers on climate change and the cities of developing countries, Annapolis, December 1999.

Consultant to the Global Change in Local Places project of the Association of American Geographers, a NASA funded research project to develop capacity in the U.S. post-secondary educational institutions to support local strategies for greenhouse gas emission reduction initiatives. (CLIENT: Association of American Geographers, 1999-2000).

Invited participant, "Integrated Human and Natural Systems to Understand Climate Change – Impacts on Cities", Aspen Global Change Institute, Summer Workshop, 1999.

With the International Council for Local Environmental Initiatives developed, over an eight year period, methods, tools and international protocols for local government strategies for greenhouse gas emission reduction and air quality improvement. Most recently, this work has included a U.S. AID funded pilot testing of these methods and tools with a group of cities from the Philippines and Mexico. (1991-1999 and ongoing).

Invited author of a study of low carbon futures for Canada (i.e. greater than 50% reduction from current levels). (Client: David Suzuki Foundation, 1999).

Developed the algorithms and content for the Canadian CO2 Calculator, a computer software game for helping individuals gauge the level of greenhouse gas emissions caused by their energy consumption and waste production. (Client: Sustainable Development Research Institute, for Environment Canada, 1999).

Invited lectures, Greenhouse Gas Emission Reduction Strategies, Harvard University, 1999.

Invited author and researcher, U.S. Global Change in Local Places project, including book chapter on theory and practice of local greenhouse gas strategic analysis and contributions to study team research efforts. (Client: American Association of Geographers, 1999).

Consultant to North Carolina in the development of methods and related software tools for identification and analysis of greenhouse gas and air pollution reduction strategies at the state level in the U.S. (Client: Appalachia State University, 1999).

Analysis, design and development of a greenhouse gas emissions pilot trade that would allow the City of Toronto to market its emission reductions in the international carbon trading market. (Client: Toronto Atmospheric Fund, 1998).

Conceptual design and overall responsibility for developing a Windows-based greenhouse gas emissions scenario tool for quantifying the long term impacts on greenhouse gas emissions of changes in the energy technologies, fuel shares, energy demand patterns and shifts in the level and structure of economic activity. With the ability to hold nested inventories (e.g. for the provinces of Canada) inside a framework that also holds a national inventory. Ongoing.

Through association with the International Council for Local Environmental Initiatives, development of software for local governments to plan and implement strategies for greenhouse gas emission reductions. The software is emerging as the international standard for local governments and is licensed to over 200 cities in the United States, Canada, Australia, England and Wales, Italy, Mexico, the Philippines, India, Indonesia, South Africa, Argentina, Chile and Brazil. The software has been translated into French, Italian and Spanish, and future editions are in preparation that will expand the scope of the software to include air pollution and greenhouse gas emissions.

Research and development of methods to analyze and quantify the greenhouse gas reduction impacts of waste reduction, recycling and composting measures. (Clients: ICLEI, U.S. Environmental Protection Agency, Environment Canada, 1997-2001.)

Under Mr. Torrie's direction, TSA has developed a tool designed specifically to support private firms and institutions seeking to track their greenhouse gas emissions and systematically plan emission reduction efforts. The eMission software was released in North America in 2000 and an international edition is scheduled for launching in the fall of 2001.

Developing Canada's first GIS based modelling tool for quantified analysis of interactions between land use, zoning, transportation and environmental stress in urban forms. With Richard Parfett and Associates for a consortium of clients, 1998.

Author of a background paper on the implementation of sustainable development practices by Canadian business, for presentation to the Congress of the International Union for the Conservation of Nature, held in Montreal in October 1996.

Directed a project to develop and implement an inventory and strategic analysis protocol for the City of Toronto greenhouse gas emission reduction programmes. (Client: Toronto Atmospheric Fund, 1996)

Worked with a group of European municipal fleet managers to pilot test and attract investment to new technologies and methods for VKT and vehicle emission reductions. (Client: European CCP, 1996)

Principal author of a methods manual on strategic analysis of urban greenhouse gas emission reductions, including energy and organic waste sources. (Client: Environment Canada and City of Ottawa, 1995)

Prepared a report that identified and assessed opportunities for emission reductions (including the transportation sector) to reduce CO2 emissions by 20% in 2005 from 1990 levels given current trends in population, economic activity and other variables. (Client: City of Ottawa, 1995)

Trained municipal staff in the collection and analysis of urban transportation energy and related emissions. Through workshops, charettes, site visits and direct technical assistance, a group of cities from the United States and Canada are developing transportation strategies to reduce urban CO2 and other transportation-related emissions. (Client: International Council for Local Environmental Initiatives, 1995-6)

Prepared the Canadian country paper for an OECD review of urban energy management for environmental improvement, with an emphasis on best practice. (Client: Canada Mortgage and Housing Corporation, 1994)

Responsible for the analysis of urban energy use for the City of London's Air Emissions Study. Recommended strategies and policies in transportation and other sectors for reducing London's contribution to global warming and maintaining and improving air quality in London over the long term. (Client: SENES Consultants, 1995)

Prepared a report on the analytical issues surrounding the problem of quantifying urban transportation energy use and the strategic issues concerning future policy and research work. (Client: City of Toronto, 1994)

Principal technical consultant, Ontario Municipal Energy Collaborative, a group of Ontario municipalities pursuing opportunities for application of conservation and renewable energy developments. (Client: International Council for Local Environmental Initiatives, 1993)

Principal author of a review of the application of sustainable development to electric utility planning, with particular reference to Ontario Hydro. (Client: Environment Canada, 1993)

Preparation of a report that described the resource production (lumber, farm products, minerals, etc.) that would take place under a provincial economic growth scenario developed by Ontario Hydro. (Client: Environmental Group Coalition, 1992).

Invited guest lecturer and expert advisor, Canada-Czech Republic program on urban energy and environment co-operation. (Client: Urban Development and Environmental Management Program, Toronto and Prague, 1993)

Principal technical and policy advisor to the Urban CO2 Reduction Project of the International Council for Local Environmental Initiatives. (Client: ICLEI, 1991-96)

Invited participant, planning meeting for the OECD/IEA Programme on Energy and Environment in Emerging European Economies. (Client: Environment Canada, 1992)

Invited author, energy chapter of the Canadian 1991 State of the Environment Report. (Client: Environment Canada, 1990-91)

Invited member and rapporteur, Energy Task Group of the Second World Climate Conference, Geneva, 1990. (Participation sponsored by the Government of Canada through Environment Canada)

Principal researcher of an assessment of the potential for conservation and energy efficiency in Canada to the year 2020. (Client: With Peat Marbek Consulting Group for Energy Mines and Resources, 1990/91).

Consultant on strategic planning, International Institute for Sustainable Development, 1990-91.

Consultant to the International Federation of Institutes for Advanced Studies on international and developing country dimensions of policy response to global warming. (Client: International Federation of Institutes for Advanced Studies, 1990).

Invited talk, Energy Policy and the Environment -- A Look to the Future, the Fourth Symposium of Parliamentarians, Scientists and Engineers, co-organized by the Royal Society of Canada, the Canadian Academy of Engineering in co-operation with the Speaker of the House of Commons, October 1990.

Invited lecturer and participant in meetings in Beijing, Shenzhen, Guangzhou and Wuhan on China-Canada science and technology relations and problems of S&T research and research management. (Client: World University Service of Canada, 1990).

Consultant to the New Brunswick Round Table on Environment and Economy. (1990)

Invited lecturer, seminars on sustainable development and the implications to trade unions. (Client: United Steelworkers of America, 1989).

Design and planning of OECD Issue Review on Energy and Environment, In-depth Review of Canada. (Client: Environment Canada, 1988)

Participation in development of consensus acceptance and rewriting of report on OECD Issue Review on Energy and Environment in Canada. (Client: OECD Environment Directorate, 1988/89)

Preparation of review paper, development of agenda, and facilitation of the Energy Working Group of the World Conference on the Changing Atmosphere hosted by Canada in June 1988. (Client: Environment Canada, 1988)

Research director, comprehensive review of Ontario Hydro's load forecasting and energy conservation programmes. (Client: Coalition of Environmental Groups for the Ontario Environmental Assessment Board, 1991-93)

Consultant to Saskatchewan Power in a review of their load forecasting and energy demand side management (DSM) planning assumptions. (Client: Executive Office of Sask Power, 1992)

Manager, comprehensive review of Hydro-Québec's electricity demand outlook, including a critical analysis of the load forecast and the related Demand Side Management targets and programmes. (Client: James Bay Committee and CCNR, 1992-93)

Principal researcher of an assessment of Newfoundland Hydro's load forecasting and demand side management analysis and policies. (Client: Innu Nation, 1992-3)

Technical consultant to and member of the strategic sub-committee for the City of Toronto's involvement in the environmental assessment of Ontario Hydro's long range plan and the development of energy efficiency programmes in the industrial and transportation sectors for the City of Toronto. (Client: City of Toronto, 1990-92)

Research director and project manager of a study to determine the full fuel cycle emissions of greenhouse gases from Canadian thermal power plants. (Client: Canadian Electrical Association, 1991)

Research director of a study to analyse the energy-related greenhouse gas emissions of the Canadian forest products sector. (Client: ESSA Ltd. for Canadian Forestry Service, 1990-91)

Invited participant and consultant, workshop to develop policy and consultants' terms of reference for B.C. Hydro's demand management programmes. (Client: B.C. Hydro, 1990)

Invited paper, annual meeting of the International Association of Energy Economists, Ottawa, September 1990. "Canadian Energy Demand from 1971-1990: A Retrospective Analysis and Policy Implications for the 1990's".

Invited expert witness before the House of Commons Standing Committee on Environment hearings into global warming, and also consultant to the committee. (Client: House of Commons, 1989).

Preparation of a preliminary review of the Balance of Power Plan, Ontario Hydro's twenty-five year business plan. (Client: Environment Canada, 1990).

Principal researcher and consultant of a study of likely energy efficiency and conservation impacts on the National Energy Board's long range energy supply and demand outlook. (Client: National Energy Board of Canada, 1990)

Consultant, study to develop conservation supply curves for Canadian electric utilities. (Client: With Marbek Resource Consultants for the Canadian Electrical Association, 1990)

Consultant, preparation of electricity conservation supply curves for Nova Scotia. (Client: With Marbek, for Nova Scotia Power, 1990)

Visiting Associate, National Institute for Economics and Industry Research, Melbourne, and principal researcher in a study of the potential for energy conservation and renewable energy to the year 2030 in the State of Victoria, Australia. (Client: National Institute for Economic and Industry Research, Melbourne, 1989/90).

Principal researcher, study of the potential for energy conservation and efficiency in the commercial buildings sector and the social, economic and environmental benefits of realizing this potential. (Client: Private, 1990).

Invited rapporteur, International Workshop on Carbon Dioxide Abatement Strategies, Budapest, 1989. (Client: United Nations University)

Assistant project manager and senior analyst of a major retrospective analysis of energy demand patterns in Canada since the OPEC price shocks of 1973. (Client: With Marbek Resource Consultants for Energy Mines and Resources, 1988/89)

Principal analyst in a study of the potential contribution of electricity conservation measures to Ontario Hydro's coal burn in the 1990's. (Client: Ontario Ministry of Energy, 1988/89)

Review of forecasts and forecasting methods of the Alberta Energy Resources and Conservation Board. (Client: Alberta Environment Network for the ERCB, 1988/89)

Member of the Technical Advisory Board and consultant to the Ontario Nuclear Safety Review (Client: Ontario Nuclear Safety Review, F. Kenneth Hare, Commissioner, 1987-88)

Invited speaker at a strategic planning seminar for senior executives of major Canadian resource corporations. (Client: Private, 1988)

Program development and chairman, seminar on management of scientific R&D, involving leading members of Canadian scientific R&D community and Chinese R&D managers. (Client: World University Services of Canada, 1987-1992)

Principal researcher and author of a study to determine the impact of lower oil and gas projections on the long-term potential for conservation and renewable energy in Canada. (Client: Canadian Environment Network, 1987/88)

Preparation of invited paper Energy Security: The Demand Side Options to Energy Options seminar "Energy: The International Dimension", Halifax, November 1987. (Client: Energy Options Canada, 1987)

Conceptualization and principal analyst in a study to determine the potential impact of emerging technologies on the demand for electricity in Canada in 2020. (Client: Marbek Resource Consultants for the Canadian Electrical Association, 1987)

Development of the conservation supply curve technique and its application to electricity policy analysis for Ontario. (Client: Ontario Ministry of Energy, 1987)

Invited expert, international review of nuclear reactor safety, Expert Panel Workshop, Brunel University, August 1986. (Client: Institute for Resource and Security Studies, Cambridge, and Gruppe Okologie, Hanover.)

Research consultant in the calibration of the Ontario Ministry of Energy's Commercial Energy Demand Model. (Client: Marbek Resource Consultants for the Ontario Ministry of Energy, 1986)

Consultant to the Federal-Provincial Research Monitoring and Co-ordinating Committee on the Long Range Transport of Air Pollutants. (Client: Environment Canada, 1987)

Integration of state-of-environment information and methodology into an analysis of the environmental implications of scientific research and technological innovation in Canada. (Client: Science Council of Canada, 1987)

Facilitator, public consultation on the draft Environmental Protection Act. (Client: Canadian Environment Network for Environment Canada, 1986)

Facilitator of Canadian participation in the World Conservation Strategy Conference and the World Commission on Environment and Development. (Client: CIDA Secretariat for World Conferences on Environment and Development, 1986)

Assistant Co-ordinator, Energy Research Group of the International Development Research Centre (Ottawa) and the United Nations University (Tokyo). As deputy director of this international expert panel, responsibilities included identification of principal questions of policy and scientific interest to developing countries, extensive research and research management, identification and liaison with consultants from all over the world (over 100 consultants in one year), writing on behalf of the Group, direction of a publication program, external relations, and overall administrative and financial management of the project. (Client: IDRC, 1984-1986)

Research and policy analyst for a study to design a strategy for Canadian research and development in applications of solar technology to the industrial and commercial sectors. (Client: Marbek Resource Consultants for the National Research Council of Canada, 1983)

Project manager and a principal researcher for a national study to produce alternative directions for energy policy in Canada and each of the provinces. (Client: Friends of the Earth Canada for Energy Mines and Resources and other federal departments, 1980-1983)

Market research study of the potential for energy conservation and energy efficiency investments in the commercial and industrial sectors in Ontario. (Client: Private, 1983)

Invited technical resource person for the Canadian International Development Agency's Country Program Director Training Program. (Client: C.I.D.A., 1983)

Expert technical witness before Joint Hearing Board, Ontario Hydro Eastern Ontario Transmission system Expansion -- Plan Stage Hearings. (Client: Hydro Consumers' Association, 1982)

Special advisor to the Chairman, OECD Working Party on Renewable Energy in Developing Countries, 1979.

Consultant to Royal Commission on Uranium Mining -- Health and Environmental Implications, British Columbia. (1979-1980)

Invited expert witness before the Ontario Select Committee on Ontario Hydro Affairs, several appearances. (1976-1988)

OTHER INTERESTS AND ACCOMPLISHMENTS

Editorial Advisory Board, Energy Studies Review (1989-95).

Invited member, Royal Society of Canada, Committee on Greenhouse Gas Emissions Research, a blue ribbon panel of the Global Change Programme (1992-3).

Canadian Who's Who, University of Toronto Press, since 1991.

President, Alternet Communications Association Incorporated, an organization specializing in the development of computer communications in the voluntary sector, (1988-90).

Built one of the world's first prototype cadmium telluride gamma spectrometers.

Education: Honours B.Sc. (Physics Major), University of Waterloo.

SELECTED PUBLICATIONS AND REPORTS

Methods for Estimating Greenhouse Gasses from Local Places, with Robert Kates, Michael Mayfield and Brian Witcher, Local Environment, 1998.

The City of Toronto Greenhouse Gas Reduction Trading Pilot Project, with Dan Leckie for the Toronto Atmospheric Fund and the City of Toronto, 1998.

Global Change in Local Places, with Robert W. Kates, Environment, Volume 40, No. 2, March 1998.

Achieving Ecologically-Motivated Reductions of Canadian CO2 Emissions, with L.D. Danny Harvey and Robin Skinner, Energy, Vol. 22, No. 7. Pp. 705-724, Elsevier, 1997.

Realizing Toronto's Target for Greenhouse Gas Emission reductions – Current Trends and Outlook, for ICLEI and the Toronto Atmospheric Fund, Toronto, 1997.

Urban Energy Management and the Cities of APEC – Opportunities and Challenges, prepared for APEC and the National Round Table on Environment and Economy, Ottawa, 1997.

Global Warming: A Briefing for the National Round Table on the Environment and the Economy, NRTEE, Ottawa, 1997.

Reviewing the Progress Made Under Canada's National Action Program on Climate Change, with Resource Futures Incorporated, Ottawa, 1997.

Quantifying Greenhouse Gas Emission Reductions from Transportation Partners Projects, for the International Council for Local Environmental Initiatives and U.S. EPA, Toronto and Berkeley, 1997.

Research and Analytical Results from the Green Fleets Project, for the International Council for Local Environmental Initiatives and U.S. EPA, Toronto and Berkeley, 1997.

Personal Mobility is Not What it Used to Be, in Ecodecision, Volume 21, Summer 1996.

Urban Greenhouse Gas Inventories and Emission Reduction Assessment – Toward a Standardized Quantification Framework, ICLEI, Toronto, revised 1996.

Municipal Building Energy Retrofits and Carbon Offsets: Opportunities and Challenges, a White Paper prepared for the Joyce Foundation, ICLEI, Toronto, 1996.

Business Strategies for Sustainable Development in the Canadian Energy Sector, prepared for World conservation Congress of the International Union for the Conservation of Nature, Montreal, National Round Table on Environment and the Economy, 1996.

Saving the Climate – Saving the Cities, with Phil Jessup for ICLEI, 3rd edition, 1995.

Urban Greenhouse Gas Inventories and Emission Reduction Assessment in Canada -- Methodological and Analytical Issues, with Robin Skinner P.Eng. of Torrie Smith Associates, City of Ottawa, December 1995.

Realizing Ottawa's Target for Greenhouse Gas Emission Reductions (Volume I -- Main Report and Volume II – Appendices), with Robin Skinner P.Eng. of Torrie Smith Associates, City of Ottawa, December 1995.

City of London Air Emissions Study, with SENES Consultants Ltd., Proctor and Redfern Ltd., and Danny Harvey Ph.D., September 1995.

Energy for Sustainable Cities -- Thinking Globally and Acting Locally, paper prepared for the Second Municipal Leaders Summit on Climate Change, Berlin, 1995, revised version published by International Council for Local Environmental Initiatives, June 1995.

Transportation Fuel Use in the City of Toronto -- Opportunities for Conservation and Efficiency Improvements (Volume 1 -- Analytical and Strategic Policy Issues), with Robin Skinner P.Eng. of Torrie Smith Associates, City of Toronto, December 1994.

Electricity and Industry in Ontario: Costs, Competitiveness, and Sustainable Development, testimony to the Ontario Energy Board, HR22, June 1994.

An Analysis of Project Justification Documentation in the Hydro-Québec Grande-Baleine Complex Feasibility Study, with Robin Skinner P.Eng. of Torrie Smith Associates and various authors from The Goodman Group Ltd., prepared for the Grand Council of the Crees (of Québec), July 1994.

Environmental Improvement Through Urban Energy Management -- Canadian Overview, Canada Mortgage and Housing Corporation, August 1994.

Employment Impacts of Energy Efficiency: Literature Review and Implications to Newfoundland, with Robin Skinner P.Eng., and Adrian Weber of Torrie Smith Associates, prepared for The Innu Nation, June 1993.

Electricity Exports from Newfoundland -- Market Outlook, with Robin Skinner P.Eng. of Torrie Smith Associates, prepared for The Innu Nation, June 1993.

Cities and CO2: Research Results from the Urban CO2 Reduction Project, paper for the ICLEI Municipal Summit on Climate Change, New York, 1993.

Technological Energy Systems and the State of the Environment, invited paper, Energy Technology Options for the Twenty First Century, McMaster Institute for Energy Studies McMaster University, Hamilton, 1992.

Towards an Ecosystem Approach, with Judy Smith of Torrie Smith Associates, Stan Rowe Ph.D., and David Rapport Ph.D., 1992.

Base Year CO2 Emissions and Implications to Urban CO2 Reduction Strategies, an interim technical report for the Urban CO2 Reduction Project, International Council for Local Environmental Initiatives, 1992.

Future Environmental Stress: Key Demographic and Economic Trends in Ontario Hydro's Forecast, Torrie Smith Associates, 1992.

Electricity Demand and Savings Potential in Ontario's Commercial Sector, prepared for the Coalition of Environmental Groups for a Sustainable Energy Future, Toronto, 1992.

Electricity Demand and Savings Potential in Ontario's Residential Sector, prepared for the Coalition of Environmental Groups for a Sustainable Energy Future, Toronto, 1992.

Electricity Demand and Savings Potential in Ontario's Industrial Sector, prepared for the Coalition of Environmental Groups for a Sustainable Energy Future, Toronto, 1992.

Carbon Dioxide Emission Scenarios Associated with Electricity Conservation Potential, City of Toronto, 1992.

Analysis of Industrial Fuel Use and Conservation Potential in the City of Toronto, City of Toronto, 1992.

Energy Use and Requirements of the Canadian Forest Products Sector and Implications for Carbon Modelling of the Forest Sector, with Carolyn Luce P.Eng. of Torrie Smith Associates, March 1991.

Investigation into Full Fuel Cycle Emissions of Radiative Gases from Canadian Thermal Generating Stations, with Carolyn Luce P.Eng. of Torrie Smith Associates, May 1991.

The Economically Attractive Potential for Energy Efficiency Gains in Canada, with various authors from Marbek Ltd. and Peat Marwick Stevenson and Kellogg, for Energy Mines and Resources, Ottawa, 1991.

Teaching and Sustainable Development -- Setting Sail for the New World, invited paper to Education Manitoba, September 1990.

Sustainable Energy Paths: The Possibilities and the Challenges, with David Brooks in J. Owen Saunders, ed., The Legal Challenge of Sustainable Development, Canadian Institute of Resources Law, Calgary, 1990.

A Preliminary Critical Review of Ontario Hydro's Balance of Power Plan, report for Environment Canada, July 1990.

Energy Demand in Canada, 1973-1987: A Retrospective Analysis. Part A: Energy and the Economy. Part B: Sectoral Analysis of Demand Patterns. Part C: Analysis of Causal Factors in Canadian Energy Demand Patterns, with Brian Kelly, Steve Diener and Kirk Hamilton, for Energy Mines and Resources Canada, Ottawa, 1989.

Electricity Conservation and Acid Rain, report to the Ontario Ministry of Energy, Toronto, 1989.

Energy Security: The Demand Side Options, invited paper presented at "Energy" The International Dimension", a seminar sponsored by Energy Options in Halifax, Nova Scotia, November, 1987.

Environmental Degradation and Information on the State of the Environment in Canada, with Judy Smith of Torrie Smith Associates, for the Science Council of Canada, 1987.

Electricity Conservation Supply Curves for Ontario, Ontario Ministry of Energy, 1987.

2025: Soft Energy Futures for Canada -- 1988 Update, prepared for Canadian Environment Network Energy Caucus, for submission to Energy Options Policy Review, Energy Mines and Resources, February 1988.

Impact of Emerging Industrial Technologies on the Demand for Electricity in 2020, Torrie Smith Associates, 1987.

An Evaluation of Environment Canada's Public Consultation on the Draft Environmental Protection Act, Torrie Smith Associates, 1987.

Pollution, Poverty and Power, a paper presented to the World Commission on Environment and Development, on behalf of Canadian Environmental Groups, Ottawa, 1986.

Calibration of the Ministry of Energy Commercial Energy Demand Model, Ontario Ministry of Energy, 1986.

Operational Characteristics and Hazards of CANDU Nuclear Power Reactors, Torrie Smith Associates, 1986.

Determining the Long Term Potential for Energy Conservation and Renewable Energy in Canada, Energy, Vol. 10, No. 6, 1985. With John B. Robinson et al.

Environment and Development -- Two Sides of the Same Coin, in Canada and the World, Group of 78, 1985.

Efficiency, Sustainability and Self-Reliance in Ontario's Energy Economy, Ontario Ministry of Energy, 1984.

Development of an R&D Plan for Industrial Process and Commercial/Institutional Solar Technology, with MARBEK Resource Consultants for National Research Council, 1984.

An Energy End Use Data Framework, with John Robinson and Charles Figueiredo, Energy Mines and Resources, 1983.

2025: Soft Energy Futures for Canada, with David B. Brooks and John B. Robinson, Energy Mines and Resources, 1983.

Toward an Acid Free Energy System, submission to the Sub-Committee on Acid Rain, Committee on Fisheries and Forestry, House of Commons, Canada, 1983.

Radioactive Wastes from Uranium Mining, for B.C. Royal Commission of Inquiry -- Health and Environmental Protection, Uranium Mining, 1980.

Renewable Energy in Developing Countries, in Alternatives, Vol 9, No. 3, 1980.

Feasibility Study of Methanol Production in Northern Ontario, for Royal Commission on the Northern Environment, 1979.

Renewable Energy in Developing Countries -- An Overview, for the Chairman, OECD Working Party, 1979.

Summary and Review of Swedish KBS Project or Nuclear Fuel Safety Project, for the Science Council of Canada, 1979.

GLEN J. WOOD **ICF INTERNATIONAL**

Senior Manager

EDUCATION
Masters of Business Administration, Wilfrid Laurier University, 1991
Bachelor of Environmental Studies, University of Waterloo, 1979

SELECT PROJECT EXPERIENCE

Factor Analysis of Electricity Consumption 1990 to 2003, Ontario Power Authority. As a new agency responsible for ensuring an adequate supply of electricity for the province and developing a "conservation culture", the OPA retained ICF International to analyse changing historic patterns of electricity consumption. During the decade prior to the creation of the OPA, electricity consumption had uncoupled from GDP to grow at rates well below prior expectations. Glen took a leadership role in analyzing electricity use by sector, sub-sector and end use to identify important trends underlying this new pattern of slower growth and identify areas meriting further investigation and analysis.

Modeling in Support of AB 32

I have been involved in the project from the beginning. I gradually assumed day to day management of the AB 32 project from Chris MacCracken in the collection and analysis of the data, working with the Toronto team in coordinating the project since its inception. By virtue of this involvement I am familiar with the energy and end-use data and emissions for California as well as some of the unique aspects of their GHG inventory. I have also provided support on the development of policies and developed the Assumptions Book documenting the data used in developing the California model.

Assessment of CDM Potential in the Ontario Electricity Market, Ontario Power Authority. The newly formed OPA was charged with developing recommendations on how Ontario should meet its long-term power supply needs. Key to this plan was the assessment of the potential for Conservation and Demand Management (CDM). Quite limited Ontario-specific data was available since utilities had exited the DSM market in the mid-1990's. Glen worked with a team of ICF experts to develop estimates of the technical and economic potential for CDM as well as estimating the "achievable" potential using two different methods. The first approach built on ICF's extensive experience to estimate the Ontario potential based on the achievements of best-practice DSM programs across the U.S.. The second approach utilized its Energy Efficiency Potential Model (EEPM) model to develop estimates of achievable efficiency potential under a range of incentive levels.

Low Emission Scenario Analysis for Canada, National Round Table on the Environment and the Economy. ICF International has been retained to perform a scenario analysis of how Canada might achieve reductions in its Green House Gas (GHG) emission by 50-60% as part of an effort to attain sustainable levels of CO_2 emissions worldwide. Glen is working as part of a team leading the effort that will inform Canada's next generation of climate change response policies. NRTEE's goal for this program is to identify the strategic directions for energy and climate policy the government must pursue now to put the country on a course for a 60 percent reduction in greenhouse gas emissions by 2050 in a manner that will contribute to Canada's economic prosperity and competitiveness.

Strategic Initiatives

Maintained a strategic focus on containing costs while improving customer service levels. Serviced 25% increase in customers over 13 years while reducing full time equivalents by one position and maintaining customer satisfaction rates at or above those of competitors in market.

Created and implemented numerous innovative programs and services designed to help customers gain a better understanding of the drivers of their costs, allowing them to make decisions to maximize value

received for their expenditures. Repeated customer surveys reported customer satisfaction ratings that equaled or exceeded those of any comparable service in the community.

Optimized use of IT resources by focusing on system improvements that addressed high volume repetitive functions to yield the maximum benefits.

Championed the adoption of a community based model that addressed the needs of low income families, tackling numerous barriers in order to establish an arms length charitable organization, repositioning a very negative public relations issue into a positive story.

Convinced both corporate and community partners to actively participate in a fundraising campaign and ongoing administration of the new Charity, securing the necessary resources and leadership needed to address a serious community need.

Identified opportunity and negotiated joint program between Ontario Hydro and Region of Waterloo, convincing them to fund material costs of a City-wide water and energy conservation initiative that reduced customer costs and improved the company's public profile despite rising rates.

Leadership and Staff Development

Established service quality standards and systems to manage and measure performance. Communicated expectations to staff and provided performance feedback and support. Routinely maintained performance above standards and met or exceeded customer expectations.

Communicated changes in policy and procedures related to credit and collections, establishing clear expectations for both staff and delinquent customers, improving effectiveness of collection notices while maintaining bad debt levels below 0.15% of service revenue.

Collaborated with other Senior Managers to successfully resolve issues to settle Collective Agreements using "Mutual Gains Bargaining" approach.

Created innovative and successful programs to market customer and energy services. Programs met objectives and were recognized with Innovation Awards by industry association.

Process Improvements

Introduced new workflows and approach (making originator of work responsible for quality) and automating processes to improve efficiency, decrease interdepartmental conflict, and reduce costly rework while increasing service levels to customers.

Established a co-operative approach to problem resolution; restructuring processes to provide immediate and objective feedback to improve ability to self manage.

Reduced costs of recurrent transactions through development of new services and system operations resulting in 70% of payments being processed electronically while maintaining a level of customer choice exceeding industry standards to service diverse market segments.

Reduced time to bill by 5 days for 80% of accounts, improving corporate cash flow and reducing resources required for billing process.

Reduced time and improved accuracy of a complex, quarterly regulatory filing by developing a database-reporting tool that leveraged an existing database. Benefits were shared among a 25-company user group.

Change Management

Managed staff through on going organizational and system changes, emphasizing the benefits of focusing on improving productivity and embracing change; thereby gaining employee acceptance while achieving organizational objectives.

Worked collaboratively with staff to identify and overcome key areas of concern and potential problems surrounding system conversion and regulatory changes, providing necessary training and ongoing information needed to generate enthusiasm and reduce anxiety when the system went "live".

Celebrated successes through and following change processes, recognizing employee achievements while actively encouraging the sharing of ideas and information that strengthened the sense of ownership and built team morale.

EMPLOYMENT HISTORY

ICF International	Manager	July 2005 – present
R W Energy Services	Partner	2004 – 2005
Cambridge & North Dumfries Hydro Inc.	Director, Customer Service	1990 - 2004
Fibretech Inc. (subsidiary of CNDHI)	Manager, Customer Service	2000 – 2001
Oakville Hydro	Manager, Marketing & Customer Service	1989 - 1990

EXHIBIT B
Standard Agreement

BUDGET DETAIL AND PAYMENT PROVISIONS

1. **Invoicing and Payment**

   A. For services satisfactorily rendered, and upon receipt and approval of the invoices, the State agrees to compensate the Contractor for actual expenditures incurred in accordance with the rates specified herein, which is attached hereto and made a part of this Agreement.

   B. Invoices shall include the Agreement Number and shall be submitted in triplicate not more frequently than monthly in arrears to:

   Air Resources Board
   Research Division
   P.O. Box 2815
   Sacramento, CA 95812-1436
   Attn: Emma Plasencia

   C. Contractor, upon written approval by the State's Project Representative, may re-budget funds for a cumulative total of ten (10) percent or $25,000 whichever is less, between the major budget categories listed in Exhibit B.

   D. Upon mutual agreement, State will give consideration to re-budgeting requests, however; no re-budgeting in excess of ten (10) percent and no re-budgeting of funds into the travel category may be performed without Research Division Chief's written approval. The total agreement cost will remain unchanged.

2. **Budget Contingency Clause**

   A. It is mutually agreed that if the Budget Act of the current year and/or any subsequent years covered under this Agreement does not appropriate sufficient funds for the program, this Agreement shall be of no further force and effect. In this event, the State shall have no liability to pay any funds whatsoever to Contractor or to furnish any other considerations under this Agreement and Contractor shall not be obligated to perform any provisions of this Agreement.

   B. If funding for any fiscal year is reduced or deleted by the Budget Act for purposes of this program, the State shall have the option to either cancel this Agreement with no liability occurring to the State, or offer an agreement amendment to Contractor to reflect the reduced amount.

3. **Prompt Payment Clause**

   Payment will be made in accordance with, and within the time specified in, Government Code Chapter 4.5, commencing with Section 927.

EXHIBIT D
Standard Agreement

SPECIAL TERMS AND CONDITIONS

1. **Excise Tax**

The State of California is exempt from federal excise taxes, and no payment will be made for any taxes levied on employees' wages. The State will pay for any applicable State of California or local sales or use taxes on the services rendered or equipment or parts supplied pursuant to this Agreement. California may pay any applicable sales and use tax imposed by another state.

2. **Settlement of Disputes**

A. In the event of a dispute, Contractor shall file a "Notice of Dispute" with ARB within ten (10) days of discovery of the problem. Within ten (10) days, ARB shall meet with the Contractor and Project Representative for purposes of resolving the dispute.

B. Any dispute concerning a question of fact arising under the terms of this Agreement which is not disposed of within a reasonable period of time by Contractor and State employees normally responsible for the administration of this Agreement shall be brought to the attention of the Executive Officer or designated representative of each organization for resolution. The decision of the State Executive Officer or designated representative shall be final.

C. In the event of a dispute, the language contained within this Agreement shall prevail over any other language including that of the proposal.

D. The existence of a dispute not fully resolved shall not delay Contractor to continue with the responsibilities under this Agreement which is not affected by the dispute.

3. **Potential Subcontractors**

Nothing contained in this Agreement or otherwise, shall create any contractual relation between the State and any subcontractors, and no subcontract shall relieve the Contractor of his responsibilities and obligations hereunder. The Contractor agrees to be as fully responsible to the State for the acts and omissions of its subcontractors and of persons either directly or indirectly employed by any of them as it is for the acts and omissions of persons directly employed by the Contractor. The Contractor's obligation to pay its subcontractors is an independent obligation from the State's obligation to make payments to the Contractor. As a result, the State shall have no obligation to pay or to enforce the payment of any moneys to any subcontractor.

Contractor shall not subcontract any services under this Agreement without prior approval of the State.

4. **Stop Work Order**

State reserves the right to issue an order to stop work in the event that a dispute should arise, or in the event that State gives Contractor a notice that the Agreement will be terminated. The stop-work order will be in effect until the dispute has been resolved or the Agreement has been terminated.

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5. **Termination**

   A. In addition to the rights under Exhibit C of the Standard Agreement, State reserves the right to terminate this Agreement at its sole discretion at any time upon thirty (30) days prior written notice to Contractor.

   B. In the case of early termination, Contractor shall submit an invoice in triplicate and a report in triplicate covering services to termination date, following the invoice and progress report requirements of this Agreement. A copy and description of any data collected up to termination date shall also be provided to State.

   C. Upon receipt of the invoice, progress report, and data, a final payment will be made to Contractor. This payment shall be for all State-approved, actually-incurred costs that in the opinion of State are justified, and shall include labor, and materials purchased or utilized (including all non-cancellable commitments) to termination date, and pro rata indirect costs as specified in the proposal budget.

6. **Amendments**

   ARB reserves the right to amend this Agreement for additional time and/or additional funding.

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ADDITIONAL PROVISIONS

1. **Travel & Per Diem**

   A. Any reimbursement from funds originating from this agreement for necessary travel and per diem shall be at rates not to exceed those amounts paid to State of California employees as set forth by Department of Personal Administration rules and regulations, or verification supplied that indicates such rates are not available to Contractor.

   B. No travel outside the State of California shall be reimbursed unless prior written authorization is obtained from State.

2. **Evaluation of Contractor**

   Performance of the Contractor under this Agreement will be evaluated. The evaluation shall be prepared on Contract/Contractor Evaluation Sheet (STD 4), and maintained in the Agreement file. For consultant agreements over $5,000, a copy of any negative evaluations will be sent to the Department of General Services, Office of Legal Services.

3. **Progress Payments**

   In computing the amount of any progress payment, the State shall determine what Contractor has earned during the period for which payment is being made on the basis of the Agreement terms, but shall retain out of such earnings, an amount equal to 10 percent thereof, pending satisfactory completion of the entire agreement. However, if the Agreement consists of the performance of separate and distinct tasks, then any funds so withheld with regard to a particular task may be paid upon completion of that task.

4. **Computer Software**

   Contractor certifies that it has appropriate systems and controls in place to ensure that State funds will not be used in the performance of this contract for the acquisition, operation or maintenance of computer software in violation of copyright laws.

5. **Meetings**

   A. Initial meeting. Before work on the contract begins, Contractor will meet with the State's Project Representative and other staff to discuss the overall plan, details of performing the tasks, the project schedule, items related to personnel or changes in personnel, and any issues that may need to be resolved before work can begin.

   B. Progress review meetings. Contractor and appropriate members of his or her staff will meet with the State's Project Representative at monthly intervals to discuss the progress of the project. This meeting may be conducted by phone, if appropriate.

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C. Technical Seminar The Contractor will present the results of the project to ARB staff and a possible webcast at a seminar at ARB facilities in Sacramento or El Monte.

6. Reports and Data Compilations

A. With respect to each invoice period, Contractor shall forward to the Project Representative an electronic copy of the progress report and mail one copy of the progress report with each invoice. (Do not use Express Mail.) When e-mailing the progress report, the "subject line" should state the contract number and the billing period. Each progress report will begin with the following disclaimer:

The statements and conclusions in this report are those of the Contractor and not necessarily those of the California Air Resources Board. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products.

B. Each progress report will also include:

1. A brief narrative account of project tasks completed or partially completed since the last progress report.
2. A brief discussion of problems encountered during the reporting period and how they were or are proposed to be resolved.
3. A brief discussion of work planned, by project task, before the next progress report.
4. A graph showing allocation of the budget and amount used to date for each task.
5. A graph showing percent of completion for each task.

C. If the project is behind schedule, the progress report must contain an explanation of reasons and how Contractor plans to resume the schedule.

D. Six months prior to contract termination date, Contractor will deliver to State twenty (20) bound copies of a draft final report for review by ARB staff. The reports may be stapled or spiral bound, depending on size. The draft final report will conform to Exhibit F.

E. Within forty-five (45) days of receipt of State's comments on the draft final report, Contractor will deliver to the State's Project Representative two (2) copies of the final report incorporating all reasonable alterations and additions requested by State and the Research Screening Committee. Upon approval of the amended final report by the State's Project Representative, Contractor will within two (2) weeks, deliver to State two (2) camera-ready **UNBOUND** originals and a final report incorporating all final alterations and additions. The final report will conform to the Contract Final Report Format, Exhibit F.

F. Together with the final report, Contractor will deliver a copy of the report on diskette, using Microsoft Word 6.0 (or newer) and a set of all data compilations as specified by the ARB Project Representative.

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G. Contractor's obligation under this Agreement shall be deemed discharged only upon submittal to and acceptance by the State of the final report, report diskette, and all required data compilations.

H. No reports, professional papers, information, inventions, improvements, discoveries, or data obtained, prepared, assembled, or developed by Contractor pursuant to this Agreement shall be released or made available, except to ARB, without prior written approval of State while the Agreement is in force. State's consent shall not be unreasonably withheld.

7. **Priority Hiring Considerations**

Contractor shall give priority consideration in filling vacancies in positions funded by this Agreement to qualified recipients of aid under Welfare and Institutions Code Section 11200.

8. **Forced, Convict, and Indentured Labor**

No foreign-made equipment, materials, or supplies furnished to State pursuant to this Agreement may be produced in whole or in part by forced labor, convict labor, or indentured labor. By submitting a proposal to State, Contractor agrees to comply with this provision of the Agreement.

9. **Insurance**

A. Contractor shall furnish to State a certificate of insurance stating that liability insurance of not less than $1,000,000 per occurrence for bodily injury and property damage liability combined is presently in effect for Contractor.

B. Contractor agrees that the bodily injury liability insurance herein provided for shall be in effect at all times during the term of this Agreement. In the event said insurance coverage expires at any time or times during the term of this Agreement, Contractor agrees to provide, at least thirty (30) days before said expiration date, a new certificate of insurance evidencing insurance coverage as provided for herein for not less than the remainder of the term of the Agreement or for a period of not less than one year. New certificates of insurance are subject to the approval of the Department of General Services, and Contractor agrees that no work or services shall be performed prior to such approval. The State may, in addition to any other remedies it may have, terminate this Agreement on the occurrence of such event.

The Certificate of Insurance must include the following provisions:

1. The insurer will not cancel the insured's coverage without thirty (30) days prior written notice to State; and
2. The State of California, its officers, agents, employees and servants are included as additional insured, but only insofar as the operations under this Agreement are concerned.

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10. **Copyrightable Materials**

A. ARB reserves the right to any copyrightable materials developed under this Agreement. Upon acceptance of the copyrightable materials developed under this Agreement, and payment of the sums then due under the terms of the Agreement, ARB shall have the sole and exclusive right, title, and interest (including trade secret and copyright interests) in the copyrightable materials. Contractor and his or her subcontractors hereby assign(s) all rights, title, and interest (including trade secret and copyright interest) in any copyrightable materials developed under this Agreement to ARB.

B. ARB, at its discretion, may grant a nonexclusive and paid-up license to Contractor and his or her subcontractors to use said copyrightable materials. Contractor and his or her subcontractors agrees to cooperate with and assist ARB to apply for and to execute any applications and/or assignments reasonably necessary to obtain any patent, copyright, trademark, or other statutory protection for all copyrightable materials.

C. Contractor and his or her subcontractors shall not disclose any copyrightable materials, any of the deliverables thereof, or any portion thereof, to any other organization or person without the written consent of ARB.

D. Contractor and his or her subcontractors shall not use the copyrightable materials, any of the deliverables thereof, or any portion thereof, in any other work performed by this Agreement subject to any license granted without the written consent of ARB.

E. Contractor's obligations under this provision shall survive the expiration or termination of this Agreement.

11. **Confidentiality**

It is expressly understood and agreed that information Contractor receives from State in performing its obligations under this Agreement may be deemed confidential by State. Therefore, Contractor agrees to:

A. Observe complete confidentiality with respect to such information, including without limitation, agreeing not to disclose or otherwise permit access to such information by any person or entity in any manner whatsoever.

B. Ensure that Contractor's employees, agents, representatives, and independent contractors are informed of the confidential nature of such information and ensure by agreement or otherwise that they are prohibited from copying or revealing, for any purpose whatsoever, the contents of such information or any part thereof, or from taking any action otherwise prohibited under this section.

C. Not use such information or any part thereof in the performance of services to others or for the benefit of others in any form whatsoever whether gratuitously or for valuable consideration, except as permitted under this Agreement.

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D. Notify State promptly and in writing of the circumstances surrounding any possession, use or knowledge of such information or any part thereof by any person other than those authorized by this paragraph.

12. **Patent Provisions**

A. Definitions

1. "Invention" means any discovery or product of creative imagination, thought, mental synthesis, or purposeful experimentation conceived or first reduced to practice in the course of or under this Agreement. The term "invention" includes, but is not limited to, any art, method, process, device, machine, manufacture, design, or composition of matter, or any new and useful improvement or application thereof, or any variety of plant, that is or may be patentable under the patent laws of the United States of America.

2. "Agreement" means any legally enforceable agreement, covenant, compact grant, or other arrangement or subcontract setting forth terms and conditions to do or not to do something and entered into by or for the benefit of the State where a purpose of the agreement is the conduct of experimental, developmental, or research work.

3. "Subcontract" means an agreement under or subordinate to a previous or prime agreement, including this Agreement.

4. "Subcontractor" means an individual or firm that contract with Contractor to perform part or all of the prime Contractor's work under this Agreement.

5. "To bring to the point of practical application" means to manufacture in the case of a composition or product, to practice in the case of a process, or to operate in the case of a machine, device, or system and, in each case, under such conditions as to establish that the invention is being worked, operated, or utilized, and that its benefits are reasonably accessible to the public.

B. Rights Granted to the State

Contractor agrees to grant to State all right, title, and interest in and to each invention discovered, conceived, or first reduced to practical application during performance of this Agreement, subject to the reservation of a non-exclusive paid-up worldwide license to Contractor.

C. Invention Disclosures and Reports

With respect to each invention, Contractor shall furnish to ARB:

1. A written disclosure of each invention within six (6) months after conception or first actual reduction to practice, whichever occurs first under this Agreement, sufficiently complete in technical detail to convey to one skilled in the art to which the invention pertains a clear understanding to the nature, purpose, and operation, and the physical, chemical, and electrical characteristics of the invention;

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2. A final report listing all inventions, including all those previously disclosed, or certifying that there are no inventions prior to final payment under this contract.

3. Information in writing, as soon as is practicable, of the date and identity of any public use, sale, or publication of any such invention made by or known to Contractor, or of any contemplated publication by Contractor;

4. Upon request, such duly executed instruments and other papers as deemed by ARB necessary to vest in State the rights granted it under this patent provision and to enable State

   to apply for and prosecute any patent application in any country covering such invention where State has the right under this patent provision to file such application; and upon request, an irrevocable power of attorney to inspect and make copies of any United States patent application filed by or on behalf of Contractor. This demand may also be made under subdivision 8.

D. Licenses Granted by Contractor to Others Subject to State's Rights

Contractor recognizes that State may contract for property or services with respect to which the vendor may be liable to Contractor for royalties for the use of an invention on account of such a contract. Contractor further recognizes that it is the policy of State not to pay, in connection with its agreements, charges for use of patents in which the State holds title. In recognition of this policy, Contractor agrees to participate in and make appropriate arrangements for the exclusion of such charges from such agreements or for the refund of amounts received by Contractor with respect to any such charges not so excluded.

E. Subcontracts

1. Contractor shall, unless otherwise authorized or directed by State, include a patent rights clause containing all the terms of this patent provision in any subcontract hereunder where the purpose of the subcontract is the conduct of experimental, developmental, or research work. In the event of refusal by a subcontractor to accept this patent provision, Contractor:

   a. shall promptly submit a written report to the State setting forth the subcontractor's reasons for such refusal or the reasons Contractor is of the opinion that the inclusion of this clause would be unacceptable, and other pertinent information that may expedite disposition of this matter; and

   b. shall not proceed with the subcontract without the written authorization of State.

2. Contractor shall not, in any subcontract or by using such a subcontract as consideration thereof, acquire any rights to inventions for his/her own use (as distinguished from such rights as may be required solely to fulfill his/her agreement obligations to State in the performance of this Agreement).

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3. Contractor, at the earliest practicable date, shall also notify State in writing of any subcontract containing a patent rights clause, furnish to State a copy of such subcontract, and notify State when such subcontract is completed. It is understood that State is a third party beneficiary of any subcontract clause granting rights to State in inventions, and Contractor hereby assigns to State all the rights that Contractor would have to enforce the subcontractor's obligations for the benefit of State with respect to inventions. Contractor shall not be obligated to enforce the agreements of any subcontractor to State with regard to inventions.

F. Right to Disclose Inventions

State may duplicate and disclose reports and disclosures of inventions required to be furnished by Contractor pursuant to this patent provision.

G. Forfeiture of Rights in Unreported Inventions

Contractor shall forfeit to State all rights in any invention which Contractor fails to report to State, at or prior to the time Contractor (1) files or causes to be filed a United States or foreign application thereon, or (2) submits the final report required by 3., B of this patent provision, whichever is later, provided that Contractor shall not forfeit rights in an invention if (a) contending that the invention is not an invention, s/he nevertheless reports the invention and all the facts pertinent to Contractor's contention to State, the time specified in 3. A above, or (b) Contractor establishes that the failure to report was due entirely to causes beyond Contractor's control and without Contractor's fault or negligence. Contractor shall be deemed to hold any such forfeited invention and the patent applications and patent pertaining thereto, in trust for State pending written assignment of the invention. The right accruing to State under this paragraph shall be in addition to and shall not supersede any other rights State may have in relation to unreported inventions.

H. Examination of Records Relating to Inventions

State shall, until the expiration of three years after final payment under this agreement, have the right to examine any books, records, documents, and other supporting data of Contractor that State shall reasonably deem directly pertinent to the discovery or identification of inventions or to compliance by Contractor with the requirements of this patent provision.

13. Equipment Provisions

A. Equipment is defined as movable articles of nonexpendable property that meet the following requirements:

1. Have a normal useful life (including extended life due to repairs) of at least one year;

2. Have a unit acquisition cost of at least $5,000 for other than land and structures (for example, identical assets costing $3,000 each for a $12,000 total would not meet the requirements); and

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3. Be used to conduct work under this contract, and/or

4. Any and all EDP equipment used to conduct work under this contract.

B. The cost of equipment includes the purchase price plus all costs to acquire, install, and prepare equipment for its intended use.

C. ARB reserves the right to purchase total equipment whose cost is greater than $25,000 and any and all EDP equipment for this contract, through the State procurement process. Contractor's proposed cost of this equipment will be deducted from the total amount payable to the Contractor.

D. In the event Contractor purchases with ARB funds, procures, uses, or otherwise takes possession of equipment owned by ARB to perform work under this contract, title to such equipment shall remain with ARB and such equipment shall become ARB's equipment upon delivery thereof into Contractor's control or possession.

E. Contractor shall obtain written approval from ARB prior to the purchase of equipment that is not specifically identified and listed in the approval budget and which is valued at more than $1,000. The contract funding shall be adjusted for any equipment or supplies furnished by ARB.

F. ARB reserves the right to full and adequate access to ARB equipment.

G. The Contractor shall maintain and administer a program for the utilization, maintenance, repair, protection, and preservation of ARB equipment, whether acquired from the ARB or purchased with ARB funds from a third party, so as to assure its full availability and usefulness for performance of this contract or as long as this equipment remains in the control or possession of the Contractor. The Contractor will install upon each item of equipment a tag identifying the equipment as belonging to the ARB and will maintain location records of all equipment. The Contractor shall take steps to comply with all appropriate directions or instructions that the ARB may prescribe for the protection of ARB equipment.

H. The Contractor shall provide to ARB, with the final invoice, a final equipment inventory. The final invoice shall contain an itemization of equipment purchased with ARB funds or procured through the State procurement process, including the type of equipment, manufacturer, serial number, and cost. All ARB equipment shall be returned to the ARB in full operating condition upon termination of this contract, unless ARB approves a different disposition in writing. Disposition of the equipment shall be in accordance with the instructions from ARB, to be issued after receipt of the final inventory.

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FINAL REPORT FORMAT

The research contract Final Report (Report) is as important to the contract as the research itself. The Report is a record of the project and its results, and is used in several ways. Therefore, the Report must be well organized and contain certain specific information. The Board's Research Screening Committee (RSC) reviews all draft Final Reports, paying special attention to the Abstract and Executive Summary. If the RSC finds that the Report does not fulfill the requirements stated in this Appendix, the document will not be approved for release, and final payment for the work completed may be withheld. This Appendix outlines the requirements that must be met when producing the Report.

Note: In partial fulfillment of the Final Report requirements, the contractor shall submit a copy of the Report on a CD in PDF format and in a word-processing format, preferably in Word - Version 6.0 or later. This is in addition to the submission of any paper copies required. The diskette shall be clearly labeled with the contract title, ARB contract number, the words "Final Report", and the date the report was submitted.

Legibility. Each page of the approved Final Report must be legible and camera-ready.

Binding. The draft Report, including its appendices, must be either spiral bound or stapled, depending on size. The revised Report and its appendices should be spiral bound, except for two unbound, camera-ready originals.

Cover. Do not supply a cover for the Report. The ARB will provide its standard cover.

One-sided vs. two-sided. To conserve paper, both the draft Report and the revised Report, except for the unbound camera-ready copies, should be printed on both sides of the page. **The unbound camera-ready copies must be printed on only one side of the page.**

Title. The title of the Report should exactly duplicate the title of the contract unless a change is approved in writing by the contract manager.
Spacing. In order to conserve paper, copying costs, and postage, please use single or one-line (1) spacing.

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Page size. All pages should be of standard size (82" x 11") to allow for photo-reproduction.

Large tables or figures. Foldout or photo-reduced tables or figures are not acceptable because they cannot be readily reproduced. Large tables and figures should be presented on consecutive 82" x 11" pages, each page containing one portion of the larger chart.

Color. Color presentations are not acceptable; printing shall be black on white only.

Corporate identification. Do not include corporate identification on any page of the Final Report, except the title page.

Unit notation. Measurements in the Reports should be expressed in metric units. However, for the convenience of engineers and other scientists accustomed to using the British system, values may be given in British units as well in parentheses after the value in metric units. The expression of measurements in both systems is especially encouraged for engineering reports.

Section order. The Report should contain the following sections, in the order listed below:
Title page
Disclaimer
Acknowledgments
Table of Contents
List of Figures
List of Tables
Abstract
Executive Summary
Body of Report
References
List of inventions reported and copyrighted materials produced
Glossary of Terms, Abbreviations, and Symbols
Appendices

Page numbering. Beginning with the body of the Report, pages shall be numbered consecutively beginning with "1", including all appendices and attachments. Pages preceding the body of the Report shall be numbered consecutively, in ascending order, with small Roman numerals.
Title page. The title page should include, at a minimum, the contract number, contract title, name of the principal investigator, contractor organization, date, and this statement: "Prepared for the California Air Resources Board and the California Environmental Protection Agency"

Disclaimer. A page dedicated to this statement must follow the Title Page:

The statements and conclusions in this Report are those of the contractor and not necessarily those of the California Air Resources Board. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products.

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Acknowledgments. Only this section should contain acknowledgments of key personnel and organizations who were associated with the project. The last paragraph of the acknowledgments must read as follows:

This Report was submitted in fulfillment of [ARB contract number and project title] by [contractor organization] under the [partial] sponsorship of the California Air Resources Board. Work was completed as of [date].

Table of Contents. This should list all the sections, chapters, and appendices, together with their page numbers. Check for completeness and correct reference to pages in the Report.

List of Figures. This list is optional if there are fewer than five illustrations.

List of Tables. This list is optional if there are fewer than five tables.

Abstract. The abstract should tell the reader, in nontechnical terms, the purpose and scope of the work undertaken, describe the work performed, and present the results obtained and conclusions. The purpose of the abstract is to provide the reader with useful information and a means of determining whether the complete document should be obtained for study. The length of the abstract should be no more than about 200 words. Only those concepts that are addressed in the executive summary should be included in the abstract.

Example of an abstract:

A recently developed ground-based instrument, employing light detecting and ranging (lidar) technology, was evaluated and found to accurately measure ozone concentrations at altitudes of up to 3,000 meters. The novel approach used in this study provides true vertical distributions of ozone concentrations aloft and better temporal coverage of these distributions than other, more common methods, such as those using aircraft and ozonesonde (balloon) techniques. The ozone and aerosol measurements from this study, in conjunction with temperature and wind measurements, will provide
a better characterization of atmospheric conditions aloft and the processes involved in the formation of unhealthful ozone concentrations than can be achieved with traditional ground-based monitors

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Executive Summary. The function of the executive summary is to inform the reader about the important aspects of the work that was done, permitting the reader to understand the research without reading the entire Report. It should state the objectives of the research and briefly describe the experimental methodology[ies] used, results, conclusions, and recommendations for further study. All of the concepts brought out in the abstract should be expanded upon in the Executive Summary. Conversely, the Executive Summary should not contain concepts that are not expanded upon in the body of the Report.

The Executive Summary will be used in several applications as written; therefore, please observe the style considerations discussed below.

Limit the Executive Summary to two pages, single spaced.

Use narrative form. Use a style and vocabulary level comparable to that in Scientific American or the New York Times.

Do not list contract tasks in lieu of discussing the methodology.

Discuss the results rather than listing them.

Avoid jargon.

Define technical terms.

Use passive voice if active voice is awkward.

Avoid the temptation to lump separate topics together in one sentence to cut down on length.

The Executive Summary should contain four sections: Background, Methods, Results, and Conclusions, described below.

The Background section. For the Background, provide a one-paragraph discussion of the reasons the research was needed. Relate the research to the Board's regulatory functions, such as establishing ambient air quality standards for the protection of human health, crops, and ecosystems; the improvement and updating of emissions inventories; and the development of air pollution control strategies.

The Methods section. At the beginning of the Methods section, state what was done in general, in one or two sentences.

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The methodology should be described in general, nontechnical terms, unless the purpose of the research was to develop a new methodology or demonstrate a new apparatus or technique. Even in those cases, technical aspects of the methodology should be kept to the minimum necessary for understanding the project. Use terminology with which the reader is likely to be familiar. If it is necessary to use technical terms, define them. Details, such as names of manufacturers and statistical analysis techniques, should be omitted.

Specify when and where the study was performed, if it is important in interpreting the results.

The findings should not be mentioned in the Methods section.

The Results section. The Results section should be a single paragraph in which the main findings are cited and their significance briefly discussed. The results should be presented as a narrative, not a list. This section must include a discussion of the implications of the work for the Board's relevant regulatory programs.

The Conclusions section. The Conclusions section should be a single short paragraph in which the results are related to the background, objectives, and methods. Again, this should be presented as a narrative rather than a list. Include a short discussion of recommendations for further study, adhering to the guidelines for the Recommendations section in the body of the Report.

Body of Report. The body of the Report should contain the details of the research, divided into the following sections:

Introduction. Clearly identify the scope and purpose of the project. Provide a general background of the project. Explicitly state the assumptions of the study. Clearly describe the hypothesis or problem the research was designed to address. Discuss previous related work and provide a brief review of the relevant literature on the topic.

Materials and Methods. Describe the various phases of the project, the theoretical approach to the solution of the problem being addressed, and limitations to the work. Describe the design and construction phases of the project, materials, equipment, instrumentation, and methodology. Describe quality assurance and quality control procedures used. Describe the experimental or evaluation phase of the project

Results. Present the results in an orderly and coherent sequence. Describe statistical procedures used and their assumptions. Discuss information presented in tables, figures and graphs. The titles and heading of tables, graphs, and figures, should be understandable without reference to the text. Include all necessary explanatory footnotes. Clearly indicate the measurement units used.

Discussion. Interpret the data in the context of the original hypothesis or problem. Does the data support the hypothesis or provide solutions to the research problem? If appropriate, discuss how the results compare to data from similar or related studies. What are the implications of the findings? Identify innovations or development of new techniques or processes. If appropriate, discuss cost projections and economic analyses.

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Summary and Conclusions. This is the most important part of the Report because it is the section that will probably be read most frequently. This section should begin with a clear, concise statement of what, why, and how the project was done. Major results and conclusions of the study should then be presented, using clear, concise statements. Make sure the conclusions reached are fully supported by the results of the study. Do not overstate or overinterpret the results. It may be useful to itemize primary results and conclusions. A simple table or graph may be used to illustrate.

Recommendations. Use clear, concise statements to recommend (if appropriate) future research that is a reasonable progression of the study and can be supported by the results and discussion.

References. Use a consistent style to fully cite work referenced throughout the Report and references to closely related work, background material, and publications that offer additional information on aspects of the work. Please list these together in a separate section, following the body of the Report. If the Report is lengthy, you may list the references at the end of each chapter.

List of inventions reported and publications produced. If any inventions have been reported, or publications or pending publications have been produced as a result of the project, the titles, authors, journals or magazines, and identifying numbers that will assist in locating such information should be included in this section.

Glossary of terms, abbreviations, and symbols. When more than five of these items are used in the text of the Report, prepare a complete listing with explanations and definitions. It is expected that every abbreviation and symbol will be written out at its first appearance in the Report, with the abbreviation or symbol following in parentheses [i.e., carbon dioxide (CO_2)]. Symbols listed in table and figure legends need not be listed in the Glossary.

Appendices. Related or additional material that is too bulky or detailed to include within the discussion portion of the Report shall be placed in appendices. If a Report has only one appendix, it should be entitled "APPENDIX". If a Report has more than one appendix, each should be designated with a capital letter (APPENDIX A, APPENDIX B). If the appendices are too large for inclusion in the Report, they should be collated, following the binding requirements for the Report, as a separate document. The contract manager will determine whether appendices are to be included in the Report or treated separately. Page numbers of appendices included in the Report should continue the page numbering of the Report body. Pages of separated appendices should be numbered consecutively, beginning at "1".