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Industrial Consumption of Energy Survey: The 1990 NAICS based estimates

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The analytical contribution of Serge Grenier, Steve Matthews , Gary Smalldridge, John Svab and Steve Thomas to this report are also acknowledged.

Note: *This document was initially prepared and presented to a panel of experts for discussions as to the preferred method of estimation for the production of the 1990 NAICS based estimates for the Industrial Consumption of Energy Survey. The development of the various options was based on an investigation of sources and quality of data available for 1990.*

Following these discussions, Option A was chosen as the preferred method of estimation. Several small changes in processing the individual fuel types were required to improve data quality and ensure consistency with the current series. These changes only became obvious once the estimation process had begun. These changes are noted in Section H: The Process of Estimation.

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Executive summary

As part of an international effort to address the issues of global warming, the Government of Canada joined with other nations in signing the Kyoto Accord. The Federal government launched the First National Business Plan on Climate Change. Through this initiative, the Energy Section of the Manufacturing, Construction and Energy Division (MCED) of Statistics Canada began working with government lead departments to identify and fill data and analytical gaps. The ***NAICS Conversion Project*** is one such initiative funded by Natural Resources Canada (NRCan) and Environment Canada to address this issue.

The main objective of the ***NAICS Conversion Project*** was to convert the estimated data of the Industrial Consumption of Energy (ICE) Survey from the Standard Industrial Classification (SIC) to the North American Industrial Classification System (NAICS) for 65 industries and 14 fuel types for 1990 and 1995-2000 inclusively. Estimates for the 1995-2000 period were completed and released in December 2002, along with a methodological paper that was distributed in February 2003. Presented below is the document which provides a summary of the estimation procedure used to produce the 1990 Energy Fuel Consumption Estimates for manufacturing industries on a NAICS basis. This paper provides the background of the ICE survey as well as the approached that were considered for the development of the 1990 estimates. A shorter version of the methodological development of the estimates, " A Summary of the Methodological Development of the 1990 Energy Consumption Estimates for Manufacturing Industries" as well as a set of Tables of Quality Indicators were released with the 1990 estimates on August 1st 2003. A detailed description of data quality and methodology of each of the source surveys is also available by contacting the Marketing and Dissemination Section of Manufacturing Construction and Energy Division (MCED). A methodological paper describing the 1995-2000 process was prepared and distributed in February 2003.

This paper presents a number of options that were considered for the production of the North American Industrial Classification System estimates for the year 1990 as well as an explanation of the final approach that was undertaken. The development of these options was based on an investigation of sources of data available for 1990, which could potentially be used to produce the energy consumption estimates.

In 1990, the Industrial Consumption of Energy Survey (ICE) did not have sufficient sample to produce estimates of energy consumption by the manufacturing sector with today's required level of industrial disaggregation. It was therefore necessary to utilize additional sources of data to produce these estimates.

The data sources investigated include:

- A number of surveys conducted by the Energy Section of Manufacturing, Energy and Construction Division of Statistics Canada, in particular the Industrial Consumption of Energy Survey
- The Annual Survey of Manufacturers, which included financial and limited quality data on fuel consumption of a portion of the required fuel types
- Quantity series maintained by the Input-Output Division, Environment Accounts and Statistics Division and prices from the Prices Division of Statistics Canada

The estimates contained in the 1990 ICE NAICS based energy consumption tables were derived from a number of monthly, quarterly and annual manufacturing and energy surveys and administrative records received by Statistics Canada. The source surveys include: the Industrial Consumption of Energy Survey, the Annual Survey of Manufactures, the Monthly and Quarterly Refined Petroleum Products Survey, the Electricity Monthly Survey, the Electricity Supply and Disposition Quarterly Survey, the Natural Gas Disposition Survey, the Coke Monthly Survey, and the Electric Power Thermal Generating Stations Fuel Consumption Annual Survey.

Energy consumption data for the year 1990 is available at an aggregate level on a Standard Industrial Classification basis in the Quarterly Report on Energy Supply and Demand in Canada (QRESD). It provides benchmarks for major sectors of manufacturing (Pulp and Paper, Iron and Steel, Smelting and refining, non-ferrous, Cement, Chemical, Other); however the design was based on Standard Industrial Classification versus North American Industrial Classification System. The level of detail required for the 65 North American Industrial Classification System manufacturers is not available in the Quarterly Report on Energy Supply and Demand.

The Annual Survey of Manufacturers (ASM) collected data for 1990 on consumption of purchased fuels on a Standard Industrial Classification basis. The survey requested value data for all manufacturers, however quantity data was asked for a limited number of Standard Industrial Classification industries. Although all establishments in the Annual Survey of Manufacturers universe have now been assigned a North American Industrial Classification System code, differences in coverage and variable definitions between the Industrial Consumption of Energy Survey and Annual Survey of Manufacturers dictate that work is required to make the 1990 North American Industrial Classification System energy consumption estimates consistent with the 1995-2000 North American Industrial Classification System series.

The Environment Accounts and Statistics Division produces energy estimates on a Standard Industrial Classification basis. They produced 1990 estimates in terajoules for a number of fuel types and at a disaggregated level on a Standard Industrial Classification basis. The estimates were produced using fuel consumption data from the Annual Survey of Manufacturers, and data from the Quarterly Report on Energy Supply and Demand.

The numerous data sources available for the 1990 reference period have a number of significant conceptual differences. These differences included universe coverage, definition of variables, survey cycle, reporting arrangements, and imputation and estimation processes, among others. For this reason, care was required when comparing and utilizing data from different sources to ensure similar concepts were applied in the estimation process. A second caveat in producing the estimates is that not all data sources included the full set of fuel types, which were to be estimated. It was therefore necessary to utilize different data sources and adapt alternate estimation processes to accommodate each fuel type.

A number of options have been explored for producing energy consumption estimates for 1990 for the 65 North American Industrial Classification System manufacturing industries:

Option A Calculate 1990 NAICS energy consumption estimates using a combined macro/micro approach depending on the type of fuel. Establish control totals at the fuel type and aggregate industry levels using the QRESD and supplement with other sources where required. Where available, use 1990 ICE NAICS data directly. Use 1990 ASM NAICS to model detailed industry distribution based on 1990 volume data and estimate quantities using provincial-level price data. Use Energy Section surveys for data on self-generated energy.

Option B Calculate energy consumption estimates for each industry using the 1990 ASM NAICS dollar value estimates for purchased fuels, and unit cost estimates from 1991 ASM NAICS.

Option C This is the same as Option B but instead of calculating a price index by industry or some other group, the price would be calculated at the unit level.

Option D Apply macro-adjustments from the 1991 ASM NAICS or the 1995 ICE NAICS to the 1990 ASM NAICS dollar value estimates for purchased fuels.

Option E Apply SIC to NAICS concordance factors using value of shipments from the ASM to the 1990 EASD SIC estimates.

Option F Use Option A for the main energy-consuming industries and Option D or E for the less energy-intensive industries choosing the option that provides the most coherence and consistency.

The recommended option is Option A, for the following reasons:

- Given the importance of the 1990 reference year as the base year for the Kyoto Protocol, it is essential to develop the very best set of estimates possible. To do this, more than one source of data must be investigated. In 1990, there was not one single source of data that would provide sufficient information to produce estimates for all fuel types and at the level of industrial detailed required.
- A combined macro/micro approach is consistent with Statistics Canada approaches in the past. A macro approach such as that described in Option D would produce results faster, but may result in under coverage or double counting for some fuel types and less defensible data. The combined approach is more complicated and more time consuming, but would provide estimates of energy consumption more in line with previously published estimates and of a higher quality.
- The process to validate these estimates would include trend analysis with Gross Domestic Product, data confrontation internally by comparing various survey data in the Energy Section, estimates published by Manufacturing Construction and Energy Division and Environment Accounts and Statistics Division as well as estimates currently available in the public domain including those of Environment Canada and Canadian Industrial Consumption of Energy End-Use data and Analysis Centre.

A. Introduction

As part of an international effort to address the issues of global warming, the Government of Canada joined with other nations in signing the Kyoto Accord. From this commitment, the federal government launched the First National Business Plan on Climate Change. Through this initiative, the Energy Section of the Manufacturing, Construction and Energy Division (MCED) of Statistics Canada began working with government lead departments to identify and fill data and analytical gaps. The ***NAICS Conversion Project*** is one such initiative funded by Natural Resources Canada (NRCan) to address this issue.

The main objective of the ***NAICS Conversion Project*** was to convert the estimated data of the Industrial Consumption of Energy (ICE) Survey from the Standard Industrial Classification (SIC) to the North American Classification System (NAICS) for 1990 and for the years 1995-2000 inclusively. Estimates for the 1995-2000 period were completed and released in December 2002, along with a methodological report distributed in February 2003. The reference year 1990 is much more complicated than the 1995-2000 period. In 1990 the ICE Survey had very limited coverage. As a result other sources of data will need to be utilised.

This report was originally written to discuss the data available in 1990 and options available to produce estimates for that year. The options included in this paper were presented to Natural Resources Canada and Environment Canada in order to establish the preferred estimation approach. Option A presented below was chosen. Small changes to the initial approach were incorporated, in order to improve data quality and ensure the best possible estimates, as new information became available. This paper has now been expanded. In addition to the original options suggested, an explanation of the final process that was employed to produce these estimates has been included.

The report is organised into 9 sections. **Section A** provides an introduction. **Section B** provides a background of the ICE Survey. **Section C** discusses the project requirements. **Section D** provides an overview of the data sources that exist for 1990 and discusses the benefits and limitations of each source as well as an explanation of some of the differences between these sources. **Section E** discusses the fuel types and is supplemented by **Appendix C** that includes a discussion of the major issues around each fuel type. Appendix C includes both the proposed and actual estimation process. **Section F** discusses anomalies that may exist in an industry and again is supplemented by **Appendix D** that discusses in detail industries that require particular attention. **Section G** ties the previous three sections together with six methodological options for estimation. It specifies the benefits and limitations of each option. **Section H** discusses the process for estimation. The final process employed is explained in this section. **Section I** is a glossary of terms. **Appendix A** includes a number of tables referenced within the paper. **Appendix B** discusses the approach that was used for the 1995-2000 period. **Appendix E** included tables of Data Quality rated by industry and fuel type**. Appendix F** provides a detailed description of the project as defined in the Memorandum of Understanding (MOU) with NRCan.

B. Background

In 1997 Statistics Canada (STC) replaced it's SIC system with the NAICS. This system was developed jointly between Canada, Mexico and the United States to provide a common definition of the industrial structure for all three countries. NAICS was based on a production oriented or supply based conceptual framework. This meant that production units or establishments using a similar production process would be grouped together for the compilation of production statistics.

The Kyoto Accord is an international initiative, signed by Canada in 2002, to address issues of global warming by establishing limits on the production of Greenhouse Gas (GHG). Through this agreement Canada agreed to limit the production of GHGs to 6% below levels produced in 1990. The objective of the *NAICS Conversion Project* was to convert the estimated data from the ICE Survey for the manufacturing sector which was on a SIC basis to a NAICS basis for 1990 and for the years 1995-2000 inclusively (See Appendix F for a description of the project). This would provide our clients with a consistent set of data for time series analysis of energy use under the new classification system. This report presents methodological options for reference year 1990.

The ICE Survey was established in 1977 as a quarterly survey collecting energy data for a sample of 260 establishments from a population of 400 establishments. The survey collected information pertaining to Pulp and Paper (SIC 2710), Petroleum Products Industry (SIC 3611), Other Primary Steel Industries (SIC 2919) and Electrical Power Systems Industry (SIC 4910). The ICE Survey was oriented mainly at tracking consumption and inventories of commodities such as coal, coal coke, petroleum coke, and heavy fuel oil to supplement disposition surveys used to compile the Quarterly Report on Energy Supply and Demand (QRESD). The survey was at this time funded by STC and remained the same size until 1994.

Beginning in reference year 1994, NRCan began providing supplemental funding for an expanded sample to cover all Tier 1 (energy-intensive) industries. In 1995, the quarterly sample was expanded and an annual component was added to be able to produce energy consumption estimates for the manufacturing sector at a national level (Tier 1 and Tier 2)[1]. The quarterly component is a sample of larger establishments, while the annual component is a sample of smaller establishments. Beginning in 1995 estimates of total consumption were produced that incorporate both a quarterly and annual component. In 1995, the Energy Section began producing estimates for the entire manufacturing level at 2 digits SIC level and for select 3, and 4 digits SIC manufactures. In 1996, specialised questionnaires were used to collect data for the non-conventional oil and gas extraction petroleum products industries (SIC 0712, 3611), the other primary steel industries (SIC2919), the electric power thermal generating stations (SIC491) and a specific questionnaire for Chemicals.

Until the reference year 1998, establishments were sampled on a SIC basis only. For the 1999 and 2000 reference years, the sampling procedure for the ICE Survey was modified to create reliable estimates on both SIC and NAICS basis. Beginning with the 2001 reference year, the annual ICE estimates were produced on a NAICS basis only.

C. Project requirements

The first results of the *NAICS Conversion Project*, the 1995-2000 estimates were delivered in December 11, 2002. The 2nd part of the *NAICS Conversion Project* is to investigate options available to produce 1990 estimates for the same set of manufacturing industries and the same fuel types covered for the 1995-2000 series[2]. A list of industries requiring estimates can be found in Appendix A (Tables A1 and A2).

In 1990, the ICE Survey did not have a sufficient sample to produce estimates for the manufacturing sector with the required industrial disaggregation. Until 1994, the survey population for the quarterly ICE Survey had been restricted to the largest establishments in a limited number of industries. The sample units were selected to provide better coverage of specific fuels, which where included as input into the QRESD.

The target population for the 1990 estimates under the *NAICS Conversion Project* is all manufacturers in Canada.[3] It is therefore necessary to investigate alternative sources of data available in the 1990 reference year to determine which source or combination of sources could potentially be used to produce reliable estimates for fuel consumption.

D. Available data sources

The first step in this exercise was to examine the sources of data that existed in 1990. For each source, the benefits and limitations are presented as well as a brief description of the extent of coverage for the manufacturing sector. The following data sources will be discussed:

List of surveys and data sources

D.1 ICE: Industrial Consumption of Energy Survey, STC
D.2 RPP: Monthly Refined Petroleum Products, STC
D.3 EM: Electricity Monthly, STC
D.4 ESDQ: Electricity Supply and Disposition Quarterly, STC
D.5 TG: Electric Power Thermal Generating Station Fuel Consumption Annual, STC
D.6 NGD: Natural Gas Transportation and Disposition Survey, STC
D.7 Coal: Coal Monthly Survey, STC
D.8 Coke: Coke Monthly Survey, STC
D.9 QRESD: Quarterly Report on Energy Supply and Demand, STC
D.10 ASM: Annual Survey of Manufacturers, STC
D.11 IO: Input Output Division, STC
D.12 EASD: Environment Accounts and Statistics Division, STC
D.13 Prices: Price Information, STC
D.14 CIEEDAC: Canadian Industrial Energy End-use Data and Analysis Center

Comparing data sources directly should be done with caution. There are often differences between surveys such as universe coverage, treatment of in/out of scope units, definition of variables, survey cycle, reporting periods[4], reporting arrangements, and

1. *Tier 1 Industries are those industries identified as highly energy intensive users. These industries include: Pulp and Paper, Iron and Steel, Chemicals, Aluminum, Non-ferrous Metal Smelting and Refining, Petroleum Refining, Cement, and Fertilizer. All other manufacturing industries are included under Tier 2 industries.*
2. *Estimates are required for the following fuel types: coal. coke coke, coke oven gas, petroleum coke, coke from catalytic cracking catalyst, refinery fuel gas, heavy fuel oil, middle distillates, propane, natural gas, wood, spent pulping liquor, steam electricity and total energy consumed as fuel in terajoules.*
3. *A list of NAICS industries can be found in Appendix A.*
4. *The reporting period could vary by survey. The ICE survey uses the calendar year for its surveys. The annual and quarterly components report consumption of electricity used from January to December of the survey year. In 1990 the ASM has respondents report for their fiscal year end. Not all fiscal year correspond to calendar years. This could have a significant impact on the estimates given the huge price spike in oil and gas late 1990 and early 1991 due to the Iraq war.*

imputation and estimation processes. Who completes the questionnaire will often have an impact on what data can be provided. The ICE Survey aims to send its questionnaire to the plant controller, while the contact on the ASM is often the accountant. Often a respondent is reporting for more than one establishment or more than one manufacturing activity on one report. This makes comparison at the aggregate level complicated and individual records need to be researched to ensure consistency.

In 1990, both the ASM and ICE surveyed at the respondent serial number (RSN). This was essentially equivalent to the establishment number. The establishment is defined as the most homogeneous unit of production for which the business maintains accounting records from which it is possible to assemble data elements used in production such as gross value of production, cost of material and services, labour and capital. An establishment is classified to an industry when its activity meets the definition for that industry. When an establishment is engaged in more than one activity the activity with the largest value added is identified as the establishment's primary activity. Sometimes combined activities are given special recognition. They are a consequence of the technology of production or of the efficiency to be gained from combining certain activities in the same establishment. Ancillary units, which could be a head office or a warehouse for an establishment, can be classified to the industry of its own activity or to the activity of the establishment that it manages. Both the ASM and ICE survey have instances of special reporting arrangements where one respondent reports for more than one establishment. These special arrangements need to be taken into consideration in the estimation process.

A second consideration given to each potential data source will be the extent to which the required fuels are available. How many of the required fuel types are included in a given data source and how much of the industry is covered with the survey will also be assessed.

D.1 Industrial consumption of energy survey

The Energy Section of the MCED at Statistics Canada conducted the 1990 ICE Survey. The ICE Survey collects information on the energy consumption by the Canadian manufacturing industries and selected other industries. The 1990 ICE Survey included consumption of coal, coal coke, petroleum coke, heavy fuel oil, natural gas, wood, spent pulping liquor and purchased steam[5]. The results of this survey were used in the preparation of the *Quarterly Report on Energy Supply and Demand in Canada* QRESD (Catalogue 57-003).

Benefits of ICE data

The 1990 ICE Survey data provided good coverage for coal, coal coke, coke oven gas and petroleum coke. Given that ICE data is a direct observation on energy consumption by the establishment it is deemed to be more accurate than the disposition surveys which are based on the classification efforts of refineries and gas and electric utilities. For the fuel types that were covered the fuel is well reported and is the best data available. A further consideration with respect to ICE data is that all 1990 establishments have now been assigned their appropriate NAICS code. Since the 1990 sample was specifically designed to provide coverage for specific fuel types, the distribution of these fuel types should be as simple as assigning to the amounts the new NAICS codes.

Limitations of ICE data

The 1990 ICE Survey did not provide the same level of coverage it did for the 1995-2001 period. In 1990, the ICE Survey collected data on butane, coal, coal coke, coke oven gas, heavy fuel oil, natural gas, petroleum coke, spent pulping liquor, wood and purchased steam, however these fuels were collected for a select group of establishments that were known to consume particular fuel types. As a result, there is under coverage for heavy fuel oil, natural gas, steam, and wood. ICE did not have data available for refinery fuel gas, middle distillates, propane, or electricity.

Beginning in 1995, the ICE Survey population was expanded to include establishments representing 95% of total manufacturing shipment value based on the ASM population. The other 5% of shipment value was not sampled since little additional statistical accuracy was gained compared to the time and resource commitments required to account for these units. Instead, an adjustment was made to include the uncovered portion in the estimation.

D.2 Monthly refined petroleum products (Catalogue 45-004-XIB)

Data published monthly in the *Refined Petroleum Products* (RPP) catalogue is collected through the Monthly Refined Petroleum Products survey. Data is reconciled with data collected from surveys such as the *Monthly Crude Oil and Natural Gas Production* (Catalogue 26-006) and the *Monthly Oil Pipeline Transport* (Catalogue 55-001). The response rate for the Refined Petroleum Products Survey is 100% and therefore no estimation or bias exists.

Benefits of RPP data

For the 1990 *NAICS Conversion Project*, data on producer consumption of petroleum products from the Monthly Refined Petroleum Products Survey would have to be used to incorporate consumption of self-generated fuels such as refinery fuel gas, petroleum coke and heavy fuel oil.

The RPP collects data on a monthly basis for all petroleum refining companies in Canada as well as a selection of major wholesalers and distributors. Data from this survey can be used to estimate producer consumption of petroleum products by the petroleum refining industry. Although it is possible for small amounts of refinery fuel gas to be transferred to other industries within

5. Although these fuel types were collected the sample was designed to provide full coverage for coal, coal coke, coke oven gas, and petroleum coke.

close vicinity of the production plant, the majority is used within the petroleum and coal products manufacturing industry. Therefore, the total amount of refinery fuel gas produced should be allocated as consumption for Petroleum Refineries (NAICS 324110).

A quarterly questionnaire requests from refineries a detailed breakdown of their deliveries by end use or type of consumer. These results are published in the QRESD.

Limitations of RPP data

Producer consumption of petroleum coke does not distinguish between marketable petroleum coke and coke from catalytic cracking.

D.3 Electricity monthly

The *Electric Power Statistics* Catalogue 57-001-XIB publishes data collected from the Electric Monthly Survey. This survey collects information on electric power generation, imports, exports and inter-provincial transactions from electric utilities and industrial establishments. The Electricity Monthly Survey collects information on electricity from hydro, steam, nuclear, internal combustion, combustion turbine, wind and tidal. These values are published by province in**.**

D.4 Electricity supply and disposition quarterly

This survey collects information on electricity generated by source and disposition of electricity, with a breakdown of gross deliveries of electricity and the amount used for own operation. The purpose of this survey is to obtain information on the supply and demand for electricity in Canada. Sections 9 (electricity used for own use or given as compensation) and 10 (sales to ultimate customer) are of particular interest to the NAICS 1990 ICE estimation project, as is Section 10 “Deliveries to Ultimate Customers”. The threshold for this survey is any utility or firm that has at least one station with a generation capacity of 500 KW or is involved in the distribution of electricity. The survey collects data on the volume and value of sales of electricity to the final consumer on a volume and value basis. It collects electricity generated by source including hydro, steam conventional, steam, nuclear, internal combustion, combustion turbine, tidal, and wind.

Benefits of electricity supply and disposition quarterly data

Record level information is available to calculate consumption of self-generated electricity by manufacturing establishments in 1990. Data collected in this survey is published in the QRESD and in *Electric Power Generation, Transmission and Distribution* Catalogue 57-202 (Table 3). From the Sales to Ultimate Customers reported in Table 3, it is possible to determine a price by province for electricity used in the mining and manufacturing sector. This price could be applied to ASM value data for 1990 to calculate quantities consumed.

Limitations of electricity supply and disposition quarterly data

The data on sales to ultimate customers has the same level of industry aggregation as the QRESD, since it comes from the same feeder survey (the Electricity Supply/Disposition Quarterly).[6]

D.5 Electric power thermal generating station fuel consumption survey (annual)

This survey collects data on fuels used to generate electricity by electric utilities and industrial establishments. It collects data on each fuel type about the average heat content, quantity of consumed, total cost and electricity generated. The fuels covered include Solid fuel (bituminous coal, sub bituminous coal, lignite, spent pulping liquor, wood, petroleum coke, other), liquid (light fuel oil, heavy fuel oil, diesel, other), gaseous (natural gas, heavy fuel oil, coke oven gas, methane, other) and other (nuclear, and waste heat). The data are reported in the QRESD and in *Electric Power Generation, Transmission and Distribution*, Catalogue 57-202 (Table 6).

Benefits of electric power thermal generating station fuel consumption survey

This survey provides a list of manufacturing establishments involved in electric power generation and a measure of the volume and type of fuel used to produce this electricity. The information can be used to ensure all appropriate adjustments have been accounted for.

D.6 Natural gas transportation and disposition (catalogue 57-205-XIB)

The Natural Gas Distribution Survey reports monthly statistics on natural gas pipeline transport and the natural gas distribution industries. The natural gas distribution industry includes establishments who are primarily engaged in selling natural gas to ultimate customers through distribution pipelines. The survey collects data on class of customer including residential, commercial and industrial. The industrial customers are those primarily engaged in the process that creates or changes raw material or unfinished material into another form or product. This survey provides a breakdown by class of customer including distribution to establishments in the mining and manufacturing sector.

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6. There is a difference between how establishments are assigned to NAICS on the ICE and ESDQ surveys. The Business Register at Statistics Canada classifies respondents for the ICE survey. Whereas the ESDQ rely on utility companies assigning customers to a particular industry. This results in discrepancies between the two methods at a disaggregated level.

D.7 Coal monthly survey (catalogue 45-002-XIB)

This survey collects data on coal production by type of coal (bituminous, sub-bituminous, lignite, anthracite), thermal and metallurgical, and imports, exports and inter-provincial transactions. It also includes disposition to industrial customers (total only). This survey provides a breakdown of coal by type.

D.8 Coke monthly survey (catalogue 45-002-XIB)

This survey collects information on the inventory of coal and the supply and disposition of coke. From it, the plant efficiency can be determined and thereby the amount of coke oven gas produced.

D.9 Quarterly report on energy Supply and demand (catalogue 57-003-XPB)

Data from this publication are derived primarily from monthly and quarterly surveys and administrative records received by STC, from the National Energy Board and various energy producing provinces and territories. In general, supply data are taken from monthly STC energy surveys. Disposition data come mainly from quarterly surveys of energy suppliers and is supplemented by the ICE Survey.

The QRESD is compiled on a SIC basis. The report includes estimates on Pulp and Paper (SIC271), Iron and Steel (291), Smelting and Refining (SIC 295), Cement (SIC 352), Petroleum Refining (361), Chemicals (SIC 371 and 3721) and Other Manufacturing which included all manufacturers not specifically listed.

Benefits of QRESD data

The QRESD publishes consumption estimates for coal, crude oil, natural gas, gas plants natural gas liquids (NGL), electricity, steam, coke, coke oven gas, refinery liquid petroleum gas (LPG), still gas, motor gasoline, kerosene and stove oil, diesel fuel oil, petroleum coke, light fuel oil, heavy fuel oil, aviation gasoline, aviation turbo fuel, wood, spent pulping liquor, and non-energy products. These aggregate totals are balanced from information from supply and disposition surveys. Data from the ICE Survey was one direct feed into this report. For the period 1995-2002, the QRESD included the quarterly component of the ICE estimate only. Where ratios of energy consumption by fuel type, reported on the QRESD and ICE are consistent for the 1995-2001 period, these ratios can be compared to adjust 1990 estimates or to ensure reasonableness.

Limitations of QRESD data

In 1990, the QRESD used mainly information directly from the Quarterly End-Use of Refined Petroleum Products Survey, Electricity Supply/Disposition Quarterly Survey and the Quarterly Natural Gas Disposition Survey to allocate consumption by the manufacturing sector. It uses data collected by the Quarterly ICE Survey as the source of input for the remaining fuel types. The QRESD publishes disaggregated estimates for Pulp and Paper, Iron and Steel, Smelting and Refining (non-ferrous), Cement, Chemicals, Other Manufacturing and a (mathematical) sum for "Total Manufacturing" for the fuels mentioned above on a SIC basis. ICE data was and is only available from a limited number of establishments. This means that industrial coverage was not confirmed by a sampling plan, resulting in statistical under-coverage of the large energy-intensive industries. The QRESD bases the "Total Manufacturing" estimate from data received from the disposition surveys. The "other manufacturing" category is then the residual of total manufacturing less the amount allocated to the industry breakouts. A second caveat is that the total manufacturing figure based on the disposition surveys is not always equal to the estimates provided by ICE. This divergence is due to coverage issues between the two sources.

Another point that needs to be considered in the use of the QRESD is that the 1990 estimates are based on disposition surveys that collected data on a SIC basis. The conversion to NAICS resulted in the movement of some units between classification groups. For example the name Iron and Steel industry in the QRESD included units under the SIC which was a product oriented classification system. The Iron and Steel Industry as specified under the new process-based NAICS basis does not include the same units. Therefore, direct substitution of a QRESD estimate is only possible where there is a one-to-one relationship between the SIC and NAICS classification systems. Another point is that the QRESD provides a higher-level aggregation than requested by the client (e.g. the QRESD has a total for pulp and paper, while NRCan is looking for estimates for 6 digit NAICS in this industry). The QRESD industry names correspond to a specific set of SIC or NAICS industries.

An annual reconciliation process is completed between the QRESD and ICE. This process compares data from a number of sources and is used to validate estimates. The numbers from the two sources do not always match exactly because of coverage differences, however the QRESD is used as a guide to ensure the ICE estimates are reasonable.1995 ICE NAICS based estimates were compared with the 1995 QRESD estimates at several levels. At the aggregate level and the defined industry level, values were compared for total manufacturing consumption and industry trends. Each of the reported fuel types and industries were compared. This process identified where relationships between the two data source existed. It is assumed that the same relationships that exist between data in the period 1995-2000 existed in 1990.

The following issues need to be considered when using data from QRESD. The definitions of industries are based on the SIC definitions and although the names of a particular industry are the same, the ICE NAICS based estimates may include different establishments in its estimates than QRESD[7]. Secondly, the QRESD at the present time only includes reported values from the quarterly component of ICE. This means that in many cases the ICE estimates will be higher since it includes both a quarterly and

7. The QRESD currently uses the Quarterly component of the ICE Survey as input into its tables. Although the 1990 ICE Survey was composed of a Quarterly component only, data feed into the QRESD must be keep in mind when comparing ratios from 1995 and on, for consistency comparisons.

annual component and is adjusted for small establishments not covered by the survey. This adjustment is calculated on a national basis and can not be incorporated into the QRESD without proceeding to a provincial allocation of this factor. Thirdly, the definitions of the fuel type are not explicit. In some cases to compare ICE estimates with the QRESD estimates you must compare a number of ICE fuel types with an aggregate value. For example the QRESD published total LPG while ICE provides a breakdown of propane, butane and ethane. Given an understanding of these differences, this comparison is still a valuable exercise in the analysis process.

D.10 Annual survey of manufacturers (catalogue 31-203-XPB)

The Annual Survey of Manufacturers collects financial and commodity data on the manufacturing sector in Canada. In 1990, this survey collected information for about 40,000 Canadian manufacturing establishments grouped into 22 SIC-based major industry groups. The ASM population is divided into three strata by industry. In 1990, the take-all stratum included the largest manufacturers who were sent a long-form questionnaire, the take-some portion is the sampled portion and was covered by a short-form questionnaire, and the take-none portion of the population relied on tax data. Head office and ancillary units were sent a "Head Office Questionnaire"[8]. While MCED produced estimates for its principal statistics file for the entire population, fuel detail was only collected for the take-all portion of the survey. This take all portion represented more that 90% of the total value of shipments for most industries. Section 5 on the long-form questionnaire, collected detailed information on purchased fuels and electricity.

The ASM collects data on the consumption of purchased fuel and electricity. It asks for a breakdown of coal, natural gas, gasoline, diesel fuels, light fuel oils, liquefied petroleum gas, electricity, steam, and all other fuel purchased and used. In addition it asks for a total of fuel and electricity used. If the total value from the purchased fuel and electricity section is reported as 0 the questionnaire asks if fuel and electricity is included in the rent. There is no measurement of this amount.

Benefits of ASM data

The most important benefit of ASM survey data is that is provides the most comprehensive set of data that is available for the manufacturing sector in Canada for 1990. In 2000, the Annual Survey of Manufacturers Section of MCED completed a back casting exercise for all manufacturers in Canada. As part of this exercise each establishment was assigned a NAICS code. Given the large proportion of establishments that were sent long form questionnaires therefore collecting data on purchased fuel and electricity, there is sufficient detail on expenditures of fuel and electricity to be used as a starting point to produce reliable estimates for 1990 on a NAICS basis for some fuel types. Although detailed fuel data is only available for long form questionnaires coverage ratios can be determined at a provincial level for all NAICS codes. An imputation system was designed to estimate detail for the long from questionnaires in the case of non-response. However, no detail was estimated for the short-form or tax portions of the sample.

Limitations of ASM data

In 1990, the ASM collected data on the volume and value of purchased fuel and electricity by type for "16"- 4 digit SIC codes (table 1). Only value data was collected from establishments in the rest of the manufacturing sector.

A point that needs to be considered is the reporting periods for the ICE Survey and the ASM are different. The ICE Survey uses the calendar year or the four quarters within the calendar year, while the ASM uses the fiscal year. Of the ASM establishments 70% have year-ends corresponding to the fiscal year. This means that 30% of the two sources could be potentially reporting values for different periods. This could have a significant impact for the estimates of some industries during the 1990-1991 period due to price fluctuations resulting from the Persian Gulf War.

Table 1
Industries Surveyed for Volume and Value of Purchased Fuel and Electricity, ASM, 1990

1980 SIC	Industry name
2512	Sawmill and planing mill products industry
2711	Pulp industry
2712	Paper industry
2713	Paperboard industry
2714	Building board industry
2719	Other paper industries
2911	Ferro-alloys industry
2912	Steel foundries
2919	Other primary steel industries
2950	Non-ferrous smelting and refining industry
3521	Cement industry
3611	Petroleum products industry
3711	Industrial inorganic chemicals
3712	Industrial organic chemicals
3721	Chemical fertilizers industry
3731	Plastic and synthetic resin industry

8. These units are out of scope in the ICE methodology.

One shortcoming of the ASM identified in analysis of the ASM data is that the volume data was often overridden by the ASM editing process to "fit" a pre-specified unit-price ratio (provided by the energy section) for each form of energy on a provincial basis. In addition, the volume data was sparsely reported on ASM in those years. Micro-data files coded to NAICS are available from the ASM. There are a number of issues of consistency of treatment of energy forms between ICE and ASM that need to be resolved. The collection of volume data for all SIC was reinstated for the 1991 reference year.

ASM figures for "Other Fuels" would need to be compared with ICE records to avoid possible double counting of energy consumption for fuels such as petroleum coke. Examining which commodity codes are captured as "other fuels" can complete this investigation. The purchased fuel and electricity values from the ASM for 1990 would have reflected tabulated data from its statistical census. One caveat is that the adjustment should only be applied to fuels generally consumed by the industry (namely, natural gas and electricity).

D.11 Input output division, Statistics Canada

Although the Input Output Division (IO) does produce commodity data, the level disseminated is at too aggregate a level for what is required in this exercise. This data is further limited by the fact it is on a SIC basis only for 1990.

Industry definitions used by the Input Output Division are different from the ICE NAICS groupings. IO publishes their data at the W or working level, which combines or splits some SIC codes. IO data is available on a NAICS basis beginning in 1997. The mapping between the SIC and the IO table is described below.

Pulp and Paper: (SIC 2711 and 2712), I-O industries 73-75 and part of 62
Iron and Steel: (SIC 291), I-O industries 83 and 84
Smelting and Refining: (SIC 295), I-O industry 87
Cement: (SIC 352), I-O industry 136
Petroleum Refining: (SIC 361 and 369), I-O industries 143 and 144
Chemicals (371 and 3721), I-O industries 145, 146, and part of 147
Other: all others not listed above

The IO tables balance the supply side with the demand side at a national level. However these estimates are available on a SIC basis only. There is a low correspondence between the IO tables and SIC and we are estimating on an NAICS basis where there are fewer one to one relationships. ICE estimates could be compared to the quantity of fuel reported in the IO tables at an aggregate level only. IO tables can be used for trend analysis.

D.12 Environment accounts and statistics division, Statistics Canada

Energy conversion factors are provided to the Environment Accounts and Statistics Division (EASD) of Statistics Canada by Environment Canada. These factors are applied to the energy accounts maintained by EASD. The Energy Section currently provides energy data from the ICE Survey, the QRESD and a number of other surveys to EASD to supplement their estimates. Other manufacturing data are used to derive process-based emissions. However in 1990, EASD relied solely on ASM and QRESD data to produce their energy estimates. This Division links energy consumption and emissions data to the economic data found in the system of national accounts. EASD publishes its estimates in Table B.3.1 of *E-connections* (Catalogue 16-200-XKE). Although there are slight conceptual differences between EASD and ICE variables, after adjusting for these differences EASD data can be used for trend analysis on a joule basis for some fuel types.

Benefits of EASD data

EASD produces estimates for a number of specific fuel types at the industry level on a terajoules basis. It combines data from a number of sources within Statistics Canada relating to environment and environmental issues. Energy data is converted to a common unit known as terajoules. Conversion factors are those provided by Environment Canada. Terajoules are calculated by fuel type, and then summed to produce a distribution of terajoules consumed at the working or W level aggregation.

Limitations of EASD data

The tables produced by EASD are produced at the same level of aggregation as the IO tables. This aggregation does not necessarily correspond to the NAICS groupings. There is no data available for coal coke, coke oven gas, petroleum coke, coke from catalytic cracking catalyst, heavy fuel oil, middle distillates, propane, wood, spent pulping liquor, and steam. The data that is available in 1990 is on a SIC basis only. There are a number of caveats on the fuel types produced by EASD: diesel includes own use transportation, LPG is a composite including gas plants LPGs, as well as refinery still gas and coke oven gas, and coke is a composite of petroleum coke and coal coke.

D.13 Price information, Statistics Canada

In order to determine quantities of fuels used from ASM value data, a price per unit needs to be determined for each fuel type. There are a number of issues that need to be considered with respect to prices. Prices vary by fuel type and by province. This variation is due in part to the different tax structure within a province, to the cost of production of electricity, which varies depending on source for electricity generation, and due to the cost of transportation or distribution of fuel. In addition to these factors, an establishment may negotiate a price with a distributor, which is below market price. It is impossible to know these special arrangements. Gate prices are available for a number of fuels however this does not factor in the different tax structures and profitability of the distributor.

ASM: price edits

In 1990, ASM used price data obtained from NRCan. This price data appears in Publication 57-601. Prior to 1995, electricity price data was obtained from NRCan (Oil Division). The NRCan survey collected information on electricity rates. This survey was discontinued in 1994. Starting in 1995, electricity price data can be calculated from *Electric Power Generation, Transmission and Distribution* (Cat 57-202-XPB) table 3 and is an average of total revenue from sales to the mining and the manufacturing sectors which is conceptually different from average revenue. Coal prices come from the *Annual Coal Mines Survey* (Cat 26-206-XPB) table 4 and are an average of total value of production.

Prices for 1990 ICE estimates

There is sufficient data available to determine a price by province for the required fuels:

- **Electricity:**

  Prices by province for the mining and manufacturing sector can be determined using Table 3 from *Electric Power Generation, Transmission and Distribution* (Catalogue 57-202-XIB Volume II 1990). If further detail is needed on sub-sectors, the micro-data can be examined.

- **Middle distillates:**

  Prices are available from Prices Division.

- **Natural gas:**

  The Energy Statistics Handbook implicit price series, taken from the Natural Gas Monthly, has industrial rates by province.

- **Propane:**

  Energy Statistics Handbook

- **Heavy fuel oil (HFO):**

  Energy Statistics Handbook

D.14 Canadian industrial energy end-use data and analysis center

The Canadian Industrial Energy End-Use Data Analysis Center (CIEEDAC) is a research organization at Simon Fraser University funded mainly by NRCan. Information relating to CIEEDAC has referenced from the published report, "The Development of a 1990 Industrial Energy Use Baseline", January 10th 1994 written by John Nyboer and Alison Bailie. It appears that CIEEDAC took its 1991 to 1994 data on energy consumption for the manufacturing sector mainly from Table 13, Consumption of Purchased Fuel and Electricity by the Manufacturing Industries, produced by the ASM supplemented by some additional information obtained from MCED's Energy Section. For 1990, CIEEDAC estimated energy consumption estimates at a four-digit SIC level based on 1991 ASM data and some price movement assumptions

Assessment of CIEEDAC data

One aspect of the CIEEDAC production of 1990 estimates is the energy consumption trend from the base year. CIEEDAC has calculated an energy efficiency ratio, calculating a terajoules-per-unit of GDP ratio for each year, beginning in 1990.

In order to calculate an estimate of energy use for manufacturing, CIEEDAC derived 1990 figures for these other SICs based on a 1991 energy unit-cost and volume data taken from the 1991 Annual Survey of Manufactures. As table 2 shows, there are some question marks about the energy consumption estimates when put in this context, especially in industries where energy efficiency is showing a marked decline (as the ratio moves up, energy efficiency declines).

In the ASM, there is a reference to "Other Fuels." In 1990, it represented 9.8% of fuels purchased by the manufacturing sector. It includes purchased steam (which would have been coded as line 5.10.1) and other fuels such as petroleum coke, for which there was no code. The CIEEDAC database makes no allocation for these "Other" fuels. This means that we cannot simply take the "Other Fuels" and allocate it. We need to examine its composition in order to avoid double counting with ICE information.

The biggest shortcoming of the CIEEDAC data is that it must rely on aggregate public information. Without access to respondent-level information from a number of energy surveys, it is not in a position to incorporate information that could affect energy trends (such as establishment births, deaths, reclassification and validation of information).

Among the available sources of data, consumption data collected directly from the energy consumer or an administrative source is considered to be the most reliable and of the best quality. Respondent consumption data from the ICE survey was used for the 1990 NAICS energy consumption tables when available. However, the 1990 ICE survey was originally designed to provide energy estimates for specific fuel types and thus does not yield a complete set of energy consumption estimates for all fuel types for the entire manufacturing sector. The Annual Survey of Manufactures (ASM) collects financial and commodity data on the manufacturing sector in Canada. The questionnaire, which was sent to the largest manufacturers, included a section asking for fuel and electricity use. In 1990, the ASM collected complete value data for energy forms, but only limited quantity data for a select set of energy

Table 2
Energy Consumption as a Ratio of GDP 1990/1995: Terajoule Basis

1980 SIC	Industry name	1990	1995	% change
10	Food	9.08	8.58	-5.5
11	Beverage	6.77	4.70	-30.6
12	Tobacco	2.12	1.77	-16.5
15	Rubber	8.61	6.26	-27.3
16	Plastic products	6.42	6.52	1.6
17	Leather and allied products	3.1	3.14	1.3
18	Primary textile	14.65	18.64	27.2
19	Textile products	6.63	10.12	52.6
24	Clothing	2.08	2.53	21.6
25	Wood	7.62	11.78	54.6
27	Paper and allied products	100.48	114.83	14.3
28	Printing, publishing and allied	1.49	2.59	73.8
29	Primary metal	66.33	66.65	0.5
30	Fabricated metal product	4.25	6.15	44.7
31	Machinery	3.49	3.32	-4.9
32	Transportation equipment	3.93	3.86	-1.8
33	Electrical and electronic products	2.23	1.22	-45.3
35	Non-metallic mineral products	40.58	48.38	19.2
36	Refined petroleum products	146.06	136.81	-6.3
37	Chemical and chemical products	32.43	35.04	8.0
39	Other manufacturing	2.54	2.69	5.9

forms and SIC based industries. For the remainder of the respondents and variables, quantity data for the 1990 NAICS energy consumption tables was calculated using price data available in the *Energy Statistics Handbook*, *Catalogue 57-601*, produced by the Energy Section of MCED. After adjusting estimates to correct for conceptual differences between the ASM and the ICE survey, the ASM provided the most comprehensive set of data available for the manufacturing sector in 1990 for some fuel types and was used for industry allocation where feasible.

A number of the energy supply and disposition surveys listed above feed into, and are balanced and published in *the Quarterly Report on Energy Supply and Demand (QRESD), Catalogue 57-003.* The validation exercise of balancing the supply and demand side data, which occurs with the production of QRESD, ensures the highest possible quality and consistency in the estimates at the aggregate level. Therefore, estimates from the 1990 QRESD were used as control totals at the aggregate level wherever possible.

As part of the validation process of the estimates, comparisons between the various sources was undertaken, including the QRESD and its numerous feeder surveys, special tables made available internally through the Environmental Accounts and Statistics Division of Statistics Canada (EASD), and previously released 1990 Gross Domestic Product (GDP) estimates. If the initial methodology produced results that were found contradictory to other data sources the approach was reviewed and if necessary an alternative methodology was applied. The final approach is described by fuel type below as they appear in analytical tables.

E. Fuel specific issues

In 1990 there was not one data source that covered all fuel types or all industries. Some surveys only requested volume data while others requested both volume and value data. Some surveys collected quantity information but at a much more aggregate level than was required for this project. Some industries were surveyed for a particular fuel of interest. This section examines the coverage of each fuel type by data source provided in Appendix C. It lists the extent to which a particular fuel type is available and then proposes the best approach for estimation.

The fuels that require estimates are: coal, coal coke, coke oven gas, petroleum coke, coke from catalytic cracking catalyst, refinery fuel gas, heavy fuel oil, middle distillates, propane, natural gas, wood, spent pulping liquor, steam, and electricity. Not all fuels are used by all industries. Table A1 in Appendix A provides NAICS tables indicating which fuels are expected in which industry.

One assumption that will be made with this process is that if a particular industry used a fuel type during the 1995-2001 period, that the same fuel type would have been consumed during 1990. The quantity of fuels used and the mix of fuel types within an industry, however, may have changed. Table A1 in Appendix A provides a list of the industries for which estimates would be produced at the 3-digit NAICS level (Table A2 lists the NAICS being estimated below the 3 digit level). The cell corresponding to each fuel type and industry will either be left blank or grayed in. No value is expected for the grayed cells. For those cells where data is expected there is an indication of whether the estimates should come directly from data or required modeling. The same approach would be taken for the 4, 5, and 6 digit level estimates.

Table A3 in Appendix A lists each data source that was available for the 1990 period. It summarizes each source by fuel type. This table provides a general picture of industry coverage by data source.

A detailed analysis by fuel type is provided in Appendix C.

F. Industry specific issues

There are two types of industry specific issues that need to be considered. The first has to do with the assumption made with a macro estimation approach and the second has to do with coverage differences between the different sources of data. Any estimation technique regardless of the approach will include a set of generalization or assumptions that will influence the behavior of a particular variable. This assumes that the structure of an industry remains the same between two time periods. This may work in the short run. The further in time the estimates are from the reference year the less likely it will portray a realistic representation. Particular production processes may require a particular fuel source. Internal or external shocks such as a strike or the introduction of a tariff could affect production decisions within the industry. The elasticity of fuel substitution may vary between manufacturing industries and in fact between establishments within the same industry. There are a number of adjustments which need to be made to the ASM data to ensure consistency with the 1995-2001 energy consumption profile. This section will discuss issues that need to be considered for particular industries.

Issues related to specific manufacturing industries are provided in Appendix D.

G. Methodological options for estimation

Section G presents six options proposed for estimation. Each option should be considered in the context of the information presented in Appendix C that discusses fuel specific issues and Appendix D that discussed industry specific issues.

Options for estimation

There are some general issues that should be kept in mind when choosing an option for estimation. A macro approach works best when the basic data is sound. With a macro approach the further in time the base data is from the concordance year the greater potential for technological or structural changes in a given industry. If a base year of 1995 were chosen to estimate 1990 data, the assumption would have to be that the basic fuel mix has remained constant and that there was no energy economizing technologies. This is a big assumption to make for a five-year period given the intended use of the data by the client. A macro approach would also ignore fuel switching that takes place in the market. It may be safe to assume that if a particular industry consumed two particular fuel types in one year that the same two fuels were consumed in another year; however, it is unlikely that the mix remained the same. A macro adjustment from 1990-1995 is likely too big unless a series for the entire 1990-1995 period is constructed. It is not consistent with other back casting exercises undertaken at STC.

The ASM could be used as a starting point for the distribution of purchased fuels, although data would have to be prorated to account for the short forms and the tax portion of ASM. The 1990 ASM requested value of fuel for a limited number of industries. However there is a sound assignment of SIC to NAICS at the establishment level in the manufacturing industries. It is also possible to determine prices of fuel by province and apply these prices to value data to determine quantities. The quantity distribution could then be applied to the industry aggregates. The 1991 ASM data does have both volume (which would require some validating) and value data. However there were price differentials between 1990 and 1991.

Adopting a combined macro/micro estimation process is consistent with STC approaches in the past. Different fuel sources require different estimation processes. Coal, coal coke, and petroleum coke are referred to as tabulated fuels and could be a simple aggregation of the ICE database. Estimates for fuels such as wood and spent pulping liquor could take the numbers from ASM and make deductions based on the Electric Power Thermal Generating Station Fuel Consumption Annual Survey. Refinery fuel gas could come directly from the RPP. Fuels such as natural gas, middle distillates, electricity and propane could be modeled based on pricing by province. The Electric Power Thermal Generating Station Fuel Consumption Survey could be used to make adjustments for electricity. Natural gas would also have to be adjusted to account for non-fuel use. It is necessary to examine the micro level data for key industries by bringing in outside sources such as the Electricity Supply/Disposition Quarterly or Refined Petroleum Products (Monthly/Quarterly) Survey.

Each of the options has tradeoffs. A quick approach now may result in time spent later defending the estimates and may lead to more substantial revisions. It is important to make the best use of all data we have. We need to certify the numbers with some type of analysis and assemble them at the micro level.

This part of the methodology section presents a summary of options available for the 1990 estimates including a description of the method, the assumptions that are required, considerations that need to be addressed, limitations of the approach and the pros and cons of each option. The six options presented below should be considered for natural gas, electricity, middle distillates, heavy fuel oil, propane and steam:

Option A

Description:

A combined macro/micro approach depending on the type of fuel:

- Establish control totals at the fuel type and aggregate industry levels using the QRESD and supplement with other sources where required
- Where available use 1990 ICE NAICS data directly
- Use 1990 ASM NAICS to model detailed industry distribution based on 1990 fuel volume data, when available. When only the 1990 fuel value data is available, estimate volumes using provincial-level price data.
- Use Energy Section surveys for data on self-generated energy

Assumptions:

- The Energy Statistics Handbook could be used to determine prices by province
- ASM has good coverage of industries and characteristics in 1990 for fuel types requiring modeling.

Considerations:

- Care must be taken to ensure consistency and coherence between data sources

Pros

Consistency: Adjustments would be made to each fuel type to ensure concepts are consistent with 1995-2000 series.

Coherence: Work will be undertaken to adjust for differences between ICE and ASM in framework, definitions, and classifications.

Relevance: This would provide the best possible estimate taking into account all known data sources.

Reliability: Analysis is much easier when estimates are derived from actual micro-level estimates. This option will include data confrontation from a number of data sources.

Accuracy: Where possible estimates will be based on real respondent data. All sources of reliable data will be investigated and the source most appropriate to the fuel type and the industry in question will be utilized. This option will produce the best possible results.

Timeliness: Time spent up front would reduce the possibility of revisions later.

Cons

Consistency: There is a lot of work that will be required at the micro level detail.

Coherence: Care must be taken as purchased fuel and electricity concepts are not the same as on ICE.

Relevance: Must ensure that all relevant information is included in estimates.

Reliability: There is no one source of data for this period.

Accuracy: This approach would result in the best quality estimates.

Timeliness: This would be the most complicated and most time consuming approach.

Option B

Description:

Use the 1990 ASM NAICS dollar value estimates for energy consumption. This would involve taking the 1990-dollar estimate and applying a 1991 ASM NAICS price index to it to determine the quantity. This 1991 ASM price index would be calculated at the industry/provincial level.

Assumptions:

- ASM price index is constant from year to year.
- ASM price index is correct for 1991.
- ASM has good coverage of industries and characteristics in 1990.
- Data is of high quality for both 1990 and 1991.

Considerations:

- Data from either ASM or the Energy Statistics Handbook could be used as the price index source. Might have to do other adjustments to make up for under-coverage.

Limitations:

- Quantitative data on energy data was not available for all industries in 1990. Only the16 largest industries were asked for quantity data. It was sparsely reported. ASM data is provided for both dollars and physical quantities of energy purchased for 1991. This method would be to calculate Giga joules and $/GL for all fuel industries for 1991. Apply these price indices to 1990 data.

Pros	Cons
Consistency: Building estimates from a price index would lead to consistency between periods.	**Consistency:** This approach is not consistent with 1995-2000 estimates and although consistent may not depict the true picture of the industry.
Coherence: Some initial work will be undertaken to adjust for differences in ICE and ASM for framework, definitions, and classifications.	**Coherence:** Care must be taken to avoid double counting for natural gas estimates. Purchased fuel and electricity concepts are not the same as on ICE; they need to be adjusted for fuels used to generate electricity and to produce steam as well as for sale as well as off site usage.
Relevance: 1991 should a close proxy of the industry structure.	**Relevance:** There may be some differences in prices between 1990 and 1991. Any real shift in price between 1990 and 1991 will skew energy consumption.
Reliability: This is the most complete set of manufacturing data available for the 1990 period.	**Reliability:** Depends on how similar the two periods were in consumption behavior.
Accuracy: Provides the same consumption distribution over time.	**Accuracy:** Using a price index assumes the fuel mix remains constant over time and ignores fuel switching due to market conditions.
Timeliness: A macro approach is timelier.	**Timeliness:** Faster time may compromise the quality of the estimates.

Option C

Description:

This is the same as Option B but instead of calculating a price index by industry or some other group, the price would be calculated at the establishment level. Use a unit cost from 1991ASM NAICS, where volume and value are available, to derive 1990 data at the record level. 1989 volume and value data would also be used in this exercise.

Assumptions:

- ASM price index is constant from year to year.
- ASM price index is correct for 1991.
- ASM has good coverage of industries and characteristics in 1990.
- Data is of high quality for both 1990 and 1991.

Considerations:

- Need to develop an ASM price index.
- Might have to do other adjustments to make up for under-coverage
- This method would only be better than option B if it was thought that the price could vary quite considerably between different units.

Pros

Consistency: Analysis is much easier when estimates are derived from actual micro-level values.

Coherence: This option would allow for differences in prices at the unit level to be accounted for in the estimates.

Relevance: Can establish consistency between 1990 and 1995-2000 for main establishments.

Reliability: Estimate will be based on real respondent data. Analysis is much easier when estimates are derived from actual micro-level values.

Accuracy: As well, users usually have more confidence in estimates that are based on real values. Opportunity for data confrontation with other series to confirm the data.

Timeliness: Easy link for tabulated fuels with data disseminated in the QRESD. Fairly simple.

Cons

Consistency: This approach is not consistent with 1995-2000 estimates.

Coherence: Some initial work will be undertaken to adjust for differences in framework, definitions, and classifications.

Relevance: There may be some differences in prices between 1990 and 1991.

Reliability: This method is more prone to outliers than Option B. Option B can mask outlying indexes since large or small values can be lost in the summations.

Accuracy: Not all establishments pay the same price for a particular fuel. Quantity values were sparsely reported and some were imputed with an average price. This may skew the estimates.

Timeliness: May take more time than option B.

Option D

Description:

Apply "macro" adjustments from the 1991 ASM NAICS or 1995 ICE NAICS to the 1990 ASM NAICS purchased fuel and electricity data.

Assumptions:

- Estimates (1991 or 1995) are of dependable quality
- Coverage and terminology are the same
- Technology and Industry structure remained the same during time period.

Considerations:

- The farther in time the reference year is from the base year the weaker the estimates

Pros	Cons
Consistency: Can establish consistency between 1990 and 1995-2000 for main establishments.	**Consistency:** Degree of subsequent work required by MCED to validate information and maintain time series consistency. Would require ensuring some consistency with QRESD for tabulated fuels.
Coherence: Some initial work will be undertaken to adjust for differences in ICE and ASM of framework, definitions, and classifications.	**Coherence:** Presumes consistency of fuel use profile(which would prevent using the estimates to study fuel switching).
Relevance: Would have to be applied every industry-fuel code combination to be effective.	**Relevance:** The farther in time from initial period the base year is the less relevant estimates may be, may not capture structural changes in industry.
Reliability: Methodologically correct.	**Reliability:** Size of adjustment may be affected by data confrontation with other sources. Other back casting exercises at STC have shown that the quality of adjustment weakens over time.
Accuracy: Somewhat accurate.	**Accuracy:** May require backend clean up and data confrontation with other data sources.Quality of the volume data captured by the ASM.
Timeliness: Perception that it would produce results faster.	**Timeliness:** Greater variability in estimates could lead to more errors and more subsequent revisions after user feedback.

Option E

Description:

Apply SIC to NAICS concordance factors using value of shipments from ASM to the 1990 SIC estimates or the 1990 EASD SIC estimates.

Assumptions:

- Estimates are of dependable quality
- Coverage and terminology are the same
- Concordance factors are good

Considerations:

- This option was tried for the 1995-1998 period and did not always produce reliable estimates

Pros	Cons
Consistency: Estimates would be consistent with data already in the public domain however estimates may not be reliable.	**Consistency:** Does not allow for data confrontation with other series. May not produce consistent estimates.
Coherence: Some initial work will be undertaken to adjust for differences in ICE and ASM for framework, definitions, and classifications.	**Coherence:** Does not maximize use of available record-level information.No micro-level values for analysis.
Relevance: The level of detail required for this set of estimates is not available through EASD.	**Relevance:** Other back casting exercises in STC have found that the macro approach works best if the concordance factors are based on the variable to be estimated rather than a proxy (such as the value of shipments).
Reliability: Methodologically correct.	**Reliability:** Depends on how well the price of energy represents the quantity consumed. Not all establishments pay the same price.
Accuracy: Estimates are based on defendable values for some industries.	**Accuracy:** Lack of micro data will make analysis difficult. Trend analysis difficult as no reference period to compare.
Timeliness: Initial allocation should be a quick process, adjustments will be required.	**Timeliness:** Time saved up front may result in revisions later.

Option F

Description:

Use Option D for the main energy-consuming industries and Option E for the less energy-intensive industries.

Assumptions:

Option D

- Estimates (1991 or 1995)are of dependable quality
- Coverage and terminology are the same
- Technology and Industry structure remained the same during time period.

Option E

- Estimates are of dependable quality
- Coverage and terminology are the same
- Concordance factors are good

Considerations:

Option D

- The farther in time the reference year is from the base year the weaker the estimates

Option E

- This option was tried for the 1995-1998 period and did not always produce reliable estimates

Pros

Consistency: Can establish consistency between 1990 and 1995-2000 for main establishments for energy intensive industries only.

Coherence: Some initial work will be undertaken to adjust for differences between ICE and ASM in framework, definitions, and classifications.

Relevance: Main energy consuming industries.

Reliability: Estimates for main energy consumers would be based on real respondent data, other industries modeled For other industries estimates would be methodologically correct.

Accuracy: Greater quality of estimates for more energy-intensive industries.

Timeliness: Minimizes time required for less energy-intensive industries. While ensuring more complete analysis of high profile industries.

Cons

Consistency: Allow for data confrontation with other series for main consumers. For others, no confrontation is possible.

Coherence: Does not maximize use of available record-level information. May be less coherent in lower profile industries.

Relevance: Other back casting exercises in STC have found that the macro approach works best if the concordance factors are based on the variable to be estimated rather than a proxy (such as the value of shipments).

Reliability: Those industries using option E less reliable.

Accuracy: Less energy intensive industries will not be as accurate.

Timeliness: Quality of the volume data produced by the ASM.

H. The process of estimation

This sectin of the paper will discuss the process involved in the development of the 1990 ICE estimates. It is broken down into two sections. The first section discussed work that is required in order to ensure that the concepts of the various data sources are consistent with the estimates that were produced for the 1995-2000 period. This work is required regardless of which estimation option is chosen. The second section discusses the data validity that will be undertaken once the initial set of estimates has been produced.

Preparatory work

Regardless of which option is chosen to produce the 1990 estimates, some amount of quality control will be required to ensure concepts are consistent with the 1995-2000 period estimates.

Historically, the ASM had low response rates for volume questions on purchased fuel and electricity. For those respondents where quantities are available for 1990 period these data could be used. Responses, which fell outside the parameter of the unit price edit, were often adjusted to the set unit price. There would therefore be a requirement to do some work on the quality of the physical volume estimate before any of the options could be successfully applied. One possibility would be to identify the top contributors for each energy form by industry (at a minimum, for the most energy-intensive ones) to examine the unit price. Determine how well it matches with known unit prices for the province and sector, and determine if there is a need to “adjust” the data. The data could be adjusted based on historical ICE versus ASM for that record or other information.

A second option would be to use the value data as reported, then using unit price derived from data sources in the Energy Section and calculate quantities based on ASM values and fuel prices. An alternative approach would be to use the shipment-based allocation of energy consumption by NAICS from purchased fuel and electricity as a starting point. This would also conform to the standard approach at Statistics Canada for back casting time series. However, the 1995-1998 exercise showed that this method, at times, led to large inconsistencies in allocation (for example, ratio-based estimates of sampled industries sometimes were lower than the raw total of sampled units in that industry). Working at it from a micro-record basis, at least for the most energy-intensive industries, might therefore be more useful especially since this was a statistical census year for the ASM.

There is a need to develop an approach that would produce estimate for all manufacturing establishments including those that were not in the manufacturing sector in the 1980 SIC based estimates. Testing a couple of different approaches will determine which method will produce the best results. The “tobacco manufacturing industry” and the “motor vehicle assembly manufacturing industry” are small industries with few respondents and no 1990 volume data. This test could be applied to fuels such as natural gas, middle distillates, propane, heavy fuel oil and electricity to determine the market share and the composition of fuel.

Starting with a macro approach for the Tier 2 industries may make sense and test cases would determine which approach would make the most sense. Tier 1 industries require special attention and Pulp and Paper and the Chemicals industries in particular have additional concerns.

The process

The steps taken to produce estimates for the 1990 period will involve several iterations of analysis. Step one in our estimation process will be the initial allocation of data. First round estimates will be produced by industry and by fuel. The method is yet to be determined Step two will involve trend analysis. The 1990 estimates will need to be assessed with respect to the 1995-2000 estimates. Comparisons will be made at the joule level because of substitutability between fuels. At this step in analysis estimates will be compared between years. Step three will include data confrontation with Gross Domestic Products (GDP) figures or Value of Shipment figures from the Survey of Manufactures. Comparisons will be made at the three, four, five and six digit NAICS levels for each fuel type where available.

- **Step 1: Initial allocation of data**

  This initial allocation of data will depend on the estimation option chosen. Adopting a macro approach on the other hand is only as good as the correlation between the value of shipments variable and the energy use. The fit of this variable varies amount industries and does not convey information on the fuel mix.

  Fuel values can be estimated two ways, the approach used depending on the fuel type. The first approach is applied to what are referred to as tabulated fuels; the second we call estimated fuels. The tabulated fuels are not as commonly used or tend to be used by particular industries. The ICE survey includes all establishments using these fuel types in its sample. The estimates are simply the addition of all values reported by the respondents. Tabulated fuels for 1995-2001 process included coal, coal coke, coke oven gas, petroleum coke, coke from catalytic cracking, refinery fuel gas and steam. For 1990 this approach can be taken for coal, coal coke, coke oven gas and petroleum gas.

  The other ten fuels are more commonly used regardless of which industry an establishment falls within.

- **Step 2: Trend analysis**

  Once estimates are produced, the data will be verified through trend analysis. Trends in consumption of fuel will be compared with trends in GDP first at a total joule basis and then on an individual fuel basis. This trend analysis will be completed at the manufacturing sector level, and then the 3, and selected 4, 5, and 6 digit NAICS industry level.

  Differences in trends will be investigated to ensure data legitimacy. There are a number of legitimate reasons why there may be year to year changes in the consumption of a particular fuel. Price peaks in a specific energy source may produce fuel switching as manufacturers substitute less expensive energy sources. Reclassification of an establishment's could result as product mix changes and particular production outputs are dropped or added. In some cases a respondent will approach STC after the data has been released to change reported values. A difference in trend does not necessarily indicate a problem, however all such anomalies must be researched to ensure accuracy in the data.

- **Step 3: Data confrontation**

  Another tool used to evaluate the estimates is to compare energy consumption trends with Gross Domestic Product. An investigation for each NAICS and each fuel is required. Once this is done we can look at output to GDP ratios over time. Large year to year changes in the ratios would suggest that further analysis is required. The joule per GDP for each estimation-level industry will be explained for 1990 relative to the 1995-2000 estimates in conjunction with the QRESD, and EASD estimates for the manufacturing sector to ensure that the NAICS estimates are reasonable. It should be noted that the different data sources use different conceptual and methodological processes and may have coverage issues. Therefore the numbers can not always be compared directly.

  The 1995-2001 was compared with estimates on a SIC basis however such estimates do not exist for 1990. An alternative approach then would be to look at the energy intensity indexes for 1990, 1995, and 2000. This would identify any anomalies that required further investigation.

  Once the data has been released there are a number of outside agencies that confront the ICE estimates. NRCan and EC regularly assess ICE data. The Canadian Industry Program for Energy Conservation (CIPEC) was established to promote voluntary action by industry to reduce industrial energy use per unit of production. To achieve this objective, 23 task forces and 38 industry trade associations as well as many manufacturers and mining companies have worked together to attempt to achieve greater energy efficiency. CIPEC will review the estimates and provide feedback. Industries requiring special attention are listed in Table 3 below. Data is also interpreted by the CIEEDAC. The Energy Section has worked with these task forces to scrutinize the data and ensure accurate estimates are produced. This scrutiny of the estimates by these groups can serve as another check to the validity of the ICE data.

Table 3
High Profile Industries

NAICS Code	Industry description
312120	Breweries
321111	Sawmills (except shingle and shake mills)
321216	Particle board and fiberboard mills
322111	Mechanical pulp mills
322112	Chemical pulp mills
322121	Paper (except newsprint) mills
322122	Newsprint mills
322130	Paperboard mills
324110	Petroleum refineries
325110	Petrochemical manufacturing
325181	Alkali and chlorine manufacturing
325190	Other basic organic chemical manufacturing
325210	Resin and synthetic rubber manufacturing
325313	Chemical fertilizer (except potash) manufacturing
327214	Glass manufacturing
327310	Cement manufacturing
327410	Lime manufacturing
331100	Iron and steel mills and ferro-alloy manufacturing
331313	Primary production of alumina and aluminum
331410	Non-ferrous metal (except aluminum) smelting and refining
336110	Automobile and light-duty motor vehicle manufacturing

Suppression and confidentiality of cells

Cells in the data tabulations can be suppressed for two reasons. A number of cells are suppressed because the estimates do not meet data quality requirements. These tend to be instances of sporadic consumption of a fuel by an industry, where it is felt that the surveyed units can not reliably estimate its level. Suppressed cells are represented by the symbol "…". The other reason a cell is suppressed is because of confidentiality. If one or more respondents represent too great a proportion of the estimate so that it is potentially possible to identify those respondents the data will be suppressed.

I. Glossary of terms

Coal: A black or brownish black combustible substance formed by the partial decomposition of vegetable matter without access to air. It should be noted that heat content varies depending on the mine.

Co-generation: Any of several processes which either use waste heat produced by electricity generating to satisfy thermal needs or process waste heat to electricity or produced mechanical energy. A co-generating system produces electricity and heat in tandem. Such systems are used where there is a significant requirement for electricity coupled with a large demand for process steam. It is normally thermal with excess electrical energy, if any, being transmitted into the local power supply companies' lines.

Coal coke: A hard, dry carbon substance produced by heating coal to a very high temperature without air. Coke is used in the process of making iron and steel.

Consumed as fuel: The quantity of energy consumed in the production process of the plant, which includes heating the premises.

Consumed for non-fuel use: Energy consumed for uses other than as fuel in the plant production process. This includes products used as petro-chemical feedstock, anodes/cathodes, greases, lubricants, etc.

Consumed to produce electricity or steam for sale: Energy consumed in the production process of electricity for own use or sale, or energy used in the production of steam which is then sold to a user outside of the plant location.

Conventional generation: Electricity that is produced at a generating station where the prime movers are driven by gases or steam produced by burning fossil fuels

Diesel: All grade of distillate fuel used for diesel engines including low sulphur content (lower than 0.05%). Does not include diesel used for transport off the plant site.

Electricity: A form of energy emanating from electric charges at rest or in movement. This should include purchased electricity and self generated electricity kept for on-site usage.

Energy content: The factor which coverts the energy form from its natural units to a joule scale on a higher heating value basis.

Energy source: The primary source that provides the power that is converted to electricity. Energy sources include coal, petroleum, and petroleum products, gas, water, uranium, wind, sunlight geo-thermal, and other sources.

Gas plants NGLs (natural gas liquids): Includes propane, butane, and ethane.

Heavy fuel oil: All grades of residential type fuels including low sulphur. Usually used from steam and electric power generation and diesel motors. Includes fuel oil no 4, 5, and 6.

Natural gas: A mixture of hydrocarbons (principally methane) and small quantities of various hydrocarbons existing in the gaseous phase or in solution with crude oil in underground reservoirs. Reported in thousands of cubic meters in the gaseous state.

Other: This is a catch all category and does not include the same fuels in each survey. This varies by survey.

Other middle distillates: Includes light fuel oils (no 1,2,and 3), kerosene, mineral lamp oil, stove oil furnace fuel oil, gas oils and light industrial fuel. Does not include gasoline used for transportation off site.

Petroleum coke: A final product, often called "waste product", of the petroleum refining process, which is the output of the refinery after all of the higher distillates and oils have been distilled from crude oil, leaving a product that has the appearance of coal, and can be found in various types of petroleum coke depending on the size of the output product, including "sponge", "shot", and "fluid" coke.

Propane: A normally gaseous straight-chain hydrocarbon (C3H8) extracted from natural gas or refinery gas streams. It can also take a liquid form.

Primary electricity: Production is hydro and nuclear generated electricity. (There is no distinction made between primary and secondary electricity on the consumption side)

Secondary electricity: The amount of electricity generated by thermal production.

Spent pulping liquor: A by-product of the paper making process containing carbohydrates and lignin decomposition products. Also known as black liquor.

Steam sold: Steam Sold includes only known steam sales of large producers and therefore excludes any steam produced for own consumption as process steam or space heating.

Steam purchased: A gas resulting from the vaporization of a liquid or the sublimation of a solid, generated by consolidating or non-condensing turbines. Report only purchased steam and the name of supplier.

Wood: Wood and wood energy used as fuel, including round wood (cord wood), lignin, wood scraps from furniture and window frame manufacturing, wood chips, bark, sawdust, forest residues, charcoal and pulp waste.

Appendices

Appendix A

Table A1
Industry Fuel Estimate Requirements

NAICS	Industry	Coal	Coal coke	Coke oven gas	Petroleum coke and coke from catalytic cracking catalyst	Refinery fuel gas (4)	Heavy fuel oil	Middle distillates	Propane	Natural gas	Wood	Spent pulping liquor	Steam	Electricity	Joules
		Metric tonnes	Metric tonnes	Méga-litrres	Metric tonnes	Thousand cubic metrres	Cubic metrres	Cubic metrres	Cubic metrres	Thpusand cubic metres	Metric tonnes	Metric tonnes	Giga-joules	Méga watts-hours	Téra-joules
311	Food manufacturing	..	..	..	..	..	M	M	M	M	..	..	D	M	C
312	Beverage and tobacco product manufacturing	..	..	..	..	..	M	M	M	M	..	..	..	M	C
313	Textile mills	..	..	..	..	..	M	M	M	M	..	..	..	M	C
314	Textile product mills	..	..	..	..	..	M	M	M	M	..	..	..	M	C
315	Clothing manufacturing	..	..	..	..	..	M	..	M	M	..	..	D	M	C
316	Leather and allied product manufacturing	..	..	..	..	..	M	M	M	M	..	..	..	M	C
321	Wood product manufacturing	..	..	..	..	..	M	M	M	M	M	..	D	M	C
322	Paper manufacturing	D	..	..	..	..	M	M	M	M	D	D	D	M	C
323	Printing and related support activities	..	..	..	..	..	..	M	M	M	..	..	..	M	C
324	Petroleum and coal products manufacturing	D	..	..	D	D	M	M	M	M	..	..	D	M	C
325	Chemical manufacturing	..	..	..	D	..	M	M	M	M	..	..	D	M	C
326	Plastics and rubber products manufacturing	..	..	..	..	..	M	M	M	M	..	..	D	M	C
327	Non-metallic mineral product manufacturing	D	D	..	D	..	M	M	M	M	M	..	D	M	C
331	Primary metal manufacturing	D	D	D	D	..	M	M	M	M	..	..	D	M	C
332	Fabricated metal product manufacturing	..	..	..	..	..	M	M	M	M	..	..	D	M	C
333	Machinery manufacturing	..	..	..	..	..	..	M	M	M	M	..	..	M	C
334	Computer and electronic product manufacturing	..	..	..	..	..	..	M	M	M	..	..	..	M	C
335	Electrical equipment, appliance and component manufacturing	..	..	..	..	..	M	M	M	M	..	..	..	M	C
336	Transportation equipment manufacturing	D	D	..	..	..	M	M	M	M	..	..	D	M	C
337	Furniture and related product manufacturing	..	..	..	..	..	M	M	M	M	M	..	..	M	C
339	Miscellaneous manufacturing	..	..	..	..	..	..	M	M	M	..	..	D	M	C
NAICS	**Total manufacturing**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**C**

.. *not available for a specific reference period*
C *Converted*
D *Survey data is available for this fuel type*
M *Estimate will require modelling to produce consumption estimate, method depends on fuel type and industry*

Table A2
Additional Manufacturing Industries Requiring Estimates

311400	Fruit and vegetable preserving and specialty food manufacturing
311500	Dairy product manufacturing
311600	Meat product manufacturing
311800	Bakeries and tortilla manufacturing
312100	Beverage manufacturing
312120	Breweries
312200	Tobacco manufacturing
321111	Sawmills (except shingle and shake mills)
321216	ParticlebBoard and fiberboard mills
322111	Mechanical pulp mills
322112	Chemical pulp mills
322121	Paper (except newsprint) mills
322122	Newsprint mills
322130	Paperboard mills
322200	Converted paper product manufacturing
324110	Petroleum refineries
325110	Petrochemical manufacturing
325120	Industrial gas manufacturing
325130	Synthetic dye and pigment manufacturing
325181	Alkali and chlorine manufacturing
325189	All other basic inorganic chemical manufacturing
325190	Other basic organic chemical manufacturing
325210	Resin and synthetic rubber manufacturing
325313	Chemical fertilizer (except potash) manufacturing
326100	Plastics product manufacturing
326193	Motor vehicle plastics parts manufacturing
326200	Rubber product manufacturing
327214	Glass manufacturing
327310	Cement manufacturing
327410	Lime manufacturing
331100	Iron and steel mills and ferro-alloy manufacturing
331313	Primary production of alumina and aluminum
331410	Non-ferrous metal (except aluminum) smelting and refining
331511	Iron foundries
336110	Automobile and light-duty motor vehicle manufacturing
336120	Heavy-duty truck manufacturing
336310	Motor vehicle gasoline engine and engine parts manufacturing
336320	Motor vehicle electrical and electronic equipment manufacturing
336330	Motor vehicle steering and suspension components (except spring) manufacturing
336340	Motor vehicle brake system manufacturing
336350	Motor vehicle transmission and power train parts manufacturing
336360	Motor vehicle seating and interior trim manufacturing
336370	Motor vehicle metal stamping
336390	Other motor vehicle parts manufacturing

Table A3
Energy Consumption Fuel Coverage by Data Source 1990

	Data source									
Fuel	ICE	RPP	COAL	TG	ESDS	NG	QRESD	ASM	EASD	CIEEDAC
Coal	T-D	N	T-S	P-A	N	N	T-S	T-C	J-A	J-C
Coal coke	T-D	N	N	P-A	N	N	T-S	N	J-A	J-A
Coke oven gas	N	N	N	P-A	N	N	T-S	N	J-A	J-A
Petroleum coke	T-D	N	N	P-A	N	N	C	N	J-C	J-C
Coke from catalytic cracking catalyst	N	N	N	P-A	N	N	C	N	J-C	J-C
Refinery fuel gas	N	T-S	N	P-A	N	N	T-S	N	J-A	J-A
Heavy fuel oil	P-S	T-S	N	P-A	N	N	T-S	T-C	J-A	J-A
Middle distillates	N	T-S	N	P-A	N	N	T-S	T-C	J-C	J-C
Propane	N	T-A	N	P-A	N	N	T-S	T-C	N	N
Natural gas	P-S	N	N	P-A	N	TA	T-S	T-C	J-A	J-C
Wood	P-S	N	N	P-A	N	N	T-S	N	N	N
Spent pulping liquor	T-D	N	N	P-A	N	N	T-S	N	N	N
Steam	P-D	N	N	P-A	N	N	T-S	P-S	N	N
Electricity	N	N	N	N	P-D	N	T-S	T-C	J-A	J-A

Data source

ICE	Industrial consumption of energy
RPP	Refined petroleum products
COAL	Coal monthly
TG	Electric power thermal generating station fuel consumption annual
NG	Natural gas disposition survey
ESDS	Electricity supply and disposition survey
QRESD	Quarterly report on energy supply and disposition
ASM	Annual survey of manufacturers
EASD	Environment accounts and statistics division
CIEEDAC	Canadian industrial energy and end use data and analysis center

Data availability

T	Covers total manufacturing sector
P	Covers partial manufacturing sector
N	No coverage
J	Coverage on joules basis
A	Aggregate
S	Some detail
C	Different composition than ICE
D	Disaggregate

Appendix B

The 1995-2000 approach

For the 1995-2000 period there was an industry detail on a SIC basis on the survey frame. For those industries where a 1 to 1 relationship existed, we directly substituted SIC estimates into the new NAICS. The quantity that was be assigned directly to a NAICS industry was subtracted to establish a new aggregate total for each fuel type. These new quantities were then used as adjusted control totals for the remaining industries. In a case where the new classification system resulted in movement within an industry at the 6 digit level, but no movement in or out of the industry, the 3 digit SIC fuel aggregates were used as control totals for the 3 digit NAICS.

Data was allocated based on distribution ratios produced from two main sources of information. The distribution pattern of the 1999 NAICS estimates was one source of information. The other source was the raw data itself. Micro data for each fuel type was used to determine distribution patterns. Raw reported survey data from both the quarterly and annual surveys were analyzed. The proportional contribution of each source to the initial estimate was based on a combination of the level of quarterly versus annual data and the weighting given to the annual component. The assignment of weights were reassessed to ensure accuracy and relevancy under the new classification system and in a few cases it was determined that the applied weighted total needed adjustment. The decision of which information source best represented the industry estimate varied by industry and was based on the quality of data given the new classification system. A new distribution ratio was then calculated for each fuel type and the corresponding ratios applied to each fuel type control total.

Where the NAICS classification system resulted in movement of an establishment from more than one 3-digit SIC, we took a top down approach. Where the movements of establishments from several SIC where contained to a “group or cluster” of NAICS, the combined SIC aggregate totals used as control totals for the “group or cluster”. Again distribution ratios were derived and applied as described above.

The estimation approach taken for the 1995-2000 period will not work for the 1990 because there is no one source of data, which collected all energy forms required.

Appendix C

Fuel issues

Coal:

The ICE Survey feeds the QRESD for coal consumption. Therefore the QRESD and ICE values are the same at the aggregate level. Coal is a tabulated fuel (the sum of all responses) can be taken directly from ICE. Each establishment has been assigned a NAICS code and therefore data is available on a NAICS basis.

The heat content of coal depends on the mine where it is extracted. Therefore it is necessary to have the province of origin of the establishment to produce accurate joule estimates. This requirement is an argument against a macro approach for this fuel type. Data is available on ICE for the 1990 period.

Possible estimation approach:

The best estimate would be a straight plug in of data from ICE.

Actual estimation approach:

Survey data from 1990 ICE was used which provided full coverage.

Coal coke:

Possible estimation approach:

The ICE survey feeds the QRESD for coal coke. Therefore, the QRESD and the ICE values are the same at the aggregate level. Coal coke is a tabulated fuel (the sum of all respondents) which can be taken directly from ICE, as each establishment has been assigned a NAICS code.

Actual estimation approach:

Survey data from 1990 ICE was used which provided full coverage.

Coke oven gas:

Possible estimation approach:

No data was collected from ICE in 1990 for coke oven gas; however a pre-determined factor (based on joule efficiency collected on the Coal Monthly Survey) is used to determine coke oven gas based on the amount of coke produced. As the only data available is an estimate from the QRESD based on coal charged to coke ovens, and all coke oven gas use is assumed to be for the Iron and Steel Mills and Ferro-Alloy Manufacturing Industry (NAICS 331110), the QRESD 1990 estimate should be used.

Actual estimation approach:

Survey data from 1990 ICE was used which provided full coverage.

Petroleum coke:

Possible estimation approach:

The QRESD includes both petroleum refineries and upgraders in its estimates of petroleum coke[9]. For Industries other than Petroleum Refineries (NAICS 324110), the ICE Survey feeds the QRESD for Petroleum coke. Therefore ICE and QRESD are the same at the aggregate level. Petroleum coke is a tabulated fuel (the sum of all responses) which can be taken directly from ICE, as each establishment has been assigned a NAICS code.

Actual estimation approach:

Survey data from 1990 ICE was used which provided full coverage.

Coke from catalytic cracking catalyst:

ICE did not ask for coke from catalytic cracking catalyst in 1990. Therefore, it is necessary to look to other sources. The QRESD reported a combined value for coke from catalytic cracking catalyst and petroleum coke based on producer consumption of petroleum coke reported to the Monthly Refined Petroleum Products Survey.

Possible estimation approach:

Consumption of coke from catalytic cracking catalyst and petroleum coke would be combined amount for the Petroleum Refineries Industry. The Other Petroleum and Coal Products Manufacturing Industry (324190) is the major consumer of coke from catalytic cracking catalyst. The monthly RPP would be used as the data source for the combined total (petroleum coke and coke from catalytic cracking catalyst) the petroleum coke portion distributed based on the QRESD and the remainder assigned to Other Petroleum and Coal Products Industries as coke from catalytic cracking catalyst.

Actual estimation approach:

Respondent data from the 1990 Monthly Refined Petroleum Products Survey was used.

Refinery fuel gas:

Possible estimation approach:

ICE did not collect refinery fuel gas in 1990. ASM did not collect refinery fuel gas in 1990. The QRESD did report refinery fuel gas based on a total of the monthly RPP and a separate amount for Upgraders. Taking the data that is reported on RPP is the best approach. This approach would assume that all refinery fuel gas (still gas) is consumed by the respondent who produced it. Refinery fuel gas is used solely by the Petroleum Refineries Manufacturing Industry (NAICS 324110) so we can substitute this value directly into the ICE estimates. The amount that is reported on RPP as produced is also equal to the amount consumed, for this fuel type only.

Actual estimation approach:

Producer consumption of still gas from the 1990 Monthly Refined Petroleum Products

Heavy fuel oil:

Heavy fuel oil was partially reported on ICE in 1990; as there were only 260 respondents there is some under coverage in the data. These numbers will need to be adjusted upward. ASM does ask for heavy fuel oil; however no adjustment was made for that amount of HFO used to generate electricity or to produce steam for sale.

Possible estimation approach:

ASM has reliable values and prices available by province can be used to calculate quantities. ASM and the QRESD both produce quantity estimates but are different at the aggregate level. This is likely due to prices used in the ASM imputation system.

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9. Estimates for upgraders are based on information provided by Alberta Energy Utilities Board.

ICE and QRESD have historically been very close in estimates, for observed manufacturing industries such as Pulp and Paper and Smelting and Refining. The Quarterly End-Use of Refined Petroleum Products Survey is used to supplement quarterly ICE under-coverage of the Other Manufacturing. Therefore, the total from QRESD could be allocated based on the quantities estimated for 1990 ASM after adjustments for use to generate electricity or to produce steam for sale. Despite fuel substitution between heavy fuel oil and natural gas over the years, the use of HFO by manufacturing industries has been relatively constant. Therefore, a second option would be to use the QRESD aggregate total and to allocate based on the 1995 ICE distribution. To ensure the accuracy of the estimates respondents who exist on both the ICE database and ASM should be compared and adjustments made to account for missing units.

Actual estimation approach:

Historically, estimates of heavy fuel oil from the ICE survey and the QRESD have been similar for observed industries; therefore the 1990 QRESD was used as a control total. Data collected through the 1990 Refined Petroleum Products Surveys were used to validate estimates at a more aggregated level. The 1990 ASM data was originally going to be used to allocate the fuel at a disaggregated level; however price data was available for individual grades of heavy fuel oil from the *Energy Statistics Handbook, Catalogue 57-601*, for grades No. 4 and 6, while the ASM collects a combined total including grades Nos. 4, 5 and 6. When available price data for heavy fuel oil was compared to prices reported on ASM data, significant differences were noted. Secondly, without reliable provincial price data, the quality of the estimates would be reduced. Therefore, an alternate method was applied for heavy fuel oil:

(i) A trend factor was estimated for each industry based on the total shipments of goods of own manufacture for 1990 and 1995 from the ASM. The trend factor is the ratio of the total 1990 shipments of "Goods of Own Manufacture" to the total 1995 shipments of "Goods of Own Manufacture" for the industry.
(ii) The 1990 consumption estimates for heavy fuel oil are produced by applying the industry trend factor, calculated in (i), to the 1995 estimates from the ICE survey.

As part of the validation process these estimates were compared with heavy fuel oil estimates produced internally by Environment Accounts and Statistics Division.

Middle distillates:

The ICE Survey did ask for middle distillates in 1990 but did not provide full industry coverage. Other data sources will be required to estimate for this fuel type. The QRESD published estimates for kerosene & stove oil, diesel fuel oil, light fuel oil, aviation gasoline, aviation turbo fuel, and motor gasoline[10]. The ASM asks for values only at a similar breakdown of fuel types. ASM figures for middle distillates include fuel used off-site, such as transportation and no amounts have been deducted for use to generate electricity or to produce steam for sale. Also, diesel may not be reported on ASM due to an assumption that it is used only for transportation. These amounts are excluded from the ICE estimates. Some type of reconciliation exercise will be required for this fuel type. Some allocation would have to be made to make the estimates conceptually consistent. This could be determined by taking an ICE-ASM ratio and adjusting the ASM values.

Possible estimation approach:

The QRESD estimates in the manufacturing sector for diesel, light fuel oil and kerosene & stove oil as separate fuels, these can be summed to estimates for total middle distillates. In 1990, the QRESD published data collected from the Quarterly End-Use of Refined Petroleum Products Survey for Pulp and Paper, Iron and Steel, Smelting and Refining, Cement, Petroleum Refining, Chemicals and Other manufacturing as defined on a SIC basis. Direct substitution can only be used for Petroleum Refining and Cement industries.

Once an aggregate total has been determined, a distribution determined from ASM 1990 or from ICE 1995 could be used to estimate other industries. Retail prices are available as required from Prices Division. We can either bump up the QRESD or adjust the ASM. We will have to derive a ratio of the percentage used off-site in ASM and deduct this amount. To ensure a good ratio we will compare diesel and LFO from the QRESD to ICE for average of 1995 and 1996 middle distillates. If this is constant over time then we can derive a ratio to bump up the 1990 estimates from the QRESD or apply the ratio backwards to 1990 by industry.

Actual estimation approach:

There were significant conceptual differences between the data sources for middle distillates as defined on the ICE survey (diesel, kerosene and light fuel oil) and the breakdown available from other sources. In particular, the Refined Petroleum Products Survey (used for benchmark totals) provides an estimate of the total distributed quantity of Middle Distillates by province and for specific industries. The ASM also provides data on the total value of purchased middle distillates, but neither source distinguishes middle distillates used for transportation purposes from those used for manufacturing. An important difference between the ASM and the ICE survey is that the reported values for ASM include fuel used off-site such as transportation and an amount used to generate electricity or to produce steam for sale, while the ICE survey includes only energy used for manufacturing. There is currently no available method of estimating the proportion of middle distillates that are used for transportation versus manufacturing from this total. The estimates for middle distillates fuel volume were produced as follows:

10. Based on Quarterly End-Use of Refined Petroleum Products Survey.

(i) A trend factor was estimated for each industry based on the total shipments of goods of own manufacture for 1990 and 1995 from the ASM. The trend factor is the ratio of the total 1990 shipments of "Goods of Own Manufacture" to the total 1995 shipments of "Goods of Own Manufacture" for the industry.
(ii) The 1990 energy consumption estimates for diesel, kerosene and light fuel oil were produced by applying the industry trend factor calculated in (i), to the 1995 estimate from the ICE survey.
(iii) The consumption estimates for middle distillates were calculated by aggregating the consumption estimates for diesel, kerosene and light fuel oil for each industry.

Propane:

This fuel type will cause some problems, as ICE did not ask for propane in 1990. A value is available in the "Details of Natural Gas Liquids", Table 16 in the QRESD. The QRESD table titled "Details of Natural Gas Liquids" is identified as Table 16 from 1990 to 1998 and Table 17 from 1999 to date to accommodate the inclusion of Nunavut primary and secondary energy tables. However, historically the ICE and QRESD are very far apart in their estimates. Propane supply is based on provincial administrative data and included in the supply and disposition data of crude oil and natural gas. Exports, imports, inter-regional transfers, stock flows, and other adjustments are based on administrative data from the National Energy Board. Disposition data is based on Refined Petroleum Products and the Quarterly Propane Disposition Survey.

The QRESD published an amount for Gas Plants Natural Gas Liquids (NLG's). This amount includes propane, butane and ethane. A breakdown of these fuels is provided in Table 16, however the disposition includes both refinery produced propane and butane and gas plant NGLs. Therefore the ICE and QRESD are using completely different concepts as ICE respondents would not know the source of their supply.

The ASM asked for the general heading "liquefied petroleum gas", which includes propane, butane and ethane. Some assumption that most of the LPGs are to be considered propane may be required for estimation

Possible estimation approach:

ASM does ask for LPG. All of it is presumed to be propane. A price for industrial propane is available from the Energy Statistics Handbook. This price should be applied to the ASM value data to come up with a usage estimate by industry. Table AA.1 and AA.2 in Appendix A should be used to ensure that estimates are produced in all industries where this fuel is normally used.

Actual estimation approach:

Although the QRESD data produces a table with "Details of Natural Gas Liquids", this table is based on provincial administrative data and historically the estimates from the ICE survey and the QRESD have been different. This is because the QRESD data includes refinery-produced propane, butane and gas plant Natural Gas Liquids (NGL) while the ICE survey specifically collects an amount for propane. The ASM does not distinguish propane from other liquefied petroleum gases (LPG), such as butane and ethane and therefore price data can not be applied to LPG's to obtain reliable estimates of fuel volume. As there was no data available for this fuel type in 1990 the estimates for propane volume were produced using the same method that was applied to middle distillates.

Natural gas:

ICE collected natural gas consumption in 1990 from a limited number of establishments in a limited number of industries in the manufacturing sector. At this time, the ICE survey had not been designed to provide full coverage of natural gas in the manufacturing sector. Historically, this is a fuel type where there have been discrepancies between the QRESD and ICE estimates. This is due to the sources of data collection. The 1990 natural gas figures in the QRESD come mainly from the breakdown of sales to ultimate customers from the Natural Gas Monthly and the Natural Gas Disposition Quarterly. The ICE Survey collected from the manufacturer and in addition to fuel, measured fuel use for non-energy use of natural gas and used to produce steam for sale.

In 1990, the ASM collected purchases of natural gas on a value basis and quantities for a selected number of SIC industries. Price data by province is available from the Energy Statistics Handbook and can be used to calculate quantities for the remaining industries. However, there is a major conceptual difference between ICE and the ASM in the treatment of fuels used to generate electricity. This is partially significant in this time period as usage of natural gas by industry to generate electricity rose by 51% between 1990 and 1995 from 747 gigaliters to 1131 gigaliters.

Possible estimation approach:

The basic equation for natural gas for a modeling base is the quantity of natural gas used on ASM minus non-fuel adjustments from ICE minus natural gas used to generate electricity from the Electric Power Thermal Generating Station Fuel Consumption Annual minus natural gas used to produce steam for sale from ICE. We then would convert this dollar value to cubic meters.

Micro-level data would have to be reviewed for a number of large respondents to ensure they have consistent allocation of fuel and non-fuel use of certain commodities, especially natural gas in the chemical industry[11]. On the ASM, non-fuel use of natural gas is conceptually to be included as raw material input (feedstock).

11. The Chemical industry reports large quantities of natural gas for non-fuel use and particular attention is required in this industry to ensure the amounts reported on ICE and ASM correspond.

In order to achieve this, a list of all establishments with non-fuel use on ICE will need to be compared with the list of establishments on ASM that have reported material inputs. If an amount is reported as non-fuel on ICE and as purchased fuel on ASM, this amount will have to be removed from ASM. If an amount is reported as raw material on ASM and as fuel on ICE the fuel will need to be switched from raw materials to fuel on ASM. If the amount is reported as non-fuel on ICE and raw material on ASM then this amount is correct. This exercise will need to be completed to avoid over counting or undercounting of natural gas.

Actual estimation approach:

Although the ICE survey collected natural gas consumption in 1990 the limited number of respondents resulted in under coverage for this fuel type. The 1990 ASM provided good coverage of natural gas on a value basis. Prices were available by province in *the Energy Statistics Handbook Catalogue 57-601,* and were used to calculate volume. However, there is a major conceptual difference between the ICE survey and the ASM for natural gas as a fuel used to generate electricity. This is of particular interest for the 1990 reference year as the usage of natural gas by industry to generate electricity rose significantly. In order to realign the concepts for this fuel type, non-fuel use from the ICE survey and the natural gas used to produce electricity from the Electric Power Thermal Generating Station Fuel Consumption Annual Survey needed to be removed from the estimates.

(i) The estimates of total fuel value of natural gas were obtained for each domain and province from the ASM. Use of this data required a minor adjustment so that the available data adequately represents the entire population.
(ii) Using provincial-level price data, the fuel volume estimate was derived from the estimated total fuel value derived in (i), and the estimated price.
(iii) The final fuel volume estimate was derived by benchmarking the total fuel volume estimates from (ii) to the QRESD total for each industry group by province.

Wood:

ICE collected data on wood use in 1990 from establishments in the pulp and paper industry but did not collect estimates from those in the wood industry. The QRESD publishes wood waste consumption inclusive of use to generate electricity in one of its supplementary tables. The QRESD Table titled “Solid Wood Waste and Spent Pulping Liquor” is identified as Table 19 from 1990-1998 and Table 20 from 1999 to date to accommodate the inclusion of Nunavut primary and secondary tables. ASM does not ask for a breakout of wood used, as most of it is self-generated.

Possible estimation approach:

Wood is mainly used in the wood and pulp and paper industries. For 1990, the ICE information would be sufficient to derive a reasonable estimate for wood waste consumption by the pulp and paper industry after deducting for usage to generate electricity. However, there are not sufficient observations to estimate wood waste consumption for the wood industry. We could either “model” wood waste consumption by the industry based on 1995-2000 ICE returns and ASM data through a correlated variable (which would have to be researched) or come up with a growth factor by identifying the respondents that were included in the survey for years 1990 and 1995.

Wood use is significant in another industry (Furniture and Related Products Manufacturing NAICS 337, where it represented over 2% of the fuel use in the industry). A historical average contribution to the industry’s energy use could be used (if found to be stable) to fill this field.

Actual estimation approach:

In 1990 the ICE survey collected data on wood consumption from establishments in the Wood Products and Paper Manufacturing Industries. There is sufficient information from the ICE survey to derive a reasonable estimate at the aggregate level. NAICS estimates below the 3-digit level were modeled to reflect classification assignments that existed in 1990. Wood was also used in the “Furniture and Related Product Manufacturing” and “Non-Metallic Mineral Manufacturing” industry, but the ICE survey did not provide sufficient coverage to produce an estimate for these industries. The process described below was used for the Wood Products and Furniture and Related Products Industries:

(i) If the 1990 ICE survey provided a value, this value was used.
(ii) Otherwise, the value was estimated by calculating a trend factor for each individual unit. This trend factor was based on 1990 and 1995 ASM data, and for each unit was calculated as the ratio of its total shipments of goods of own manufacture for 1990 to its total shipments of goods of own manufacture for 1995. The trend factor was then applied to the unit’s wood consumption for 1995.
(iii) If the unit was not in business in 1990 the estimated value was zero.

The estimated fuel volumes are aggregated to each specified NAICS value to produce the fuel volume estimates.

Spent pulping liquor:

Possible estimation approach:

This fuel type is used exclusively in the pulp and paper industry. The 1990 ICE survey would provide a reasonable estimate for its use adjusted for its electric power generation. There is an issue of whether there is under coverage of the industry by ICE in 1990.

Actual estimation approach:

This fuel type is used exclusively in the Pulp and Paper Manufacturing Industry. ICE did collect this fuel type, but the ICE data did not provide sufficient coverage to produce an estimate below the aggregate level for this industry. NAICS assignments below the 3 digit NAICS were modeled to reflect classification assignments that existed in 1990.

Steam purchased:

ICE has partial coverage for 1990. The QRESD published a number based on steam sales reported to ICE from known steam sellers (electric power generating facilities and some industrial plants). ASM has values only, and there is no price conversion factor available.

Possible estimation approach:

The QRESD and ICE have conceptual differences when if comes to steam. The QRESD reports in its energy balances -steam sales from page 1 of the Quarterly Industrial Consumption of Energy Survey Questionnaire. ICE uses steam purchased reported by respondents. There has always been a difference between the two concepts due mostly to coverage differences.

ASM reported values could be used as an indication of which NAICS codes should be reporting this variable. There is a need to model as there is no reliable data source that can be used to produce a quantity value.

To develop a growth factor, respondents that were included on both ICE and ASM for years 1990 and 1995 should be identified. Total fuel use for each year by industry should be determined to develop this ratio. This growth rate can be applied from the 1995 estimate.

Actual estimation approach:

Although steam volume data was collected on the 1990 ICE survey, not all units consuming steam were in the survey population or sample at that time, so an alternative methodology was used to produce estimates for 1990 Steam fuel volume. For each unit present in the 1995 ICE survey population, its 1990 Steam fuel volume was estimated. The estimate was produced as follows:

(i) If the 1990 ICE survey provided a value, this value was used.
(ii) Otherwise, the value was estimated by calculating a trend factor for each individual unit. This trend factor was based on 1990 and 1995 ASM data, and for each unit was calculated as the ratio of its total shipments of goods of own manufacture for 1990 to its total shipments of goods of own manufacture for 1995. The trend factor was applied to the unit's steam consumption for 1995.
(iii) If the unit was not in business in 1990, the estimated value was zero.

The estimated fuel volumes are aggregated to each specified NAICS value to produce the fuel volume estimates.

Electricity:

The Energy Section of MCED collected electricity data from the Electricity Monthly, The Industrial Consumption of Energy Survey, The Electricity Supply and Disposition Survey, Electric Utility Financial Report, The Annual Electric Power Capacity and Load Forecast and The Electric Power Generating Station Surveys.

In 1990, Canada's electric power industry was made up of Crown corporations, investor owned utilities, municipal utilities and industrial establishments. The electricity industry was under the jurisdiction of the provinces and most of the electricity was generated by a few dominant utilities. Therefore there was full coverage on the production side.

ICE did not ask for electricity in 1990. However, historically the QRESD and ICE have gone through reconciliation processes for electricity and the numbers are very close. The ASM collected data on purchased electricity. Consumption of self-generated electricity would be available from the Electric Supply/Disposition Quarterly Survey.

Possible estimation approach:

The QRESD estimates for electricity have been very close historically to the numbers on ICE. Therefore the aggregate total from the QRESD should be used as a control total. QRESD published a split for Pulp and Paper, Iron and Steel, Smelting and Refining, Cement, Petroleum Refining, Chemicals and Other Manufacturing. Despite differences attributable to the two classifications systems the QRESD split provides a good starting point. Direct substitution can be applied for the Petroleum Refining and Cement industries.

Using the QRESD for aggregate control totals we can use the electricity based on the ASM distribution adjusted with data from the Electricity Supply/Disposition Quarterly Survey. This is the most appropriate source as it splits electricity generated for own use from electricity sold outside the plant.

If ASM data were used to estimate electricity, the electricity consumption data would have to be supplemented from data on consumption of self-generated electricity from the Electricity Supply/Disposition Quarterly Survey. The fuel purchases collected on ASM would therefore need to be supplemented with fuels used to generate electricity and to produce steam for sale. Data from

the Electric Power Thermal Generating Station Fuel Consumption Annual Survey would have to be used at the micro-level to adjust the estimate to the same concepts as the 1995-2000 ICE-based estimates. Since the detailed data is only available for the long form questionnaires, a coverage factor would have to be applied to adjust for short and tax portion.

We have the price of electricity by province for mining and manufacturing from Schedule 4 from the Electricity Supply and Distribution Survey. We can use electricity prices to determine the quantity of electricity based on values reported by respondent on ASM. The aggregate total published in the QRESD is very accurate and should then be used as a control total to allocate data based on the ASM distribution

If you include the self-generation of electricity in the Quarterly and do not deduct what has been included in ASM then you are double counting. This amount is significant in the pulp and paper and chemical manufacturing industries. The 1990 Thermal Generation Fuel Consumption Survey is very important as it allows us to modify ASM so that it is on a consistent basis with ICE estimates from 1995-2000. This adjustment will need to be made no matter which option of estimation is chosen.

Actual estimation approach:

The ICE survey did not ask for electricity consumption in 1990. However, beginning in 1994 the QRESD and the ICE survey have undergone an annual reconciliation process for electricity and have been historically very close in estimates. Therefore the aggregate 1990 QRESD data was used as the control total for electricity. The quality of data for electricity from the 1990 ASM was high; however conceptual differences between the two surveys dictate that adjustments are required for consumption of self-generated electricity. The methodology is briefly described below:

(i) The estimates of total value of electricity were obtained for each domain and province from the 1990 ASM. Use of this data required a minor adjustment so that the available data adequately represents the entire population.
(ii) Using provincial-level price data, the total fuel volume estimate was derived from the estimated total fuel value derived in (i), and the estimated price.
(iii) The final fuel volume estimate is derived by benchmarking the total fuel volume estimate from (ii) to the QRESD total for each industry group12 by province and fuel volume.

Estimates of self-generated electricity derived from the 1990 Electric Power Thermal Generating Station Fuel Consumption Annual Survey were added to the fuel volume estimate for each industry. After the initial electricity estimates were produced using ASM data, these numbers were adjusted by adding the fuel used to produce electricity from ICE and electricity generated which had been reported on the Thermal Generation Survey.

Table A4
1990 Energy Conversion Factors

Fuel type		Factor
Coal	Anthracite	27.70
	Imported bituminous	29.00
	Canadian bituminous	
	Newfoundland and Labrador, Prince Edward Island, Nova Scotia and Quebec	28.50
	New Brunswick	27.00
	Ontario	30.40
	Manitoba	30.40
	Saskatchewan, Alberta, Yukon, Northwest Territories (Future Nunavut)	30.40
	British Columbia	30.50
	Sub-bituminous	18.30
	Lignite	15.00
	Coal coke	28.83
	Coke oven gas	18.61
	Propane	25.53
	Butane	28.62
	Ethane	18.36
Still gas from refineries(refinery fuel gas)		37.28
Still gas from upgraders		43.13
Kerosene and stove oil		37.68
Diesel		38.68
Light fuel oil		38.68
Heavy fuel oil		41.73
Petroleum coke from refineries		44.48
Petroleum coke from upgraders		39.64
Natural gas		37.78
Electricity		3.60
Steam		2.75
Solid wood waste		18.00
Spent pulping liquor		14.00

12. *Pulp and Paper, Iron and Steel, Smelting and refining, non-ferrous, cement, petroleum refining, chemicals, and other manufacturing as defined in Quarterly Report on Energy Supply-Demand in Canada 2001-III, 57-003-XPB.*

Joules

Environment Canada provides conversion factors to convert energy forms to a comparable joule basis. These conversion factors evolve over time. Table A4 lists the conversion factors for 1990. Coal is of particular interest since there is a different conversion factor for each province and coal type. These factors will be applied to the quantity estimates for each industry.

Appendix D

Industry specific issues

Paper manufacturing: 322000

The coverage of the Pulp and Paper Industry on ICE and ASM is very close and it should be easy to produce a 3-digit NAICS level estimate. In 1990, there were approximately 200 respondents. It will be more difficult to produce estimates at the 6 digit splits due to the need to match establishments with their appropriate NAICS code. There is a lot of movement of establishments between 6-digit NAICS industries between years.

Consumption of self-generated electricity will also be an issue for this year and will need to be accounted for. If a pulp mill co-generates electricity from its bio-mass boilers, it would be incorrect to add both bio-mass consumed and self-generated electricity consumed to determine total energy consumption for that industry. Therefore, the ASM data would have to be lowered by amounts used to generate electricity or to produce steam for sale.

Possible estimation approach:

Derive the estimates using ASM or ICE, depending on the fuel type as discussed previously, and calculate deductions for fuels used to generate electricity or produce steam for sale.

Petroleum and coal products manufacturing: 324000

In 1995, there was a comparison done of electricity consumption for the petroleum refining sector in Alberta by the ASM as compared to the ICE survey. The two data sets should have been very close since they covered the same units and there is no electricity production by petroleum refineries in Alberta. For the three main refineries, the ASM had a total estimate of 602,765 MWh. The ICE survey had an estimate of 971,999 MWh (61% higher). All three units had the standard ASM unit price for electricity in Alberta of 5.10 cents per kilowatt hour. If the Alberta rate for petroleum refineries of 3.20 cents per kilowatt-hour had been applied, the ASM's level of energy consumption would have been 960,656 MWh, 1.1% below the ICE estimate.

Beginning in 1990, synthetic crude oil from the oil sands project was enriched by the addition of hydrogen, which originates from natural gas. This amount needs to be included as an inter-product transfer.

These differences indicate that there would be a requirement to do some work on the quality of the physical volume estimate before any of the options could be successfully applied.

Possible estimation approach:

For the tabulated fuels, the estimates would be taken directly from ICE. For heavy fuel oil and refinery fuel gas the estimates should come directly from the RPP monthly. One possible approach for the other fuels would be to identify the top contributors for each energy form by industry (at a minimum, for the most energy-intensive industries) to examine the unit price. Given the small number of establishments in the industry and its importance as an energy consumer, a comparison could be completed to see how well the calculated price matches with known unit prices for the province and sector, and determine if there is a need to "edit" the data. The data could be edited based on historical ICE versus ASM for that record.

Chemical manufacturing: 325000

Note: *In 1990 half of the industry was on strike; therefore the estimates are much lower than if the industry was in full operation.*

Micro-level data would have to be reviewed for a number of large respondents that may not have consistent allocation of fuel use and non-fuel use of certain commodities (especially natural gas). Use of natural gas to generate electricity would also need to be applied to the estimates from the Electric Power Thermal Generating Station Fuel Consumption Annual. Another deduction will also have to be made from the ASM data to deduct for fuels used to generate electricity and to produce steam for sale.

A minor issue in this industry is the degree of detail of the current estimate (it includes some 6-digit industries) and the movement of establishments from a NAICS code to another (usually still in Chemical Manufacturing.

Possible estimation approach:

Use ASM data as a base, with corrections based on ICE and Thermal data. There will be a need to do some extra record-level analysis for this industry due to its heavy scrutiny and significance as an energy-intensive industry.

Motor vehicle plastic parts manufacturing: 326193

Possible estimation approach:

There was very limited coverage on the ICE survey in 1990; therefore ASM would be a better basis.

Cement manufacturing: 327310

Possible estimation approach:

Do not model. There should be sufficient coverage in the ICE data for straight tabulations in this industry.

Lime manufacturing: 327410

Possible estimation approach:

Do not model, there should be sufficient coverage in the ICE data for straight tabulations in this industry. However industry coverage would need to be confirmed with ASM.

Iron and steel mills and ferro-alloy manufacturing: 331110

Possible estimation approach:

This is a not a one to one correspondence between SIC and NAICS. There will be a need to combine ICE and ASM data to come up with an estimate. Some record-level analysis will be required due to its importance as a key energy-consuming industry.

Iron and steel manufacturing (pipes, tubes, shapes, wire drawing): 331200

Possible estimation approach:

Electricity is a problem as there is consumption of self-generated electricity. ASM could be used with an adjustment for self-generated electricity.

Primary production of alumina and aluminum: 331313

Possible estimation approach:

Use ICE data for those fuels covered on the ICE questionnaires. For the other fuels use a combination of ICE and ASM and ensure industry coverage. For electricity combine ICE, ASM and the Electricity Supply and Disposition Quarterly to capture the consumption of self- generated electricity.

Non-ferrous metal smelting and refining manufacturing: 331410

Possible estimation approach:

Do not model, there should be sufficient coverage in the ICE data for straight tabulations in this industry. However industry coverage would need to be confirmed with ASM.

Transportation equipment manufacturing: 336000

There is little coverage of this industry in the 1990 ICE.

Possible estimation approach:

Use ASM data to model estimates.

Appendix E

Quality indicators

The following legend provides an indication of the quality of the estimates on a fuel and industry basis (for Tables A5 and A6).

	Rating	Description
A	Excellent	Direct survey data with estimated population coverage above 95% or derived from an administrative source
B	Very good	Direct survey data with estimated population coverage between 79% and 95%
C	Good	Direct survey data with estimated population coverage between 50% and 75%
D	Fair	Direct survey data with estimate population coverage below 50%
E	Qualified	No survey data, estimate based on modeled data

Table A5
Quality Ratings for 3 Digit NAICS based 1990 Industrial Consumption of Energy Estimates

NAICS	Industry	Coal	Coal coke	Coke oven gas	Petroleum coke and catalytic cracking catalyst	Refinery fuel gas	Heavy fuel oil	Middle distillates	Propane	Natural gas	Wood	Spent pulping liquor	Steam	Electricity
		Metric tonnes	Metric tonnes	Mega-litrres	Metric tonnes	Thousand cubic metres	Cubic metres	Cubic metres	Cubic metres	Thousand cubic metres	Metric tonnes	Metric tonnes	Giga-joules	Mega-watt hours
311	Food manufacturing	..	..	..	..	..	C	E	E	B	..	..	C	B
312	Beverage and tobacco product manufacturing	..	..	..	..	..	C	E	E	B	..	..	..	B
313	Textile mills	..	..	..	..	..	C	E	E	B	..	..	..	B
314	Textile product mills	..	..	..	..	..	C	E	E	B	..	..	..	B
315	Clothing manufacturing	..	..	..	..	..	C	..	E	B	..	..	..	B
316	Leather and allied product manufacturing	..	..	..	..	..	C	E	E	B	..	..	C	B
321	Wood product manufacturing	..	..	..	..	..	C	E	E	B	E	..	..	B
322	Paper manufacturing	A	..	..	..	..	A	E	E	A	B	A	B	A
323	Printing and related support activities	..	..	..	..	..	..	E	E	B	..	..	..	B
324	Petroleum and coal products manufacturing	A	..	..	A	A	C	E	E	B	..	..	B	B
325	Chemical manufacturing	..	..	..	A	..	A	E	E	A	..	..	B	A
326	Plastics and rubber products manufacturing	..	..	..	..	..	C	E	E	B	..	..	B	B
327	Non-metallic mineral product manufacturing	A	A	..	A	..	C	E	E	B	E	..	B	B
331	Primary metal manufacturing	A	A	E	A	..	A	E	E	A	..	..	B	A
332	Fabricated metal product manufacturing	..	..	..	..	..	C	E	E	B	..	..	C	B
333	Machinery manufacturing	..	..	..	..	..	..	E	E	B	E	..	..	B
334	Computer and electronic product manufacturing	..	..	..	..	..	..	E	E	B	..	..	..	B
335	Electrical equipment, appliance and component manufacturing	..	..	..	..	..	C	E	E	B	..	..	..	B
336	Transportation equipment manufacturing	A	A	..	..	..	C	E	E	B	..	..	C	B
337	Furniture and related product manufacturing	..	..	..	..	..	C	E	E	B	E	..	..	B
339	Miscellaneous manufacturing	..	..	..	..	..	..	E	E	B	..	..	C	B
NAICS	**Total manufacturing**	**A**	**A**	**E**	**A**	**A**	**A**	**E**	**E**	**A**	**B**	**A**	**C**	**A**

.. *not available for a specific reference period*

Table A6
Quality Ratings for Specific 6 Digit NAICS based 1990 Industrial Consumption of Energy Estimates

NAICS	Industry	Coal	Coal coke	Coke oven gas	Petroleum coke and coke form catalytic cracking catalyst	Refinery fuel gas	Heavy fuel oil	Middle distillates	Propane	Natural gas	Wood	Spent pulping liquor	Steam	Electricity
311400	Fruit and vegetable preserving and specialty food manufacturing	..	..	..	..	..	E	E	E	B	..	..	..	B
311500	Dairy product manufacturing	..	..	..	..	..	E	..	E	B	..	..	..	B
311600	Meat product manufacturing	..	..	..	..	..	E	..	..	B	..	..	D	B
311800	Bakeries and tortilla manufacturing	..	..	..	..	..	E	E	E	B	..	..	..	C
312100	Beverage manufacturing	..	..	..	..	..	E	E	E	B	..	..	..	B
312120	Breweries	..	..	..	..	..	E	E	B	..	..	..	..	A
312200	Tobacco manufacturing	..	..	..	..	..	E	E	E	B	..	..	..	A
321111	Sawmills (except shingle and shake mills)	..	..	..	..	..	E	E	E	B	E	..	B	A
321216	Particle board and fibreboard mills	..	..	..	..	..	E	E	E	B	E	..	..	B
322111	Mechanical pulp mills	..	..	..	..	..	E	E	E	B	E	E	..	A
322112	Chemical pulp mills	A	..	..	..	..	E	E	E	B	E	E	..	A
322121	Paper (except newsprint) mills	..	..	..	..	..	E	E	E	B	E	E	D	A
322122	Newsprint mills	A	..	..	..	..	E	E	E	B	E	E	A	A
322130	Paperboard mills	..	..	..	..	..	E	E	E	B	E	E	D	A
322200	Converted paper product manufacturing	..	..	..	..	..	E	E	E	B	..	..	..	B
324110	Petroleum refineries	..	..	..	..	..	E	E	E	B	..	..	D	A
325110	Petrochemical manufacturing	..	..	..	..	..	E	E	E	B	..	..	..	A
325120	Industrial gas manufacturing	..	..	..	A	A	..	..	..	B	..	..	..	A
325130	Synthetic dye and pigment manufacturing	..	..	..	..	..	E	..	..	B	..	..	..	A
325181	Alkali and chlorine manufacturing	..	..	..	..	..	E	E	..	B	..	..	..	A
325189	All other basic inorganic chemical manufacturing	..	..	..	..	..	E	E	E	B	..	..	..	A
325190	Other basic organic chemical manufacturing	..	..	..	..	..	E	E	E	B	..	..	..	A
325210	Resin and synthetic rubber manufacturing	..	..	..	..	..	E	E	E	B	..	..	C	A
325313	Chemical fertilizer (except potash) manufacturing	..	..	..	..	..	E	E	E	B	..	..	..	B
326100	Plastics product manufacturing	..	..	..	..	..	E	..	..	B	..	..	..	B
326193	Motor vehicle plastics parts manufacturing	..	..	..	..	..	E	..	..	B	..	..	..	B
326200	Rubber product manufacturing	..	..	..	..	..	E	E	..	B	..	..	..	A
327214	Glass manufacturing	..	..	..	..	..	E	E	E	B	..	..	..	A
327310	Cement manufacturing	A	A	..	A	..	E	E	E	A	D	..	..	A
327410	Lime manufacturing	A	..	..	A	..	E	E	E	B	..	..	..	A
331100	Iron and steel mills and ferro-alloy manufacturing	A	A	..	..	..	E	E	E	B	..	..	..	A
331313	Primary production of alumina and aluminum	..	..	E	A	..	E	E	E	A	..	..	..	A
331410	Non-ferrous metal (except aluminum) smelting and refining	A	A	..	..	..	E	E	E	B	..	..	C	A
331511	Iron foundries	A	A	..	..	..	E	E	E	B	..	..	..	B
336110	Automobile and light-duty motor vehicle manufacturing	A	..	..	..	..	E	E	E	B	..	..	..	A
336120	Heavy-duty truck manufacturing	..	..	..	..	..	..	..	E	B	..	..	..	B
336310	Motor vehicle gasoline engine and engine parts manufacturing	..	..	..	..	..	..	..	E	B	..	..	..	A
336320	Motor vehicle electrical and electronic equipment manufacturing	..	..	..	..	..	..	..	E	B	..	..	..	C
336330	Motor vehicle steering and suspension components (except spring) manufacturing	..	..	..	..	..	..	E	E	B	..	..	..	A
336340	Motor vehicle brake system manufacturing	..	A	..	..	..	..	E	E	B	..	..	..	B
336350	Motor vehicle transmission and power train parts manufacturing	..	A	..	..	..	..	..	..	B	..	..	..	A
336360	Motor vehicle seating and interior trim manufacturing	..	..	..	..	..	..	E	E	B	..	..	..	B
336370	Motor vehicle metal stamping	..	..	..	..	..	E	..	..	B	..	..	..	B
336390	Other motor vehicle parts manufacturing	..	..	..	..	..	E	E	E	A	..	..	..	B

.. *not available for a specific reference period*

Appendix F

Project description

Sponsoring section:

Energy Section, Manufacturing, Construction and Energy Division (MCED)

Requested by:

Office of Energy Efficiency
Natural Resources Canada
580 Booth Street, 18th floor
Ottawa, Ontario
K1A 0E4

Description of project, estimate of cost, time frame, special conditions:

The objective of the *NAICS Conversion Project* is to convert the estimated data from Industrial Consumption of Energy Survey (ICE) from the Standard Industrial Classification (SIC) to the North American Industrial Classification (NAICS) for 1990 and for the years 1995 to 2000 inclusively.

This conversion does not include the cost of undertaking an historical revision to the Energy balances to incorporate the new manufacturing NAICS based estimates.

The project is divided in 3 fiscal years with a total budget of $ 265,000. Year 2001-02 is $ 130,000 (with $ 120,001 salary/ 1.9 FTE and $ 10,000 non-salary) while 2002-03 and 2003-04 have been allocated $65,000 respectively (with $58,215 salary/ .65 FTE and non-salary $ 6,785).

Work to be performed by Statistics Canada:

By the methodology group:

The Business Survey Methods Division of Statistics Canada will refresh the estimates from the Industrial Consumption of Energy Survey based on the latest shipment information available from the Annual Survey of Manufactures. They will also be involved in the calculation of reallocations of energy consumption from a SIC basis to a NAICS basis.

Cost estimate for this work: $45,000

By the systems section of MCED:

Not applicable

Cost estimate for this work: N/A

By the energy section of MCED:

To manage and direct the project involving the following deliverables:

- Review of ICE estimates generated by Statistics Canada's Business Survey Methods Division for the 1999 reference year on a NAICS basis.
- Generate and analyse ICE estimates on a 1980 SIC and 1997 NAICS basis for the 2000 reference year to determine the optimal methodology for generating the historical estimates for 1995 to 1998.
- Generate, analyse and finalise ICE historical estimates (1995-1999) on a NAICS basis, including time series and relevant consistency checks.
- Release in THE DAILY in March 2002 the ICE historical data series from 1995 to 2000 on a NAICS basis.
- Begin the feasibility study on deriving NAICS estimates for the reference year 1990.

These deliverables will be conducted between September 2001 to March 2002.

Cost estimate for this work: $ 85,000

Conditions:

1. A Memorandum of Understanding between Statistics Canada and Natural Resources Canada concerning energy data covers this project.

2. Natural Resources Canada will not release the survey results to the public prior to the release of the information by Statistics Canada.

3. Natural Resources Canada is to receive recognition for funding the *NAICS Conversion Project*. The method for receiving recognition will be determined jointly.