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Energy Saving Potential in the residential sector in Canada: Insight from TIMES-Canada

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Résume

Dans cette thèse, nous nous intéressons à l'analyse de la consommation canadienne d'énergie du secteur résidentiel et de la production d'émissions en tenant compte des caractéristiques des technologis des résidentielles à l'aide du modèle TIMES-Canada. L'étape la plus importante de cette recherche a été la construction d'une base de données fiable dans laquelle les paramètres des technologies résidentielles ont été déterminés soit à partir de données réelles trouvées dans la littérature ou d'estimations fondées sur des hypothèses au sujet de la technologie.

L'objectif de cette thèse est d'évaluer le potentiel de la consommation d'énergie et réduction des émissions du secteur résidentiel au Canada à l'horizon de 2050. Lors de l'Accord de Copenhague signé en 2010, le Canada a pris l'engagement de réduire ses émissions de GES de 17% d'ici 2020 par rapport au niveau de 2005. Pour atteindre cet objectif, il y a certaines contraintes imposées par les deux paliers gouvenementeux (fédéral et provinciaux) sur les émissions de GES. Les scénarios utilisés dans cette recherche envisagent ces objectifs de réduction de GES pour évaluer le potentiel de diminuer la consommation d'énergie et le niveau d'émission dans le secteur résidentiel. On considère aussi la limitation de la pénétration des énergies renouvelables pour la production d'électricité (en remplacement des combustibles fossiles) dans le scénario de limitation des émissions de GES. Par conséquent, nous considérons trois scénarios dans cette recherché: un scénario de base (BAU), un scénario de réduction de GES (GES1) avec une part maximale de 10% à 25% de la penetration des renouvelables dans la production d'électricité à l'horizon 2050 et la même réductions GES (GES2) avec une part maximale de 10% jusqu'à 2050 por les nouvelables. Dans ces deux derniers scénarios de GES, la limitation fédérale sur les émissions de GES a été prise en compte.

Les résultats du modél TIMES-Canada montrent que pour le scénario BAU, la consommation finale totale d'énergie du secteur résidentiel a augmenté de76,42 PJ en 2050. Mais, en imposant des restrictions de GES par des politiques climatiques, la consommation totale d'énergie finale diminue de 16 PJ en 2050. Ces résultats montrent aussi que la demande pour tous les types d'énergie, sauf pour l'électricité, a diminué en 2050. Dans le secteur résidentiel cette diminution a été de: 10% pour la biomasse dans BAU et de 7% pour les scénarios de GES; de 30% pour les produits pétroliers dans BAU et GES1(2), de 48% pour le gaz naturel dans BAU et de 68% pour GES1(2). Pendant ce temps, la consommation d'électricité a augmenté de 77% dans BAU et 76% dans GES1(2). Les résultats du modèle montrent que le niveau des émissions de GES a diminué de 5% à l'horizon 2050 pour le scénario BAU qui n'a pas de limitation d'émission. Cette réduction est de 32% pour les scénarios GES1 et GES2 jusqu'en 2050.

Mots clés: TIMES, secteur résidentiel, émissions de GES

Abstract

In this thesis we are interested in analysing the Canadian residential sector energy consumption and emission production by considering residential technologies attributes using TIMES-Canada model. The most important stage of this research was building up a reliable data base in which certain attributes of the residential technologies for end use services have been built up either by actual data found in literature or estimations based on assumptions about the technology and the attributes.

The objective of this thesis is to evaluate the potential of energy consumption and emission production reduction of the residential sector in Canada in time the horizon to 2050. Canada has the GHG emission reduction commitment in the Copenhagen accord by 2010 to decline the GHG emission level by 17% of the 2005 (United Nation, 2009). To accomplish this target there are certain constraints imposed by both federal and provincial levels on GHG emissions. The scenarios used in this research are considering these GHG reduction targets to evaluate the potential of the diminishing energy consumption as well as the emission level in the residential sector. There is also the limitation on the penetration of renewable energy for electricity production to substitute fossil fuels in the GHG limitation scenario. Consequently we will have three scenarios in this research including the base line (BAU) scenario, the GHG1 scenario with a maximum 10% to 25% share of the renewable penetration in electricity production up to 2050 and the GHG2 scenario with a 10% share up to 2050. In both GHG scenarios the federal limitation on GHG emissions has been taken into consideration.

The TIMES-Canada Model results show that for BAU scenario, the total final energy consumption of the residential sector has increased 76.42 PJ by 2050. But, on the other side, by imposing GHG restrictions through climate policies, the total final energy consumption has decreased 16 PJ by 2050. It also shows that the demand for all type of energy except for electricity has declined by 2050 in all the scenarios. This decrease has been 10% for biomass in BAU while 7% for the GHG scenarios, 30% for oil products in BAU and GHG scenarios, 48% for natural Gas in BAU and 68% for the GHGs. Meanwhile electricity consumption increased 77% in BAU and 76% in the GHG scenarios. The results of the model demonstrate that the GHG emission level has decreased 5% up to 2050 for the BAU scenario which has no emission limitation. This reduction is 32% for the GHG1 and GHG2 scenarios up to 2050.

Key words: TIMES, residential sector, GHG emissions

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Acronym list

Acronym	**Description**
GHG	Greenhouse gas
RES	Reference energy system
CO_2	Carbon dioxide
GJ	Gigajoule
PJ	Petajoule
kW	kilowatt
GDP	Gross domestic product
RWMH	Residential Water heating Mobile House
RWDH	Residential Water heating Detached House
RWAP	Residential Water heating Apartment
RWAH	Residential Water heating Attached House
RREF	Residential Refrigeration
ROEL	Residential Other Electric Appliances
RLIG	Residential lighting
RHMH	Residential Heating Mobile House
RHDH	Residential Heating Detached House
RHAP	Residential Heating Apartment

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1 PJ = 10^6GJ

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Introduction

Energy consumption in the residential sector is one of the most essential needs of any society as it directly contributes to day-to-day life of the people and affects the comfort and welfare of the population. Considering the increasing residential energy demand resulting from the new lifestyle requirement, a considerable amount of energy has been demanded in this sector in diverse types of energy as energy input for home appliances. To be more accurate 16% of the total energy consumption in Canada is spent in this sector with an increase of 11% in almost the last decade (Natural Resource Canada, 2012a).

On the other hand, the effects of emissions produced from energy consumption are not negligible and should thus be controlled. The residential sector was successful in achieving the Kyoto target for emission reduction before the target date (CHBA, 2012). By signing the Copenhagen accord in 2009, the emission reduction target has been reset from 2005. Canada has committed to reduce GHG emissions by 17% below the 2005 level by 2020. The Canadian government has focused on reducing GHG emissions through new policies and regulations for all the energy sectors (Canada's Emissions Trends, 2012).

This research takes a close look at the energy saving potential and emission reduction in the residential sector. Based on all mentioned facts about the residential energy consumption and emissions production, the questions of this research would be:

First: How does climate policy affect energy consumption of the residential sector?

Second: How can the residential sector contribute to achieving its emission reduction target?

So, the objective of this research is to evaluate the potential of reduction in energy consumption and emission production for the Canadian residential sector. In fact we aim to examine how much energy can be saved in the residential sector and consequently how this reduction in energy consumption would affect the emission level of this sector. To achieve this goal TIMES model has been used to evaluate the Canadian residential sector applying the BAU scenario and climate policy scenarios GHG1 and GHG2.

Consequently an accurate monitoring of the energy sectors is required in order to control and manage the supply and demand market as well as the produced emissions. This can be achieved through policies and regulations on energy-consumption optimization and emission reduction as well as improving the efficiency of the end-use appliances.

To be able to evaluate the effects of climate policies on the residential energy demand and emission level in the long term, an energy model such as TIMES (Fishbone and Abilock, 1981) is useful. TIMES (The Integrated Markal Efom System) is the latest version of the MARKAL family of energy models. This model has been developed by the ETSAP (Energy Technological System Analysis Program) of the IAE (International Energy Agency).

This model is a bottom-up energy model which can consider all the technology attribute details and covers the whole energy supply and demand market. TIMES has been developed in a way to minimize the total cost of the energy system considering all the limitations in long-term time horizon for all the energy carrier types. This model can be used for regions and sectors separately.

In this study we will use the TIMES model developed for Canada (TIMES-Canada) for the residential sector energy evaluation. For this purpose we will supply the model with the detailed data on the technology attributes of the residential sector. This data base has been built using federal and provincial reports, websites on the technology attributes, producer reports, customer review forums and web stores. It should also be mentioned that in case of lack of reliable data in Canadian residential sector, we have used the attributes of the identical technology in United States or Europe. Therefore our contribution will be to build up the technology data base for the residential sector in TIMES-Canada and analyse this sector for its energy demands and GHG emissions.

This thesis has four chapters. The first chapter is about the actual status of the Canadian residential sector, energy consumption, forecasts and a brief description of the available end-use services. The second chapter includes a brief review on the energy modeling techniques and categories and also a literature review of the residential energy studies. The third chapter introduces the methodology and TIMES model as well as the specification of

TIMES-Canada. The forth chapter is about the database build up and assumptions as well as the residential sector RES (Reference Energy System). In the last chapter the scenarios are presented and the model results are discussed.

1. Canadian residential sector

The ability to control fire brought tremendous change in the early human's life. They learned to make fire and use it to cook, to warm their places and to have light at night. The very first fuel for making fire was wood and it remained so for centuries.

Throughout history, humans learned to use energy from different fuel types for their day to day living. The first demand in homes remained for space and water heating, cooking and lighting for long periods of time. The discovery of oil and coal as fossil fuels and the ability to produce electricity changed the energy using habits of humans within the last two centuries.

With the improvement of technology as well as a growing population, energy consumption within houses started to increase dramatically. Now different types of appliances are commonly used in homes besides space and water heating, cooking and lighting. Decreasing energy costs from one side and the resulted emission from other side, made policy makers force regulation on producers to invent energy efficient methods to decrease energy consumption and emissions. This opened a chapter in research and science about the residential sector's energy consumption and emissions.

1.1 The residential sectors

Residential sector is one of the sources of energy consumption. By increasing the population and development of economies, demand for energy increased dramatically. Despite this fact, the sources of energy remain almost unchanged. Fossil sources of energy are un-renewable and are wildly used. Making matters worse, using this energy source generates greenhouse gas (GHG) emissions. Under this context much research has been focused on the reduction of energy consumption and emissions in the residential sector.

According to TIMES the energy demand side is divided into five sectors: the residential sector, commercial sector, industrial sector, transportation sector and agriculture sector with each sector having its own end-use technologies and consumption. In this research we are studying the residential sector via TIMES model. In TIMES model, the residential sector includes any type of residence including single family residences, apartments, apartment hotels, condominiums and/or farm homes (STATCan, 2011). The energy used in the residential sector is used for comforting the living space and health of householders.

The residential buildings are divided into four major types (STATCan, 2011):

- Single-detached dwellings do not share walls with other dwellings.
- Attached dwellings share one or two common walls with other dwellings.
- Apartments share walls, ceiling, and floors with other dwellings and are typically serviced by a central building plant system.
- Mobile homes are used for transport and are typically located on a temporary foundation.

The recent changes in lifestyle such as more use of electric appliance and increases in personal living space as well as world population growth have had a dramatic effect on energy consumption in this sector. On the other hand, the improvement in technology has made space and water heating and other appliances more efficient (US.Department of Energy, 2008).

1.2 Drivers of energy use in the residential sector

The energy used in the residential sector end-use is driven from the following factors (US.Department of Energy, 2008) :

- Population, which affects the total number of dwellings
- Economic growth or real GDP
- Dwelling size or space used in the residential sector per person
- End used demand amount (space heating, lighting etc.)

- Real energy price
- The efficiency of the end-use technology

1.3 End-Use demands and technology description

In the residential sector the energy is mainly used for space heating, water heating, space cooling, lighting, cooking and appliances. Distribution of the residential energy consumption by end-use in 2009 is described in table 1.1 (Natural Resource Canada, 2012a).

Table 1.1: Distribution of the residential energy consumption by end-use in 2009

(Natural Resource Canada, 2012a)

End-use	**Energy use percentage**
Space heating	63%
Water heating	17%
Appliances	14%
Lighting	4%
Space cooling	1%

1.3.1 Space heating

In Canada space heating is one of the major sources of energy consumption in the residential sector. A space heating system can consume 40 to 60 percent of the energy used in this sector. The trend in energy use in space heating from 1990 to 2008 shows that the amount of energy used per square foot for heating houses has decreased due to more efficient appliances and warmer entries in Canada. But as the living space per Canadian has increased and the population of Canada had a growth through the time, overall energy consumption for space heating has increased 16% between 1990 and 2008(Natural Resource Canada, 2012a).

The following technologies are studied in this research among all available technologies used for space heating:

Furnace

Furnaces are a commonly used for heating in North America. A furnace functions by heating the air and distributing the heated air through ducts. (Energy.gov, 2013)

Heat pump

A heat pump is an electrical heating device that is designed to move the heat through the opposite direction of the natural heat flow. To achieve this, the device uses energy to transfer heat from the source to a heat sink. A heat pump is a not a new technology. It has been used in Canada and around the world for many years.

Heat pump is a general word and is applied to heating and air conditioning devices (HVAC). Refrigerators and the air conditioners are examples of heat pumps working in a cooling mode.

Usually heat pump cycles are reversible and can provide climate control for the whole year. An air source heat pump absorbs heat from outside in the winter and transfers heat to the outside in the summer (Natural Resource Canada, 2009c).

Baseboard heater

A baseboard is one of the electric heater types. It is usually used provide additional heat to rooms which are colder than others. They come in different sizes and models. It is also used in areas like bathrooms or garages. They provide clean safe heat were furnaces or heat pumps are not applicable (Thiele, 2013).

1.3.2 Water-heating

Residential water-heating is the process that uses energy to heat water for domestic use such as cooking cleaning and bathing. It is the second largest energy consumption source in the Canadian residential sector after space heating. Many of the technologies used for water heating, are common with space heating including furnaces and heat pumps. In Canada many oil-fired water heaters have been replaced by efficient water heaters which use natural gas as fuel. Besides, recently, higher standards are required on appliance efficiency. This lead to a 21% decrease in energy use per household. But the increasing number of households lead to an overall 5 % increase in energy consumption for water heating from 1990 to 2008 (Natural Resource Canada, 2010a).

1.3.3 Space-cooling

Space-cooling energy consumption in the residential sector depends on the climate conditions. Though Canada is a cold country, it has a humid hot summer in some provinces which brings the need for space cooling appliances. The energy used for Canadian space cooling has increased 68% from 1990 to 2008 (Natural Resource Canada, 2010b).

The three main available options are:

Air-conditioning

Air-conditioning is a device for changing air properties including temperature and humidity.

Central AC

The central AC is a cooling device for an entire house. It uses energy to take heat away. There are three types of central air conditionings (Natural Resource Canada, 2011a):

- Single package unit: has all the components and is installed through the wall or roof.

- Split-system unit: has an inside and outside unit. The indoor heat exchanger or coil is inside; the rest of the components are in the outdoor part.
- Mini-split and multi-split units: similar to the split system but has more than one indoor coil.
- Small duct high velocity units: this is a central AC which distributes air through pipes.

Room AC

The room AC is designed to cool one single room. It can be of the following types (Natural Resource Canada, 2012b):

- Through-the-wall (TTW) units: this type of AC is designed to be mounted in the wall. They are less efficient than other AC types.
- Window-mounted unit: majority of room air conditioners are window mounted. They should be installed in an open window. They are available to be installed in single and double windows as well as horizontal and casement windows.
- Portable unit: this type of ac can be moved from room to room.

1.3.4 Lighting

The best and fastest way of energy saving and global warming prevention is to use more efficient lighting appliances. By the advent of the new technologies in lighting, changing a single light bulb can save energy (EnergyBible, 2010a). Table 1.2 demonstrates the number of light bulbs types per household in 1999 and 2009.

Table 1.2: Number of light bulbs per household by bulb type, 1990 and 2009 (Bulb/household)

(Natural Resource Canada, 2012a).

Bulb Technology	**1990**	**2009**
Incandescent	29.4	19.2
CFL	0.0	7.7
Fluorescent	1.6	2.8
Halogen	0.9	2.6

Incandescent

This type of electric light produces light with heating filament wire. It has been manufactured in different sizes and voltages from 1.5 to 300 volts. Though it has a low efficiency compared to new lighting technologies, it is still widely used around the world. Many countries including Canada have regulations in limiting usage of this type of light due to its low efficiency (less than 5%).

Florescent

The florescent lamp is a low pressure mercury vapor gas discharge lamp which uses fluorescents to produce light. This new technology leads to less energy consumption in lighting and more efficiency. Though the florescent lamps have a higher investment cost compared to incandescent lamps, the lower energy cost will compensate this difference over time.

Halogen

Halogen lamps are a new generation of incandescent lamps which have a small amount of halogen added. This leads to a longer life time and helps the clarity of the lamp envelop over time.

1.3.5 Major Appliances

By viewing the trend of appliance usage from 1990 to 2009, it can be seen that Canadian households are now using more appliances at home although they are more energy efficient (see table 1.3). The usage of appliances has increased 49% for the mentioned period, but as appliances are more efficient, the energy consumption by appliances decreased by 16%. Cloth washers had the highest decrease in energy consumption of 73% followed by refrigerators which used 55% less energy in 2009 compared to 1990 (Natural Resource Canada, 2012a).

Table 1.3 : Unit energy consumption of new major electric appliances, 1990 and 2009 (kWh/yr)

(Natural Resource Canada, 2012a)

End-use	1990 (kWh/yr)	2009 (kWh/yr)
Refrigerator	956	430
Freezer	714	356
Dishwasher	277	88
Clothes washer	134	37
Clothes dryer	1,103	921
Range	772	514

Refrigeration

The refrigerator is a household technology which uses a heat pump to keep its inside space cooler than room temperature by transferring the heat from the inside to the outside of the refrigerator.

Freezing

A freezer is a technology used to keep the food in the -18 to -23°C range. The freezer might be a separate appliance or come attached to a refrigerator.

Dish-washer

The dish-washer has been used recently more often in households as it saves energy and water when compared to manual washing. Most of the energy spent in a dish washer is used for heating water. As the technology improves, less water is used to wash and this further leads to less energy consumption. It should be mentioned that if more energy efficiency is required, the dish-washer should run only when it is full. (EnergyBible, 2010b)

Cloth washer

With the improvement in technology the cloth washers are much more efficient year after year. Now cloth washers are 70% more efficient than they were in 1990 (Natural Resource Canada, 2012a).

Now we have a vast variety of washing machines that have the energy saving standards and use less water and energy. This leads to saving upwards of $110 annually on utility bills (EnergyBible, 2010c).

Washing machine types

- **Top load**

  This type of washer comes in traditional to high efficiency. Usually they don't have a lot of fancy options on them and have less efficiency when compared to other types. (Pilkington, 2013)

- **Front load**

  This type of washer has been very popular recently. They are more expensive than the top load type, but have more automatic features, and are more efficient. (Pilkington, 2013)

Dryer

Although hanging cloths out to dry is the most energy-efficient way of drying laundry, because of the climate restriction, most householders in Canada use dryers to dry their laundry (Natural Resouce Canada, 2009). This appliance's importance is increasing and the importance of the efficiency of the technology increases. In 2011 the national average of the domestic laundry was about 0.7 kWh per kg of dry cloth. In Canada most dryers have an efficiency range of +/- 7% to the average (ETSAP, 2012e).

All dryers use electricity for powering motors and controls, however to heat the air and vaporize moisture, natural gas or electricity can be used. Out of approximately 10 million dryers in Canada, 97% use electricity. The remaining 3% use natural gas. It has been estimated that dryers in Canada use about 26.4 PJ annually (Natural Resource Canada, 2012a).

Cooking

Cooker/stove are the oldest house appliances. These types of appliances are designed to provide direct heat for cooking. The energy used for this purpose could be electricity or natural gas which is the most common fuel types these days.

1.4 Energy efficiency improvement

One of the main factors preventing dramatic increase in the Canadian residential sector energy consumption is the improvement in technology including increases in the efficiency of end use technologies. The energy efficiency of the residential sector had 37%

improvement between 1990 and 2009. This has resulted in saving $8.9 billion in the residential sector in 2009 which will be $660 per household. This brings 460.6 PJ of energy saving and 22.4 Mt of GHG emissions reduction (figure 1.1) (Natural Resource Canada, 2012a).

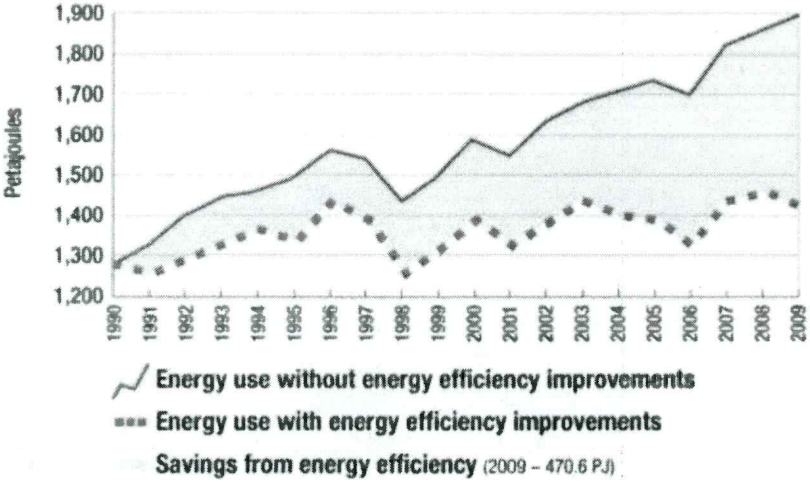

Figure 1.1: Residential energy use with and without energy efficiency improvement

(Natural Resource Canada, 2012a)

The projections also show that the energy efficiency regulations will lead to more energy-savings and also reduce emissions considerably. In table 1.4, the energy saving and the emission reduction are categorized per product types in 2010 and 2020.

Table 1.4: Estimated Impact of Energy Efficiency Regulations, 2010 and 2020

(Natural Resource Canada, 2012a)

Product	Energy saving (PJ)	Energy saving (PJ)	Co_2 reduction (Mt)	Co_2 reduction (Mt)
	2010	2020	2010	2020
Residential appliances	117.20	133.84	13.26	15.60
Refrigerators	4.92	10.96	0.49	1.10
Cloth washer domestic heater	16.20	42.67	1.29	3.61

1.5 The residential sector in Canada

Canada is one of the highest energy consumer countries in the world and consumes about 2.8% of the world's energy. Consequently it produces about 1.9 % of the carbon dioxide emissions (Government of Canada, 2011). Canadian householders represented by the residential sector, have spent $26.8 million on household energy needs in 2009 (Natural Resource Canada, 2012a). This means that among all energy consumers, the residential sector spends 16% of energy in 2009 and produced 15% of GHG emissions in Canada (see figure 1.1 and 1.2).

Based on the research done on the residential sector energy trend from 1990 to 2009 by Natural Resources of Canada, the energy consumption in the residential sector has increased by 11% and emissions have grown by 0.8% (Government of Canada, 2011). These are resulted from 22 % population growth rate, increased average living space and higher rate of appliance usage at homes. Despite the fact that technology evolution has improved the efficiency of end use technologies, total energy consumption in this section is increasing (Natural Resource Canada, 2012a).

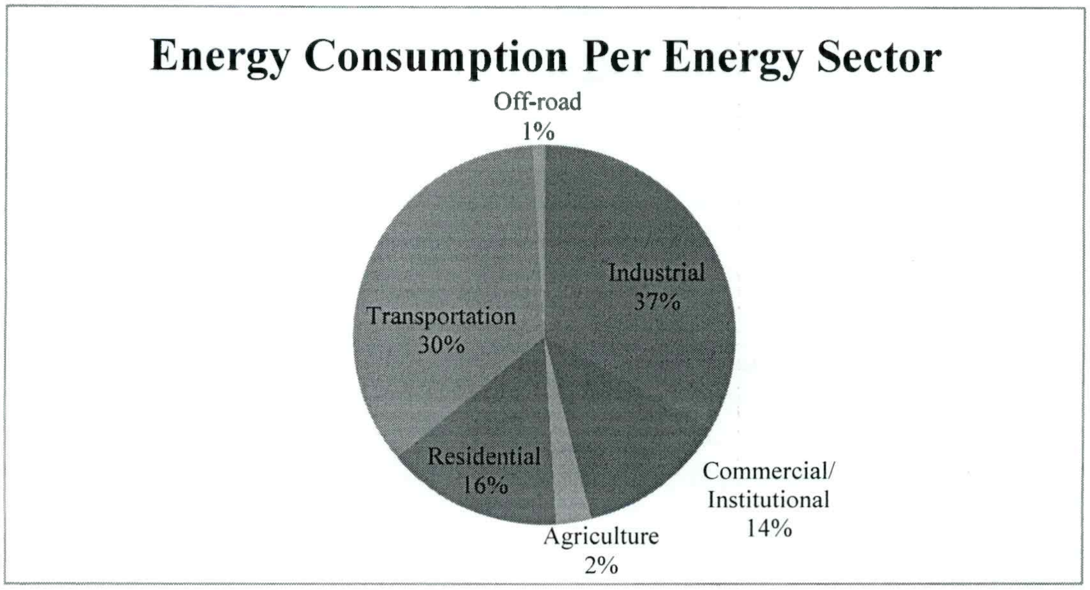

Figure 1.2: Energy consumption per sector (2009)

(Natural Resource Canada, 2012a)

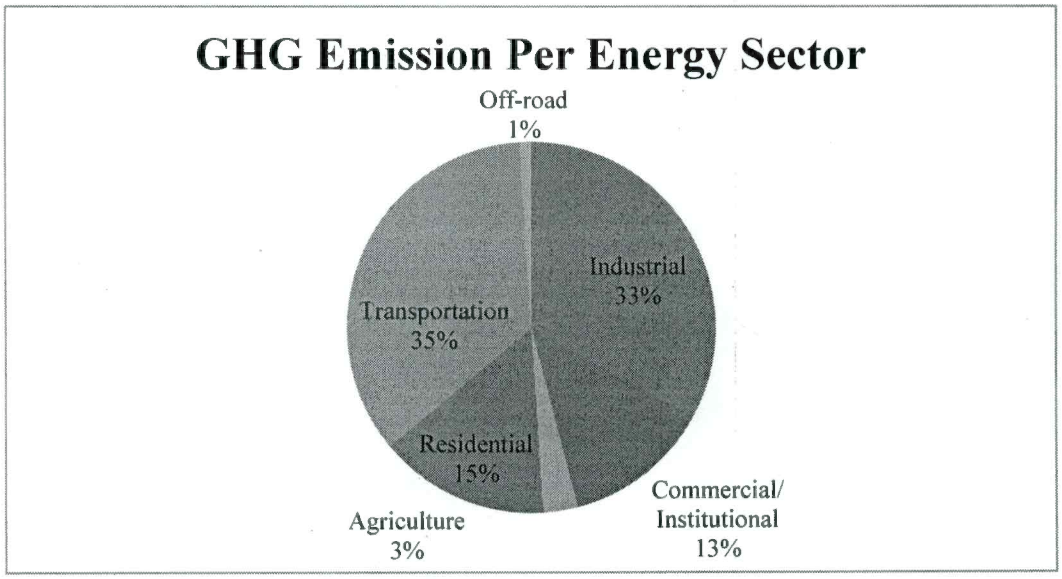

Figure 1.3: GHG emission sector per energy type (2009)

(Natural Resource Canada, 2012a)

Energy is consumed in many different activities in the residential sector including: space heating, water heating, space cooling and lighting and appliances.

In Canadian residential sector, different sources of energy are used for different activities including natural gas, electricity, wood, oil and propane. Natural gas and electricity are main sources of energy recently and oil has become less popular in new appliances. Other reasons are availability of electricity and natural gas and the higher efficiency of appliances using electricity and natural gas.

As Canada is a very cold country, 63% of the energy is primarily used for space heating and space and water heating accounts for 80% of all energy consumed in this sector (Natural Resources Canada, 2012).

1.6 Fuel type

The type of energy sources vary from region to region. But throughout the country, the share of energy used in this sector has changed throughout time. As electricity has a comparatively lower cost to other countries and natural gas is readily more available, these two energy sources have become more dominant recently. The usage of oil as an input fuel has declined by 11% from 1990 to 2009.

Table 1.5: Residential energy use by fuel type (PJ), 1990 and 2009

(Natural Resource Canada, 2012a)

Fuel Type	**Consumption in 1990 (PJ)**	**Consumption in 2009 (PJ)**
Electricity	467.4	576.9
Natural Gas	528.4	689.1
Heating Oil	186.4	63.6
Wood	78.1	106.1
Other	21.9	15.3

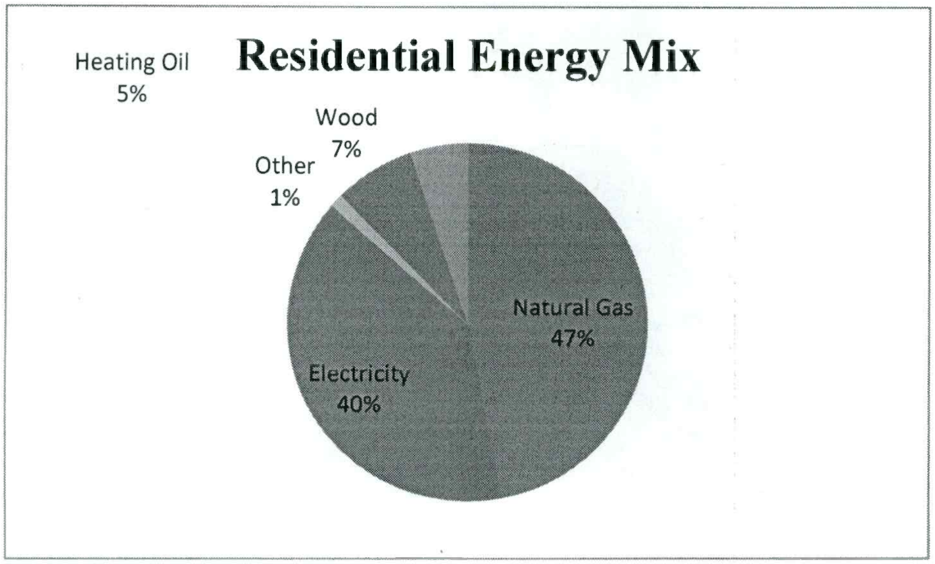

Figure 1.4: Residential energy Mix-Canada 2008

(CHBA, 2011)

2. Literature review

In this chapter there will be a brief overview on the energy modeling techniques followed by studies on residential sector energy consumption.

2.1 Energy models

There are many energy models around the world which have been classified based on many factors including the level of disaggregation, the time horizon, economic sector, etc. Choosing the right model is one of the most critical steps in energy modeling studies.

The classification which will be reviewed in this study is based on the study done by Bahn *et al* (2005) in energy modeling classification. Accordingly, there could be two classification methods. The first categorization which is considered as the main modeling approach, divides the energy models to Top-down versus Bottom-up. The second categorizing method is based on an alternative classification known as simulation versus optimization.

2.1.1 Top-down versus Bottom-up Model

The bottom-up follows the techno-economic concept which leads to a disaggregated model with great detail. This modeling approach includes explicit, detailed technologies and focuses on the energy sectors of the economy. All the technologies are defined in detail in terms of input, output, unit cost, etc. This type of model uses the "engineering approach". In this type of model, a sector is a combination of a number of technologies linked together via inputs and outputs (commodities). Examples of such models are EFOM (Van der Voort, 1982) and MARKAL (Fishbone and Abilock, 1981).

The Top-Down model is based on the macro-economic philosophy which is focusing on aggregated variables. The general equilibrium model is an example of this type in which each sector is represented by production functions. This type of model represents the whole economy by a limited number of variables and equations.

These two basic approaches are used for linking the economy and specific GHG emitting sectors to build up the energy system (Loulou *et al.*, 2005).

Table 2.1: Top-Down Model vs. Bottom-Up Model

(Beeck, 1999)

Top-Down Model	**Bottom-Up Model**
Economic approach is used	Engineering approach
Pessimistic estimate	Optimistic estimate
Does not explicitly represent technology	Allow full detail technology description
Reflect available technologies	Reflect potential technologies
Use aggregated data	Use disaggregated data
Based on observed market behavior	Independent from observed market behavior
Disregards the most efficient technologies (underestimates the potential for efficiency)	Disregards market threshold (overestimate potential for efficiency)
Determines energy demand through aggregate economic indices	Represent supply technologies in detail by using disaggregated data
Endogenizedrelationship behavior	Assess cost of technological options directly
Assumes there are no discontinuities in historical trend	Assumes interactions between energy sector and other sectors are negligible
The most efficient technologies are set by a production frontier	Efficient technologies can go beyond the frontier of the market

2.1.2 Simulation vs. Optimization

By using mathematical models, energy models could be represented in a formulized form so that computer based operations could be applied to them. In simulation models, consistent treatment as well as a techno-economic database is emphasised. There are differences between simulation and optimization models, in the sense that simulation and trend analysis models are focusing on the least probable outcomes, whereas the optimization models are designed to have the ideal outcome.

2.1.2.1 Simulation and future tendency prediction

To simulate future energy use, the prediction is based on accumulated data from the past. The level of accuracy of the prediction is based on the reliability of the database. Any energy demand is driven from a variety of energy choices made by the end-users. In order to illustrate the future demand evolution, the modellers build large and comprehensive databases which can be used in the evolving scenarios. The related methodology for forecasting future tendencies from past observation is based on the economic models which are identified by statistical methods.

2.1.2.2 Computable Economic Equilibrium Models

These types of models are focused on the energy section of the economic equilibrium. There is a distinction between *partial* and *general equilibrium* models. General equilibrium models are looking at applied conditions of the total market equilibrium while partial equilibrium models only consider specific energy sector equilibriums.

Economic equilibrium models could be computed by both top-down and bottom-up models. As an example, MARKAL-ED, which is a bottom-up energy optimization model, computes partial equilibrium for the energy market. On the other hand, the Computable

General Equilibrium (CGE) Models are top-down. It is also possible to compute the economic equilibrium by the hybrid (top-down/bottom-up) model.

The equilibrium in a given market is computed by Supply-demand equilibrium which is obtained when the demand quantity is meeting the supply. This is achieved through the optimum behavior of the economic agents, meaning that the producers try to maximize profit while consumers are maximizing their utility. This equilibrium will be discussed in detail in the following sections.

2.1.2.2.1 The Supply and Demand Curve and Supply-Demand Equilibrium

The supply curve demonstrates the quantity (Q) of goods produced by a firm with a specific price (P). In general, it is assumed that the cost of the successive unit is not decreasing and the firm stops production when marginal cost of the production is equal to the market price.

The demand curve represents the price the customers are paying for a specific quantity of a good. Accordingly, the marginal utility of the consumers are diminishing by increasing the price, so the demand curve slope is negative.

Intersection of the demand and supply represents the equilibrium price, where marginal cost and marginal benefits are equal and social benefits are maximized.

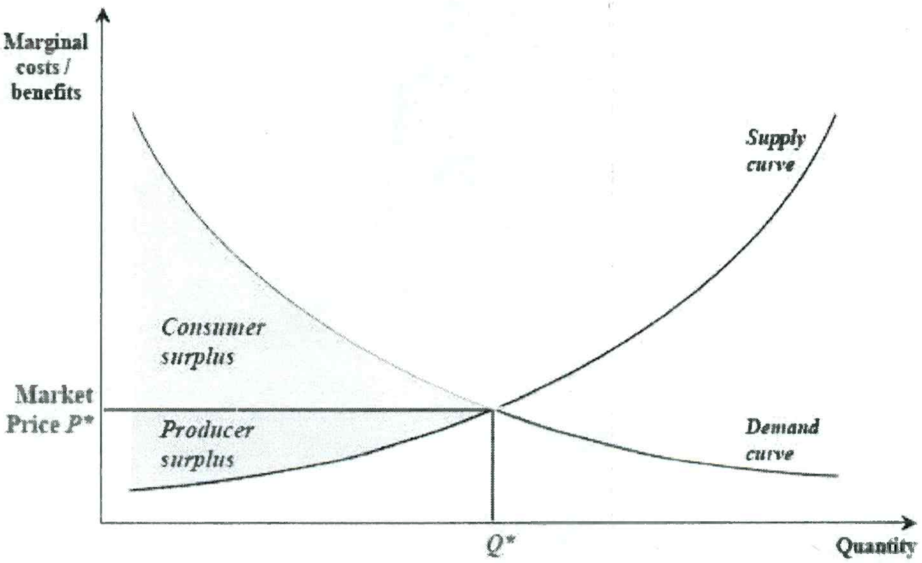

Figure 2.1: The supply - demand equilibrium

Bahn *et al* (2005)

2.2 MARKAL Model

MARKAL model is a generic model which uses the input database that contains structure and attributes of the modeled energy system and technology descriptions. The base of this model, are technologies which control emission or energy consumption. The model optimizes the energy system over a horizon of 50 to 60 years. This model can be used at a local, provincial or national level. This model type was developed over almost 20 years by ETSAP of the IEA (ETSAP, 2011).

2.3 TIMES Model at a Glance

The MARKAL family model has been contributing to energy/environment planning since 1980. TIMES (The Integration MARKAL-EFOM System) (Loulou *et al*., 2005) has been developed by improving and evolution of MARKAL (Fishbone and Abilock, 1981) and EFOM Models (Van der Voort, 1982). It is a bottom-up dynamic linear programming model which can illustrate both the supply and demand side of energy as well as the level of emission. It can provide planners with details about energy production and consuming technologies and also help understand the connection between macro-economy and energy use.

The optimization routine of the model selects energy carriers and technologies which provide the lowest-cost solution under constraint. The user defines the technology cost and technical characteristics as well as that the model matches the energy service demand and supply side technologies. By introducing a new technology which is less energy or emission intensive in TIMES, users could see the effects of this choice on the total system cost and level of GHG emission (Loulou *et al*, 2005).

2.4 Review on the studies on the residential sector energy consumption and GHG emission

Kavgic *et al.* (2010) reviewed the bottom-up building stock models for energy consumption in the residential sector. This study compares the following energy models for the residential sector:

1. Top-Down Model
2. Bottom- Up Model
    a. Approach based on Building Physics
    b. Statistical Model
    c. Hybrid models

The authors have also reviewed the UK residential stock models by focusing on the disaggregation levels, input data assumptions, uncertainty analysis, as well as the applications and transparency. The authors have also analysed and compared five bottom-up building physics stocks models based bottom-up models focusing on purpose, strength and shortcoming of the model on the UK case study. Then they identified the next generation of the coupled energy-health bottom-up models.

Lam (1996) analyzed the energy use in Hong Kong for the residential sector in his article. By gathering info for 200 types of dwellings he estimated the electricity consumption in this sector and concluded that the most electricity intensive appliances are air ventilation, lighting and refrigeration. He also concluded that over 80% of the electrical appliances are owned by households and that there is an increasing trend in the electricity consumption in entertainment and ventilation equipment.

Charlier and Risch (2012) have evaluated the impact of the environmental public policies on the residential sector energy consumption and GHG emissions for France. By mentioning that France has the target of decreasing GHG emissions up to 75% by 2050, they demonstrate that the residential sector could have a potentially significant role in achieving this target. In this article, they have put the emphasis on behavioral patterns like renovation of the dwellings.

Swan and Ugursal (2009) have reviewed modeling techniques for the residential sector end-use energy consumptions. In their study they consider the residential sector as one of the largest energy consumption sectors. According to their research, as the energy consumption characteristics have specific complications, it is essential to have a comprehensive model to assess the techno-economic impacts to adopt the technologies for efficient energy consumption and renewable energy for this sector. Based on their studies, two model types are mostly used for the residential sector energy consumption modeling: Top-Down and Bottom-Up models. For the Top-Down model the residential sector is an energy sink without looking at each end-use. The Bottom-Up models focus on household energy consumption based on the end-used energy and extrapolate that for regional and national levels. Each technique also has a different level of input information, simulation and calculation.

Kannan and Strachan (2009) have modeled the UK residential sector under long term decarbonisation scenarios using a MARKAL model. This study consists of a scenario with a GHG reduction of 60% by 2050. By using a MARKAL model and focusing on the residential sector, they have estimations on the energy end-use demand of the residential sector and CO_2 emission level. The result of his study demonstrates that this target can be achieved by decarburizing of the energy sectors and improving the efficiency of home appliances. It would also be considered useful to change consumption patterns and the types of dwellings.

Shimoda Y. *et al*, (2010) have estimated the potential for the GHG reduction in the Japanese residential sector by using a residential energy end use model. This model simulates the energy consumption in the residential sector by considering the diversity of the dwelling type in Japan. So, the energy consumption and GHG emissions have been estimated by 2025. They have also investigated the effects of the efficiency improvement of home appliances and consumer behavior of energy consumption and concluded that there is a great potential in energy demand reduction by considering the mentioned factors.

Unander F. *et al,* (2004) have studied the residential energy use for Denmark, Norway and Sweden. The study indicates that unlike Denmark and Sweden, Norway had a high level of energy consumption in the residential sector between 1944 /1973. The reason for this could be the increase of the GDP per capita for Norway. It also shows that from 1973 to 1995, Norway had a decrease in energy consumption while Sweden and Denmark's energy saving trend stopped in this period.

3. Methodology

3.1 Model

TIMES (The Integrated MARKAL-EFOM System), an economic optimization model generator is the latest version of MARKAL which has been developed in the GERAD research center under the frame-work of the Energy Technology System Analysis Program (ETSAP) under the aegis of the International Energy Agency (IEA) (Vaillancourt *et al.*, 2014). It is optimizing the energy system considering both the demand and supply sides.

In simple terms, TIMES outputs are quantitative values resulting from energy policies affecting the energy system at a local, national and multi-regional level. Though the model covers the whole energy sector, it can be used for single sub-sector as well. By using the TIMES generator as a core model, many countries have developed TIMES model adapted to their country. TIMES-Canada is the development of a TIMES model for Canada.

In this chapter, there will be a brief introduction on TIMES and its parameters; and then a glance at TIMES-Canada, the model we use in this research.

3.1.1 Basic structure of TIMES

The structure of a model is the way it approaches and analyzes the problem. In the TIMES model, the mathematical structure of the model is constant, but TIMES is a data driven model which means any change in the data structure will affect the model as well. In this way, the TIMES model will be specific for different regions considering the different attributes the data base of that region provide.

The gathered information associated with the region which could be qualitative and quantitative, defines the data base. Energy carriers as well as technologies applied in a region are examples of qualitative data. On the other hand, technological and economic parameters could be examples of quantitative data.

The TIMES model assumes a competitive market for all the commodities, and that the supply and demand equilibrium holds, and thus the model maximizes the total surplus (or minimizes the total cost).

The time horizon of the model is up to 2100 and is divided into the periods and the years. Each year is also divided into four seasons, weeks and or day/night which are called time slices.

The initial period is advised to be a single year. It is usually a past year with fixed quantities evaluated from historical values. The calibration process to the initial period is one of the most important tasks in setting TIMES Model (Loulou *et al*, 2005).

3.1.2 The RES (reference energy system) concept

The RES is a network which demonstrates the relationship among the different entities of TIMES model which consists of technology, commodities and commodity flows (see figure 3.1).

3.1.2.1 Technology (process)

Technologies (processes) are representations of devices which transform commodities from one type to another.

3.1.2.2 Commodity

A commodity can be any type of energy carrier, energy service material, monetary flow and/or emissions. In general the commodities are produced or used by the processes.

3.1.2.3 Commodity flow

A commodity flow is the link between a commodity and a technology. This link indicates the amount of the commodity coming from or ingoing to a process. In a TIMES model, a value and several attributes are attached to each flow. In figure 3.1, we show an example of commodity flows in the Reference Energy System (RES).

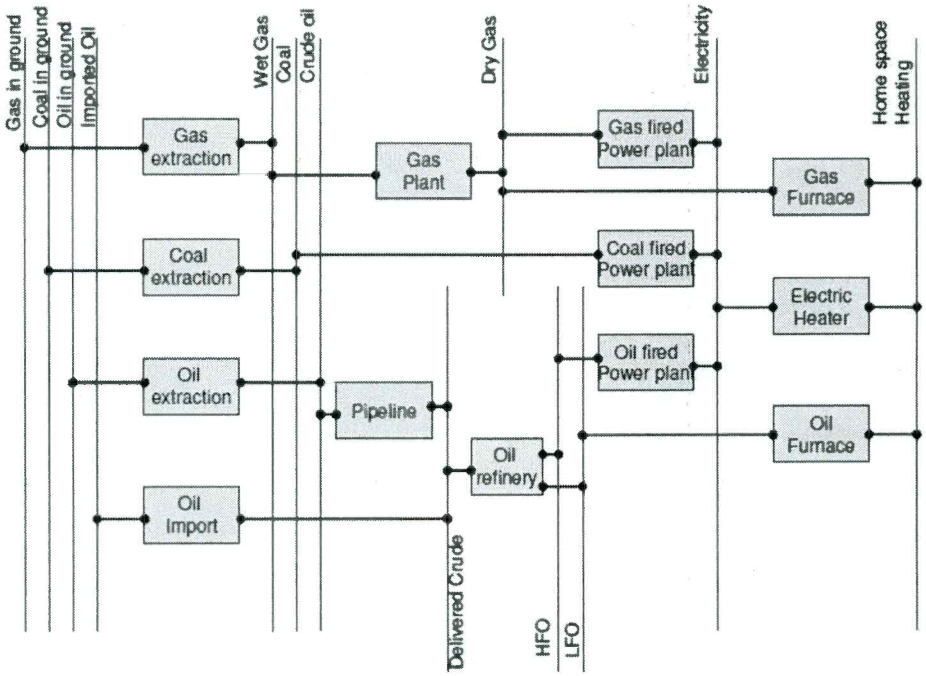

Figure 3.1: Partial view of the Reference Energy System (RES)

(Loulou *et al*, 2005)

3.1.3 Energy service demand

In a TIMES model, the demand drivers are not internal variables, but one obtained via other models or accepted sources externally (population, GDP, etc...). In the next step, after the determination and qualification of the drivers, by choosing the elasticity of demands to its drivers, the energy service demands would be computed over the horizon.

$\text{Demand} = \text{Driver}^{\text{Elasticity}}$

These demands are provided for the reference case scenario. By running the model for other scenarios, the demand will be affected and TIMES has the capability to estimate the response of demand to the new conditions.

Primary resource potential

TIMES scenario, needs to have the supply curve of energy and material primary resources.

Policy setting

The policies that affect the energy system may be part of scenario definition.

Description of set technologies

The last element that composes a scenario is the set of technical and economic parameters. In TIMES some technologies may be imposed and others would be available for a model to choose.

3.1.4 Mathematic structure of TIMES Model

As mentioned earlier, the TIMES model has an optimization formulation. That includes indices, objective function and constraints.

3.1.4.1 Indices

Equations and variables use the following indices:

r: indices of the region

t: current time period

v: vintage year of the investment

p: process

s: time slice

c: commodity (energy, material, emission, demand)

3.1.4.2 Decision Variables

Decision variables are computed through the optimization. The decision variables in a TIMES model are:

NCAP(r,v,p): new capacity addition for technology *p,* for the vintage of process *v,* in the region *r.*

CAP(r,v,t,p) : installed capacity of process *p* which includes initial residual capacity investment in region *r* in actual period *t* (optionally with vintage *v*).

CAPT(r,t,p): total capacity installed in technology *p*, which gathers all the subdivision data in region *r* in actual period *t*.

ACT(r,t,p,s): activity level of technology *p* in region *r* during actual period *t* (optionally time-slice *s*).

FLOW(r,v,t,p,c,s): the quantity of commodity *c* consumed or produced in process *p* in region *r* and period *t* (optionally time-slice *s* and vintage *v*). This variable permits to have more flexibility in technology or technology flow in TIMES.

SIN(r,v,t,p,c,s)/SOUT(r,v,t,p,c,s): the quantity of commodity *c* stocked (optionally with vintage *v*) or discharged by technology *p* in region *r* during period *t* in time-slice *s*

TRADE(r,t,p,c,s,imp)/TRADE(r,t,p,c,s,exp): the quantity of commodity *c* bought or sold by exportation(*exp*) /importation (*imp*) with technology *p* in period *t* (optionally time-slice *s*).

D(r,t,d): demand or end use energy *d* in region *r* during the actual period *t*. In the reference scenario this variable is fixed by the user.

Other commodity related variables exist in TIMES which are not strictly needed but are used mostly for reporting purposes (Loulou *et al*, 2005).

3.1.4.3 TIMES objective function

The TIMES objective is to minimize the total actualized cost of the system. This is done by transforming the surplus maximization into a cost minimization.

Each year the following elements are included in total cost (Loulou *et al*, 2005):

- Capital investment costs.
- Fixed and variable costs for annual operating and maintenance (O&M).
- Exogenous import and domestic production costs.
- Exogenous exports revenues.
- Delivery cost of the products used in the process.
- Taxes related to product flow and process activities and investments.
- Revenues from recuperation of embedded commodities.

- Salvage value of processes and embedded commodities.
- Welfare loss which is resulted from reduced end-use demands.

3.1.4.4 Constraints

Here are some of the TIMES optimization model constraints (Loulou *et al*, 2005):

- Capacity Transfer (conservation of investments).
- Definition of process activity variables.
- Use of capacity.
- Commodity Balance Equation.
- Defining flow relationships in a process.
- Limiting flow shares in flexible processes.
- Peaking Reserve Constraint (time-sliced commodities only).
- Constraints on commodities.
- User Constraints

3.1.4.5 Demand Function Definition

In each demand category a demand curve is defined as a function of price (Loulou *et al*, 2005):

$$DMi(p) = Ki * p_i^{E_i}$$

Where:

DM_i: is the ith demand

p_i: is the price taken to be marginal cost of procuring the ith commodity

E_i: is the price elasticity of demand

K_i: is a constant and is determined from a known point of the curve like (P_i^0, DM_i^0)

Note that tough times and region indices are omitted from the equation, all quantities including elasticity are time and region dependent.

We can rewrite the formula as:

$$\frac{DM_i}{DM_i^0} = \left(\frac{p_i}{p_i^0}\right)^{Ei}$$

Where

$$p_i = \left(p_i^0 * \frac{DM_i}{DM_i^0}\right)^{1/Ei}$$

When the demand is not elastic the TIMES model can be written in the following linear form:

$$Min\ cX$$

$$\text{s.t.} \quad \begin{cases} \sum_k CAP_{k,t}(t) \geq DM_i(t) \\ BX \geq b \end{cases}$$

The relation $BX \geq b$ corresponds to the constraints of the model, and where:

c: Cost vector

X: vector all the variable

i: number of demand categories

t: period of the model

CAP: variable of the end-used technology capacity

3.1.5 TIMES-Canada

TIMES-Canada is a TIMES model developed for the Canadian energy sector. It is a multi-regional model covering all provinces and regions of Canada linked together with their energy, material and emission flows.

For convenience, each of the 13 provinces and territories has been grouped in an east, west, north or center group (see table 3.1 and figure 3.2)

Table 3.1 : Canadian provinces and territories coding

Province/Territory	Code [1]	Region
Alberta	AB	West
British Colombia	BC	West
Manitoba	MB	West
New Brunswick	NB	East
Newfoundland	NL	East
Nova Scotia	NS	East
Northwest territories	NT	North
Nunavut	NU	North
Ontario	ON	Central
Prince Edward Island	PE	East
Quebec	QC	Central
Saskatchewan	SK	West
Yukon	YT	North

The Reference Energy System (RES) of TIMES-Canada is based on regions and include all 13 provinces and territories of Canada as well as the sectors including the demand and supply sides. The five demand sectors are: agriculture, commercial, industrial, residential and transportation. The supply sector is a combination of fossil fuel extraction and other types of fuel transformations such as petrol, biomass and the electricity which consist of all central electricity and heat production centers.

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[1] Correspond to the ISO (International Organization for Standardization).

Figure 3.2: Provinces and territories of Canada

(Wikipedia, 2012)

3.2 Data Base overview

The Reference Energy System (RES) of TIMES-Canada has seven sectors: five for demand side (agriculture, commercial, industrial, residential and transportation) and two in the supply side (electricity and supply). The model base year is 2007.

First of all a brief review of the Residential RES (Reference Energy System) will be given:

3.2.1 The RES (reference energy system) concept for the residential sector

As mentioned in the previous section, the RES is a demonstration of the entities relationship in the model. In this section the entities will be described specifically for the residential sector:

Technology

In this sector, technology is the end-use demand service that uses energy to provide a specific service by transforming the energy. An example of such technology could be refrigerator or heat-pump which uses electricity to reverse the natural flow of heat for cooling purposes.

Commodity

Energy is used for ignition of the technology. The type of energy is extracted from the technological process. It should be noted that in RES emissions are considered as commodities. Other examples of commodity are electricity, natural gas and oil.

Commodity flow

The link between commodity and technology is called commodity flow.

It should be mentioned that for the residential sector, similar to other sectors of TIMES-Canada, the base-year is 2007 and the time horizon is up to 2050.

3.2.2 Data Table general description

The data base table is based on technologies with different utilities and attributes in the residential sector.

Based on the residential sector glossary, all residential appliances can be categorized into the following categories: space heating, water heating, space heating, refrigeration, freezing, lighting, dish washers, cloth washers, cloth dryers, cooking and others.

In each of these categories, the most common appliances have been chosen to represent existing technologies. The major distinctions of the technologies are the type of technology, commodity–in used and its efficiency.

Some of the technologies have been repeated in space heating and water heating. These technologies have been assumed to be identical for both end-uses.

The technologies under the mentioned categories will be characterized with the following attributes found in the literature:

- Comm-IN: fuel (s) consumed by the technology
- Comm-OUT: demand (s) produced by the technology
- EFF: efficiency (the ratio of the output to input, the unit id PJ/PJ)

Based on the definition of the efficiency, the higher the value of EFF is, the more efficient the equipment. It should be mentioned that for technologies with two demand types, the efficiency is distinguished for each commodity-in. Also for those technologies which have two end-use outputs such as space heating and water cooling, or space heating and cooling, two separate efficiencies have been assigned for each end-use and showed as co-efficiency output (CEFF –O) in the table. It should also be noted that for some of the technologies the efficiency is by 1000 unit.

- START: the year in which the technology becomes available on the market (2007 for existing technologies).
- LIFE: lifetime duration in years
- INVCOST: investment costs (purchase costs) in constant Canadian dollars

Note that for the investment cost data analysis, regarding the diversity of the brand and the models, minimums and maximums have been assigned to the investment cost. The investment cost is in $/GW or $/1000 units.

- FIXOM: fix operation and maintenance costs, annually in Canadian dollars per GW or for 1000 units.
- VAROM: Variable operation and maintenance costs, annually (excluding fuel costs) in Canadian dollars per GW or for 1000 units.

It should be mentioned that to make the available data usable for the model, some data (space heating, space cooling and water heating) have been converted in form of \$/GW. For instance if the power (wattage) of a space heating system is 20kW and its price is 500\$, the heating technology will cost 25 million \$/GW. For the other end-use including lighting and appliances, they are used in 1000 units so the cost will be divided into 1000 units.

For both FIXOM and VAROM, since the costs are calculated annually, they will be in the unit of \$/GW-year or \$/k unit-year.

Based on the source of the data, the data base is grouped in three types. The first type is the group of data which have been found directly from the literature. The second type has no precise value in the literature, but has been estimated based on assumptions from the literature. The third type is data estimated using economic factors.

3.2.3 Energy Efficiency

Energy efficiency is a universal measurement factor which is used for comparing energy savings in different appliances. It should be mentioned that efficiency is measured differently for different types of technologies. The following energy efficiency types are those used in this study.

Energy Factor (EF)

The energy factor is the ratio of useful energy output from the water heater to the total amount of energy delivered to the water heater. The higher the EF is, the more efficient is the water heater (aricoplumbing). For gas-fired water heaters, the energy factor is the ratio of energy delivered to the water as compared to the total energy consumed. In Canada, the

EF is determined by the current versions of CSA P.3 and CSA P.7 test methods" (Natural Resource Canada, 2011).

Modified Energy Factors (MEF)

This efficiency unit is the combination of Energy Efficiency and the energy used for removing moisture (Bonnema, 2008). This unit is used for washing machines, dryers and dish washers.

Seasonal Energy Efficiency Ratio (SEER)

Is the efficiency rate for air conditioners or heat pumps (when used for space cooling). This unit can also be expressed in Btu/watt-hour. (Southernairnow, 2013)

Typically the SEER range is from 13 to 23. But Inventor smart source unit released up to 75 SEER (Ingram, 2013). Also there are some Mini-Split air conditioners with SEER up to 27. (Fujitsugenera, 2012)

Heating Seasonal Performance (HSPF)

Heat pumps are rated by HSPF when they have space heating functionality. A minimum HSPF rating of 8.2 is considered high-efficiency, but HSPF ratings go all the way up to 9.35 (Southernairnow, 2013).

Coefficient of Performance (COP)

Coefficient of Performance is a ratio of output energy to the input energy which is in most cases of electricity. COP is used more for heat pumps and similar heating systems with Electricity as input. Here are formulas used for converting SEER and HSPF to COP (powerknot, 2013):

$\text{COP} = \text{Output Heating}/\text{Input Electricity} = \text{HSPF} \times 0.293$

$\text{COP} = \text{EER} \times 0.293$

$\text{EER} = 1.12 \times \text{SEER} - 0.02 \times \text{SEER}^2$

Annual Fuel Utilization Efficiency Rating (AFUE)

AFUE is a measurement used for determining the efficiency of furnaces and boilers. For instance it indicates how efficient a gas furnace is in converting fuel to space heat in a typical year (Energy.gov, 2012d).

Solar Energy Factor (SEF)

This efficiency unit is used more often for collection. As a collector is usually accompanied by another energy source for nights or cloudy days, the SEF is defined by the energy delivered by the system divided by the electricity or gas energy input. The SEF ranges from 1 to 11 and the most common solar energy factors are 2 or 3 (Energy.gov, 2012b) .

In this research we have tried to unify the efficiency in the format of the Output / Input energy ratio.

It has been also assumed that in each of the technologies, the improved version had 1% growth in efficiency compared to the standard version and the advanced version had a 7 % improvement in efficiency. This assumption comes from the ratios in the world TIMES model data base in residential sector (Vaillancourt, 2010).

3.2.4 Fix O&M Cost and Variable O&M Cost

These two attributes could not be found in literature. For this reason, the data base of the world TIMES Model (Vaillancourt, 2010) has been used as a guide line. Based on this database, the higher the investment cost (capital cost), the higher the Fix O&M Cost and Variable O&M Cost. So this ratio has been calculated and used as an index.

It has been assumed that the surface of the single detached home is twice that of attached houses, attached houses are twice the size of apartments and apartments are twice the size of mobile homes. On the other hand, it has been assumed that the O&M cost have a direct relation with the surface and therefore with how much it has been used.

3.2.5 Dual demand and dual input technologies

Some of the technologies are used for more than one end-use demand. For instance heat pumps is used (if it is reversible) for both space heating and space-cooling and also for water heating. The boilers and furnaces are also used for both space heating and water heating. These are called dual demand technologies. For these types of technologies the efficiency is defined based on the type of the output and in the model it is called CEFF which is based on the output demand type.

On the other hand, some of the technologies use more than one input fuel for operating. For instance collectors use solar energy as well as another type of fuel which could be natural gas or electricity. For this type of technology efficiency is defined based on the input type.

3.2.6 Upcoming technologies

New technologies have been assumed to have the same categories as existing technologies, with the efficiency improvement available from the year of 2020. These set of technologies are selected for the most common technologies in each services, and come with at least two categories of efficiencies (standard and improved). It has been assumed that the investment cost for future technologies is identical to present technologies. It has also been assumed that the efficiency of the technologies has improved. To estimate this improvement, the government regulation for the energy star appliances has been taken into account. According to Natural Resource Canada (Natural Resource Canada, 2012b) , in 2010, refrigerators need to be at least 20% more efficient to be energy star, freezers 10%, dishwashers 17% and cloth washer at least 59%. By taking these numbers into account, it can be assumed that the standard (not energy star) home appliance will have at least met this regulation by 2020. So for projecting the efficiency of the appliances in 2020, these growth rates have been used. For the appliances for which no minimum increases have been mentioned, a 10% increase has been used.

3.2.7 World Model Data base

In some section of the data gathering process, as no accurate data could be found, similar data in the world TIMES model data base (Vaillancourt, 2010) or the ratios of the data were used. This means that for technologies with no accurate data in literature, a ratio of the existing data has been used as the estimated data values.

4. Data Base in the residential sector

The data base construction of the residential sector is an important part of this research. Some of the data was found in the literature, some data was found in customer guides or customer review web sites or even in forums about the residential sector technologies and house appliances.

It should be noted that some of required data for the attributes of appliances used in residential sector could not be found in scientific sources due to great variety. The great diversity of the brands, technology improvement, size, weight and investment cost and efficiency made this part of the research challenging. All these challenges enforced us to use many different methods and resources to build the data base. As the sources of the data are not unified and could have different perspectives for reviewing the appliance, data has been normalized as far as possible. One has tried to gather the most recent data and data has been adjusted for the reference year of 2007.

The major attributes of the appliances taken into consideration in this project are the types of technology, commodity-in, commodity-out, the efficiency, the lifetime and the investment cost of the technology.

4.1 Technology description

In this part we have a brief description of the selection of the residential sector technologies and their attributes as given in the database. This list of technologies could be bigger but we have selected those which are more commonly in use. Space heating, water heating and space cooling technologies are separated for dwellings type of attached and detached houses, apartments and mobile homes.

The technologies in each end-use type (such as space heating) are categorized based on the type of fuel they use and the technological improvement results in higher efficiency.

It has been assumed that all the attributes except for Fix O&M Cost and Variable O&M Cost is the same for all types of dwellings. The calculation of Fix O&M Cost is reviewed for some types of technology as an example and escaped for the other types in order to avoid redundancy. The Variable O&M Cost data is similar to world TIMES model (Vaillancourt, 2010) .

4.1.1 Space heating

The most energy intensive end-use demand in Canada is space heating. Here is a list of some of the technologies in use in Canada space heating:

4.1.1.1 Heat pumps

A heat pump is a device which extracts the heat from a place and transfers it to another place (Natural Resource Canada, 2009c). For countries with mild weather, heat pumps may be the best choice for heating the residential sector. However, in places with cold winters like Canada heating the outside air is very energy consuming and a backup source of heating like furnace is necessary. In such cases, as long as oil and natural gas are less expensive in comparison to electricity as a commodity, oil or gas furnaces may be a good choice for water and space heating (Furnacecompare, 2013). But the positive point in using heat pumps is that heat pumps are extremely efficient in comparison to other types of heating cooling systems, as for one unit of input they produce up to 5 thermal units of output (Sunandclimat, 2013). In Canada the attentively of the heat pump depends on the environmental factors. As it has a high performance in BC with mild climate, it is economically less attractive for cold areas like QC or AB (Natural Resource Canada, 2009c).

Heat pump types

There are many types of heat pumps based on the commodity in type. On the other hand, there are different heat pumps based on their functionality. We also have combined heat pump type in which the same device is used for space heating and cooling. We also have non-reversible heat pumps which are used only for space cooling. In this research no difference has been assumed based on the functionality types of the heat pumps.

Efficiency

Generally, heat pumps are extremely efficient compared to other space heating technologies. For one unit of input they produce up to 5 thermal units of output (Sunandclimat, 2013).

There are two methods for determining efficiency for heat pump. One is to use the term of Coefficient of Performance (COP) which is the ratio of heat movement to energy input. In normal weather of 10°C the COP of the heat pump is around 3 to 4 but as the weather gets colder the COP decreases. The COP of a geothermal heat pump is about 4 to 5.

The other efficiency unit for the heat pump is SEER and HSPF. According to literature for the reversible heat pump the heating and cooling function has different efficiency measures. A heat pump's cooling efficiency is measured by its "Seasonal Energy Efficiency Rating", or SEER which should be considered to be high in warm areas. The heating efficiency is measured by its "Heating Seasonal Performance Factor" or HSPF and should be high in cooler climate areas like Canada (Furnacecompare, 2013).

Heat pumps are very efficient heating systems in moderate weather and a good replacement of a furnace (for space heating) and air conditioners (for space cooling). The most common type of heat pumps is the electric air-source heat pump. Using this type of heat pump can reduce the heating electricity consumption by 30% to 40% comparing to to other electric heating system.

The standard heat pump efficiency should be at least SEER=12/HSPF=7.7 (see section 3.2.3 for SEER and HSPF description) to have the optimal efficiency (Energysavers, 2013). In Canadian standard regulations a HSPF of 6.7 is the lowest level accepted (Natural Resource Canada, 2009c).

According to literature, Energy Star qualified air-source heat pumps are about 20% more efficient than standard models of heat pumps (Natural Resource Canada, 2009c).

As the type of efficiency which is used in TIMES model is the ratio of the output to input, the following formula has been used to have the cooling efficiency in HSPF in COP units. It should be considered that usually the COP is used to measure the heating efficiency.

To calculate the least possible cooling efficiency which is 7.7 HSPF, the calculation would be as follows:

$COP_{\text{cooling min}} = HSPF \times 0.293 = 7.7 \times 0.293 = 2.25$

$COP_{\text{cooling max}} = HSPF \times 0.293 = 8.6 \times 0.293 = 2.51$

For the heating COP we take the minimum amount which is 3 for colder areas and the maximum amount which is 5 for areas like British Colombia.

Life

Heat pump life expectancy is 16 years in general (NAHB, 2007). Based on the information from the Natural Resource Canada publication the life time of a heat pump is from 15 to 20 years regardless of the type (Natural Resource Canada, 2009c). In the TIMES data base, a range of 15-20 years is assumed.

Investment cost

A heating/cooling heat pump could cost from $4000 to $6000 (Heatpumpsvictoria, 2013).The average heat pump power is 4700 Watt (BPS, 2013).

We would need the cost pert kW for the model. There for the cost per kW would be:

Min cost per kW = 4000$ / 4.7kW = 851.06 $/kW

(All the cost per kW are calculated similarly. Therefore it won't be repeated for other technologies.)

The results are summarized in table 4.1:

Table 4.1 : Heat Pump investment cost ($/kW)

Heat Pump	Min Cost (for $4000)	Max Cost (for $6000)
Power (14700W)	851.06 $/kW	1276.59 $/kW

Fix Operation and Maintenance Cost (FIXOM)

The ratio of the FIXOM based on the investment cost from the world TIMES model (Vaillancourt, 2010) is 4% for normal and 5% for advanced air-source heat pumps.

Standard heat pump: 851.06$/kW × 4%=34.04$/kW

Improved heat pump: 1276.59$/kW × 5%=63.82$/kW

4.1.1.2 Geothermal Heat Pumps

This type of heat pump extracts a constant heat from the earth instead of outside air, and this makes it more efficient than the air-source heat pumps. To be more accurate the efficiency of the geothermal heat pump is 300 – 600% while the air-source efficiency is 175-250% (Energy.gov, 2012c).

Efficiency

As mentioned earlier, geothermal heat-pumps are more efficient than the air-source model. According to literature, a standard heat pump uses 2 units of input for one unit of output, but the geothermal heat pump uses 1.2 units of input for a unit of output as it is 40% more efficient (Energy.gov, 2012c).

Life time

The underground parts often have often a warranty up to 25-50 years and the heat pump usually has a life time of 20 years (Energy.gov, 2012c).

Investment cost

The investment cost of a geothermal heat pump is approximately $42,000 (Greenbuildingadvisor, 2013).The input power for the Geo-thermal heat pump is 3650W on average. (Heatpumpsuppliers, 2013).Thus to run a 42000$ heat pump, it will cost 11.50 $/kW.

Fix Operations and Maintenance Cost (FIXOM)

The ratio of the FIXOM based on the investment cost from the world model is 1% for Geo-thermal heat pumps.

Geo-thermal heat pump: $42000 × 1% = $420

4.1.1.3 Exchanger (Geothermal and heat)

Considering the fact that no data could be found about the Exchanger, the attributes used in the world TIMES model (Vaillancourt, 2010) have been used as a proxy to estimate the values for this end used technology.

Regarding efficiency and lifetime, values have been used from the world TIMES model directly (Vaillancourt, 2010) and the geothermal heat pump cost has been used to estimate the attributes of this technology. This method has also been used for heating exchangers for both space heating and water heating.

4.1.1.4 Boilers

A boiler is one of the most common heating systems in Canada. A boiler is a vessel which uses oil, gas or electric resistance to heat water or produce steam and transfer the heat via water to air or water to water (Centerforenergy, 2013).

Efficiency

The minimum accepted efficiency of a boiler according to Canada's regulation is 80%-83% Annual Fuel Utilization Efficiency Rating (AFUE) for oil and gas boilers. The efficiency of the electric boiler is assumed 100% (Natural Resource Canada, 2009a). For the sample brand of Lennox, the efficiency of the gas boilers are among 81.6AFUE to 85.2 AFUE for the standard boilers and up to 90 AFUE for the energy star types (Lennox, 2013).

In this research the range of 80%-85% will be considered for non-electric boilers and 100% will be assumed for electric boilers.

Lifetime

The life time of a boiler is approximately 13 years for an electric boiler and 21 years for a gas boiler (NAHB, 2007).

Investment cost

The price of a boiler varies from $1000 to $4000 (Pexsupply, 2013) (Uswitch, 2013). The power of a boiler is 1400 W (Power, 2013). Thus, the investment cost would be 714.3 $/kW to 2857.14 $/kW and is equal to 714.3 to 2857.14 million dollars per GW.

Fix Operations and Maintenance Cost (FIXOM)

The ratio of the FIXOM based on the investment cost from the world model is 4% for boiler.

Standard Boiler: 714.3 $/kW ×4% = 28.57 $/kW

Improved Boiler: 2857.14 $/kW ×4% = 114.28$/kW

4.1.1.5 Furnace

A furnace is very popular heating system for both space heating and water hearting (Energy.gov, 2012d). A furnace uses fuel for heat creation and in this manner is different from a heat pump as the heat pump transfers the heat. .

Efficiency

AFUE (Annual Fuel Utilization Efficiency) is used for measuring the efficiency of the furnace. It calculates the ratio of the fuel spent to the heat produced. An electric furnace is assumed an AFUE of about 95% –100 %.

The furnace which uses gas as a fuel has the highest efficiency among non-electric furnaces and converts more than 90% of the fuel to heat. About 40% of households use gas furnaces in the U.S. (Lacoma, 2013). The efficiency of the furnace with natural gas as a commodity-in varies based on the technology used (Uniongas, 2013):

- High efficiency: 88-97%
- Mid efficiency: 78%-82%
- Low efficiency: less than 78%

Based on the Canadian standard there is a limitation on the minimum AFUE to the furnace (Natural Resource Canada, 2009a) .

An oil furnace is a traditional heating system. The standard energy star high efficiency oil furnace has an efficiency of more than 85%. The mid efficiency oil furnace has an efficiency of 83 -89% (Natural Resource Canada, 2010).

Investment cost

The investment cost differs based on many different factors including efficiency, capacity technology fuel type etc. Based on this, furnaces have great range of investment costs (Wright, 2013):

- Gas Furnace $1400 - $2500 (low cost of gas as commodity- in).

- Oil Furnace $2000 - $8000 (low efficiency – routine maintenance is necessary).
- Electric Furnace $1000 - $2500 (high energy cost).

The power of the furnace on average is 260W – 350 W (Power, 2013). So the price per kW are summarized in table 4.2, 4.3 and 4.4.

Table 4.2: Gas Furnace investment cost ($/kW)

Gas Furnace	Min Cost (for 1400$)	Max Cost (for 2500$)
Min Power(260W)	5384.38 $/kW	9615.38 $/kW
Max Power(350W)	4000.7 $/kW	7142.85 $/kW

Table 4.3 : Oil Furnace investment cost ($/kW)

Oil Furnace	Min Cost (for 2000$)	Max Cost (for 8000$)
Min Power (260W)	8695.23 $/kW	7403.84 $/kW
Max Power (350W)	5714.18 $/kW	22857.43 $/kW

Table 4.4 Electric Furnace investment cost ($/kW)

Electric Furnace	Min Cost (for 1000$)	Max Cost (for 2500$)
Min Power (260W)	3845.92 $/kW	9615.85 $/kW
Max Power (350W)	2857.71 $/kW	7142.85 $/kW

Lifetime

The life time of the furnace varies based on the commodity-in used for the furnace. It is generally from 15 to 20 years. To be more specific, the life time is 15 years for electric furnaces, 18 years for gas furnaces and 20 years for oil furnaces (NAHB, 2007).

4.1.1.6 Baseboards

Electric resistance is used for heat production and transfers almost 100% of the electricity to heat. But as electricity is an expensive commodity. Usually when using electricity as an input, a heat pump is a better choice as it uses 50% less electricity than electrical baseboards. This is especially true in Canada where heating is a major issue for householders. The baseboard heater is controlled by a thermostat usually in each room.

The efficiency of the baseboard heater is 100% (Energy.gov, 2012a)

The life expectancy of the baseboard heater is more than 35 years (Dagenaisinspections, 2013).

From the online shopping website of Rona Canada the price of the electrical baseboard is in the range of \$30 – \$60 on average (Calibex, 2013).

The power of the baseboard is 250W for each foot (BCREMC, 2013). Assuming that a normal baseboard is about 4 feet long (Rongey, 2013) that would be 1000W per baseboard per room. Considering a 3-bedroom 2-bathroom house as well as a living room, dining room and basement, 8 baseboards would be needed for a typical house. Assuming that a detached house is twice that of an attached house, 4 times that of apartments and 8 times that of a mobile home, 4 baseboards would be needed for a detached house 2 for apartments and 1 for the mobile home.

For a house with 8 baseboards, 8000W is used for heating. Considering the price of each baseboard to be \$30-\$60, a total price would be approximately \$240-\$480 with an investment cost of 30\$/kW – 60 \$/kW.

4.1.2 Water heating

As mentioned in the first chapter, water heating is the second energy consuming end-use demand in the Canadian residential sector. The following pages describe water heating technologies and their attributes:

4.1.2.1 Water heater Heat pump

Heat pump water heater works as an air conditioning heat pump. It can work stand alone or be combined with space heating heat pumps. Stand-alone heat-pump-water heaters extract heat from surrounding air and use it to heat the water tank (Energy.gov, 2013).

The attribute of the water heater heat pump has been assumed to be identical to that of air conditioning heat pumps.

4.1.2.2 Furnace

As the heated water of the furnace is used for domestic hot water, it is considered as one of the water-heating end-use technologies. The attributes have been assumed to be the same for both end use services of space heating and water heating.

4.1.2.3 Water storage and tank less water heater

Another type of equipment used for water heating in many Canadian households around the globe is water heaters. There are two types of water heaters, the storage tank type and the tank-less type.

The efficiency of the water heater is based on the Energy factor (EF). It is calculated based on the amount of hot water produced by consuming one unit of fuel (Energy.gov, 2012d).

4.1.2.3.1 Storage water heater

The storage water heater heats water from the municipal network or a well, warms it and stores it in the tank.

Efficiency

The efficiency of the water heaters, like all other types of water heating equipment is based on the fuel type. The least accepted efficiency for the storage gas water heater is 62% (Natural Resource Canada, 2011). Based on this information and considering the fact that generally the oil fuel heating are less efficient, it has been assumed that oil water heater are 10% less efficient which would be 52% (Geo-Exchange, 2010).

Life

The average lifetime of a water heater is 10 years for gas and 11 years for electric water heater (NAHB, 2007). It also has a minimum of 6 year of warranty (Natural Resource Canada, 2011).

Investment cost

The price of the electric water heater varies from $180 to $480. For the natural gas type the investment cost is higher and is between $500 and $1000. (Lowes, 2013). The power is 3000 W (Power, 2013)

So the investment cost is summarized in table 4.5 and 4.6:

Table 4.5 : Electric water heater investment cost ($/kW)

Electric Water Heater	Min Cost (for $180)	Max Cost (for $480)
Power(for 3000 W)	60 $/kW	160 $/kW

Table 4.6 : Natural Gas water heater investment cost ($/kW)

Natural Gas Water Heater	Min Cost (for $500)	Max Cost (for $1000)
Power (for 3000 W)	166.66 $/kW	333.33 $/kW

4.1.2.3.2 Tank-less water heater

In this technology water will be heated by passing on a water heater instantly when hot water is needed. This type of water heating systems comes in electric gas or propane fuel type.

Efficiency

The least accepted efficiency by Canadian regulation is 82%. Also it is assumed that electric water heater has 100 % efficiency.

Life

The expected life time of a tank less water heater is 20 years (consumerenergycenter, 2013).

Investment cost

The price of electric type of water heating is from $170 to $700 while the natural gas type is from $600 to $1300 (Nextag, 2013).

A tank-less water heater power for the whole house can be up to 28000 W (JEA, 2013) . The result is summarized in table 4.7 and 4.8.

Table 4.7 : Electric tank-less water heater investment cost ($/kW)

Electric tank-less water heater	Min Cost (for $170)	Max Cost (for $700)
Power (for 28000W)	6.07$/kW	25$/kW

Table 4.8 : NAG tank-less water heater investment cost ($/kW)

Natural Gas tank-less water heater	Min Cost (for $600)	Max Cost (for $1300)
Power (for 28000W)	21.42$/kW	46.42$/kW

4.1.2.4 Collector

Collector or the solar water heating system uses solar energy accompanied with another fuel type such as electricity or natural gas for heating the water. This type of water heating systems usually cost more to buy and install, but they save money and energy through time and are a greener type of equipment. (Energy.gov, 2012b)

Solar fraction (SF) is another concept which indicates the amount of water heated by the solar energy. The higher the SF the less back up energy supplement is needed. SF varies from 1 to 10 (SolarHome, 2013).

Efficiency

The efficiency of the collector calculated by SEF range from 1 to 11 but in average its value is 2-3 (Energy.gov, 2012b).

Lifetime

The average life time of a solar water heater is 20 years which is higher than average non solar water heating systems (Energystar, 2013).

Investment cost

The solar collector cost varies from $2000 to $4000 (Boone, 2013). The power output of the solar collector is from 1414W to 1926W (WATT, 2013). The result is summarized in table 4.9.

Table 4.9 : Collector investment cost ($/kW)

Collector	Min Cost (for 2000$)	Max Cost (for 4000$)
Min Power (for 1414W)	1414.42 $/kW	2828.85 $/kW
Max Power (for 1926W)	1038.42 $/kW	2076.84 $/kW

4.1.3 Space cooling

There are different types of space cooling including heat pumps, central (large unit) and room (small units) air conditioners. But in Canadian climate type, AC is the most efficient for space cooling as it has longer life time and is less expensive.

4.1.3.1 Air conditioning

Efficiency

For the room Air Conditioner (AC) to be acceptable in Canada they must exceed the government of Canada's minimum standard of energy efficiency by 10% or more. For small units, this means an EER of at least 10.7; for mid-sized, at least 10.8; and for larger models, 9.4 (Natural Resource Canada, 2013).

The efficiency of room and central AC in EER and SEER is 10.9 EER for room and 13 SEER for the central unit (Natural Resource Canada, 2013) .

For having a normalized efficiency based on output to input definition, EER and SEER efficiencies will be transformed to Coefficient of Performance (COP), which will be:

COP = EER × 0.293jc

EER= 1.12 x SEER – 0.02 × SEER^2

Therefore:

Room AC COP= 10.9×0.293 = 3.1

Central AC COP= (1.12 x SEER – 0.02 x SEER^2) × 0.293= (1.12 ×13– 0.02 ×13^2) = 3.27

Investment costs

Central AC

Central AC investment cost is from a minimum of 1400$ to maximum of 3290 $ (Wright, 2013) (Central-air-conditioner-and-refrigeration, 2013). The power is 5000 W (Wholesalesolar, 2013). The result is summarized in table 4.10.

Table 4.10 : Central AC investment cost ($/kW)

Central AC	Min Cost (for $1400)	Max Cost (for $3290)
Power (5000W)	280 $/kW	18 $/kW

Room AC

To be more practical, two popular shops in Canada have been chosen for the investment cost range; among which Canadian tire seemed to be more appropriate for a Canadian study. The result is summarized in table 4.11.

- Canadian tire: Min 110$ Max 549 $ (Canadiantire, 2013)
- Best Buy: Min 140$ Max 700$ (Consumerreports, 2013)
- The power is from 750 to 1050 W. (Power, 2013)

Table 4.11 : Room AC investment cost ($/kW)

Room AC	Min Cost (for 110$)	Max Cost (for 549$)
Min Power (for 750 W)	146.66 $/kW	732 $/kW
Max Power (for 1050 W)	104.76 $/kW	522.85 $/kW

Life time

The average life time of room air conditioner found in literature is about 10 to 15 years (NAHB, 2007) and the central air conditioner lifetime is 15 years (Natural Resource Canada, 2011).

4.1.3.2 Solar central AC with electricity back up

For the solar central AC no specific data could be found. So in this research this technology has been assumed to be identical to the standard central AC with the same attributes.

4.1.4 Lighting

Lighting is another source of energy consumption in the residential sector. The choice of a lamp depends on the shape and the technology used for the lamps. The more technology improves the more energy efficient lamps will be available in the market. There are different types of lamps in use in this sector but those more commonly in use are the General Lighting Service (GLS) which are the incandescent lamps, Halogen Lamp (HL) and the Compact Florescent Lamps (CFL). HL and CFL are more efficient type of lamps (ETSAP, 2012a). It should be noted that the FIXOM and VAROM of the lighting end-use have been assumed to be negligible.

4.1.4.1 Lamp bulb technologies

The efficiency of lamp depends on the amount of light emitted from certain amount of electricity consumed (Lumens /Watt) where lumens represent light output (NRCAn, 2009).There are many types of lamps with different technology in the residential sector market, but only those used more frequently in normal life have been presented in this study.

4.1.4.1.1 Incandescent (GLS)

The GLS lamps are the oldest and least efficient lighting technology. The efficiency of the GLS is 5-17 Lm/Watt (ETSAP, 2012a). They also have a low life time of approximately 1000 hours and by dividing it to the 8760 hours in a year the life time would be 0.11 year (ETSAP, 2012a). It should be mentioned that the average investment cost for the 60 Watt GLS is 0.5 $ (Natural Resource Canada, 2009b).

4.1.4.1.2 HL (Halogen Lamp)

The efficiency of the HL type of lighting is 10-30 Lm/Watt which is moderate in this technology (ETSAP, 2012a). The lifetime of the HL is 2000 to 8000 hr, which would be 0.2 year to 0.9 year (ETSAP, 2012a). The investment cost defined range is from 4$ to16$ (IKEA, 2013).

4.1.4.1.3 CFL

The efficiency of the CLF lamps are more than GLS and is about 35-75 Lm/Watt. For this reason, there has been an intention to replace GLS lamps with the more efficient CLFs (ETSAP, 2012a). Note that the efficiency of the CFL depends on many factors including Wattage component and configuration (ETSAP, 2012a).

The life time of incandescent lamps are 6000 to 15000 hours and by dividing it to the 8760 hours in a year the life time would be 0.68 to 1.71 year (NRCAn, 2009). The average Investment cost and for the energy star CFL is 6.99 $ (Natural Resource Canada, 2009b).

4.1.4.1.4 Kerosene Lamp

As no specific data could be used for this technology, the data used in the world TIMES model (Vaillancourt, 2010) has been used as proxy to evaluate the values for this lighting type. The efficiency of this technology has been assumed to be half of the incandescent lamp and the life to be 10 years based on the world model data. The cost has been assumed to be 20 times the incandescent light.

4.1.4.1.5 Solar Lamp

For the solar lamp no accurate data could be found. It has been assumed that the type of the lamp is florescent and the same data has been used for the solar lamp.

4.1.5 Home appliances

There are many different home appliances available in Canadian residential sector. For normalizing the efficiency in home appliances, it has been assumed that the standard electric version of the appliance has the efficiency of 1. The rest of the models have been estimated based on this assumption. In this section, some of the main appliances will be described:

4.1.5.1 Refrigeration

As there are several types of refrigerators with variety of investment costs, components and efficiencies; in this research we have chosen the average standard top mounted and improved top mounted refrigerator (ETSAP, 2012b). To choose the data from the available data base the average of the Investment cost, efficiency and life time has been taken in to account.

Efficiency

The refrigerator efficiency unit is SEER similar for the cooling systems. The efficiency for the standard refrigerator is assumed to be 1 based on the ratios from the world TIMES data base (Vaillancourt, 2010). For improved and energy star refrigerators efficiency is 6-14 SEER for Improved and 15-20 SEER for Energy star refrigerator (NREL, 2013d).To normalize the efficiency the SEER will be changed to COP:

$\mathrm{COP} = \mathrm{EER} \times 0.293$

$\mathrm{EER} = 1.12 \times \mathrm{SEER} - 0.02 \times \mathrm{SEER}^2$

Standard Refrigerator COP: Assumed to be one from World model ratios

Improved refrigerator COP: $(1.12 \times \mathrm{SEER} - 0.02 \times \mathrm{SEER}^2) \times 0.293 = 1.75 - 3.7$

Energy Star refrigerator COP: $(1.12 \times \mathrm{SEER} - 0.02 \times \mathrm{SEER}^2) \times 0.293 = 3.8 - 4.21$

It should be mentioned that among different types of refrigerator, top-freezer models are more energy efficient than side-by-side models (Natural Resource Canada, 2010).

Investment cost

The sources of the Investment cost are different including the online shopping websites. Natural Residential Efficiency Data has been chosen as the main source for the investment cost as it offers variety of efficiency and price combination. The average column of the investment cost is for standard refrigerator is from 650$ to 900$ and for the improved refrigerator is 700$ – 1000$ (NREL, 2013d).

Life

For the lifetime we have two different sources. One is the National Association of Home Builders/ Bank of America Home Equity Study of Life Expectancy of Housing Components (13 years) (NAHB, 2007) and the other is Natural Residential Efficiency Data (17.4 years) for the refrigerator (NREL, 2013d).In this research the range of 13-17.4 will be considered for the refrigerator life time.

4.1.5.2 Freezing

The two models of the freezer which will be studied in this research are chest freezer and upright model.

The chest freezers are more efficient than upright model as it losses less energy each time the door of the freezer is open. From the other perspective the manual defrost freezer is more energy efficient than automatic defrost (Natural Resource Canada, 2010).

Efficiency

The efficiency of the standard freezer is from 6 to 14 SEER and for the improved appliance the range is from 15 to 20 SEER. (NREL, 2013c). The normalized efficiency in COP will be similar refrigerator.

Investment cost

The standard investment cost range for the freezer is from \$600 – \$700 (NREL, 2013c).

Life

For the lifetime we have two different sources. In this research the value will be assumed in the range of 11-22 years (NAHB, 2007).

4.1.5.3 Dish washing

The automatic washing of the dishes is more energy and water efficient than the manual washing.

Efficiency

The efficiency of the dish washing machine is in kWh/year while the minimum of 245 kWh/year and a maximum of 345 kWh/year for the average machine (CEE, 2012).

Investment cost

For the investment cost there have been many sources including the online shopping websites, but we have used the ETSAP data source (ETSAP, 2012d) which is $359 for the standard and $362 – $420.7 for the improved dishwasher.

Standard→ 256 euro = $359

Improved→ 285 – 300 euro = $362 – $420.7

Life

The life of the dishwasher is from 9 years (NAHB, 2007) to 11 years (NREL, 2013e).

4.1.5.4 Cloth washing

We have two types of cloth washing machines, front door and top door. In this research we focus on the front door machine as they are more efficient (NREL, 2013b) .

Efficiency

The efficiency of the washing machine is measured by the Modified Energy Factor (MEF) and from the available data it has the range of 1.8 to 3 (EnergyBible, 2010). As the definition of the MEF is cloth to the ratio of the output energy to input, the efficiency values will be taken as it is which would be 1.8 for the standard appliance and 3 for the improved one. For the standard cloth washer the efficiency is assumed to be 1 based on the world model data base.

Life

The lifetime of the washing machine typically is 10 years (NAHB, 2007).

Investment cost

The investment cost of the front door washer on average of 3.6 c.f. ranges from 649$ - 1499$ (Pilkington, 2013).

4.1.5.5 Drying machine

Dryer is an appliance which has an extreme importance in a country like Canada with a climate that is not suitable for outdoor drying during long periods of the year. The dryer machine is one of the most energy consuming appliances at homes regardless of the commodity in type. But overall, the gas drying machine has faster cycles and less energy cost. The dryer type with electricity as commodity is for simple low maintenance drying process. The type which is working with gas is usually for long term investment (Crist, 2013). There is a variety of sources about drying machine, but we have focused mainly on ETSAP (ETSAP, 2012e) and National Residential Efficiency Measures Database (NREL, 2013a)

Efficiency

The efficiency unit of the dryer varies in different countries. In Canada, energy factor (lb/kWh) is a unit for efficiency and is measured as internal volume of the dryer (cubic feet) per kWh. The higher the efficiency, the more efficient is the appliance. According to ETSAP the national average energy efficiency is 0.69 (kWh/kg) (ETSAP, 2012e).

Investment cost

The investment cost for electric dryer is from 350$ to 1650$ and for the gas dryer, it is from $550 to $1750 (Crist, 2013) .

Life

The life of the dryer machine is about 13 years (NREL, 2013a).

4.1.5.6 Cooking

There are not many sources about the cooking appliance's attributes. Especially efficiency is very difficult to be found in literature. Some data could be found in ETSAP documentation about Europe and has been generalized for Canada. The appliance type is Oven (ETSAP, 2012c) .

Efficiency

As mentioned earlier, a specific direct source about the efficiency could not be found, so in this research the power rating will be taken as a proxy for the efficiency. The power rating of an oven with the commodity-in gas is 10.5 kW and for the electricity as commodity-in is 3.57kW (ETSAP, 2012c).

Investment cost

From the same source the investment cost of the average oven has been estimated for the gas oven from 160 to 1500 Euro unit 2007 which will be $230 to $2150 and for electric oven 350 -1500 Euro which will be $350 to $2150 (ETSAP, 2012c).

Life

The life time of the cooking appliance in average is around 15 to 20 (ETSAP, 2012c) .

5. Results

TIMES-Canada has been used to analyse the three mentioned scenarios in methodology (BAU, GHG1 and GHG2). In this chapter the energy demand and primary production as well as GHG emissions will be analyzed.

5.1 Scenarios characterization

In this section the scenarios will be reviewed: the baseline scenario and the climate policy scenarios with limitations on GHG emissions.

5.1.1 Baseline scenario

In the baseline scenario denoted by BAU (Business-As-Usual), no climate policy is enforced meaning that the baseline scenario has no limitation on GHG emissions.

Under this scenario end-use demands have been projected up to 2050 by using socio-economic drivers for each of the end-use services. Figure 5.1 illustrates these projections.

Figure 5.2, represents the demand for different energy carriers in Canadian provinces and territories in 2007 as the base year of the model (it should be note that for demonstrating purposes, we have categorized the Canadian provinces and territories into four areas: East, West, Center and North).

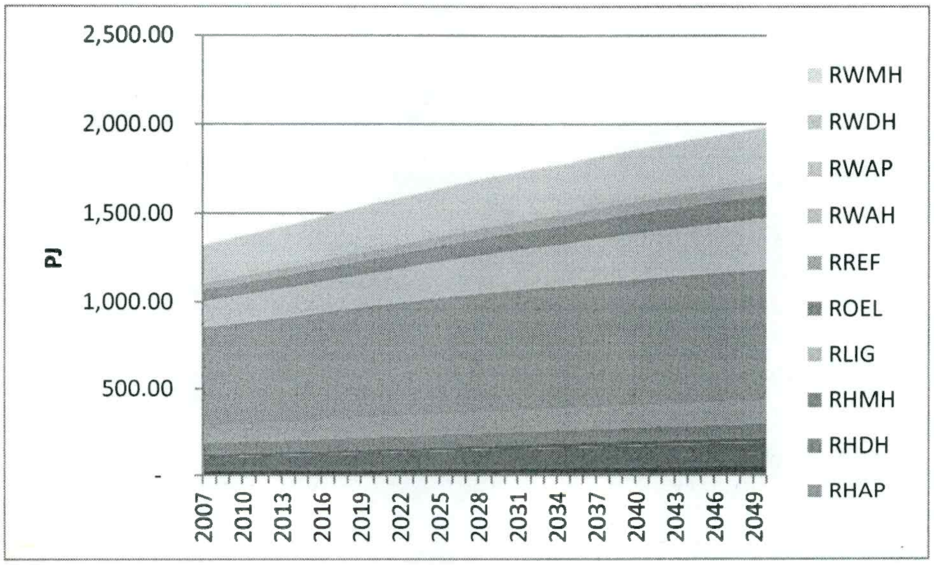

Figure 5.1 : Demand projection for energy per end-use in the BAU

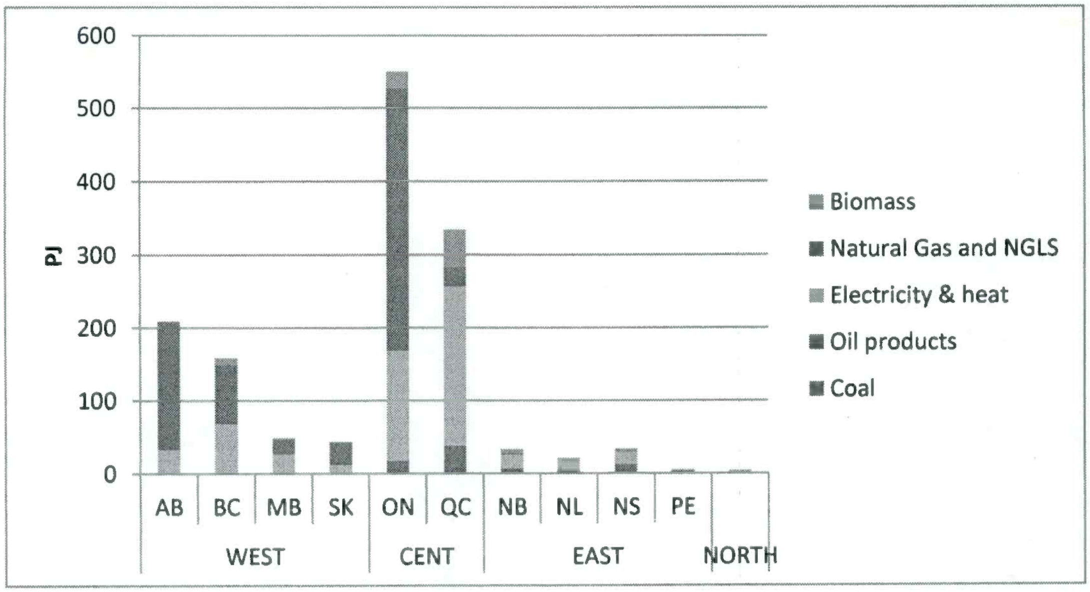

Figure 5.2 : Demand for energy in provinces and territories for the base year 2007

5.1.2 Climate Policy Scenarios

By accepting the Copenhagen accord (United Nation, 2009), Canada has a commitment to meet the reduction target of 17% below the 2005 emissions level by 2020. There is also an emission reduction commitment taken by provincial governments (Environment Canada, 2011). The climate policy in this study uses the provincial target for the provinces and imposes the federal target for the Canadian territories as there is no specific target for Canadian territories. The Climate policy scenarios extend 2020 targets up to 2050 by using a linear interpolation up to maximum of 50% restriction. This reduction target is achievable by reducing emissions in all the energy sectors including the residential sector. In particular, the penetration of renewable fuels for electricity generation could be useful to meet this target. From this point of view the two GHG reduction scenarios will be defined as follows:

GHG1: In this scenario the maximum of renewable share penetration in electricity generation grows from 10% to 25% by 2050.

GHG2: This scenario constrained the maximum renewable share to remain constant at 10% up to 2050.

5.2 Scenario analysis

In this research the TIMES Canada model has been used to analyze the three mentioned scenarios (BAU, GHG1 and GHG2). In this section, the result of this analysis will be described in form of energy production and consumption, GHG emissions and the electricity production sources as well as energy demand by technology.

5.2.1 Primary energy supply

The primary energy supply evolution for different energy sources from 2007 up to 2050 is presented in this section (figure 5.3).

The total primary energy supply has 22 % increase up to 2013 and then it decreases 19 % from 2030 to 2050.The supply mix seems similar to base year except increase in renewable supply share.

The share of fossil fuels in the energy supply is increasing 6% through the time up to 2050. Oil share increases 80% up to 2030. Later, that will decrease 29% from 2030 to 2050. So overall, there is 28% increase in the oil supply from 2007 to 2050. Gas share decrease 13% and coal supply decrease 11%up to 2050.

Uranium share has decreased in 2007-2050 by 48%. The biomass supply has increased 319% from base year to 2030, but had declined of 100% in production from 2030 to 2050. The renewable energies production increased 1551% and 463% from 2030 to 2050 and the hydro supply share has improved by 319% up to 2030 and decreased 100% by 2050.

Figure 5.4, indicates that share of fossil fuel increased 13% by 2025 and then decreased 11% up to 2050 for BAU scenario. Renewable share increased constantly up to 215% by 2050. The share of biomass has also great increase of 556% up to 2050.

For the first climate scenario GHG1, fossil fuel decreases 3% up to 2050. Renewable source and biomass source shares increase 262% and 216% respectively by 2050.

In the second climate scenario GHG2, fossil fuel share decrease 2% while renewable and biomass shares increase 216% and 557% respectively up to 2050.

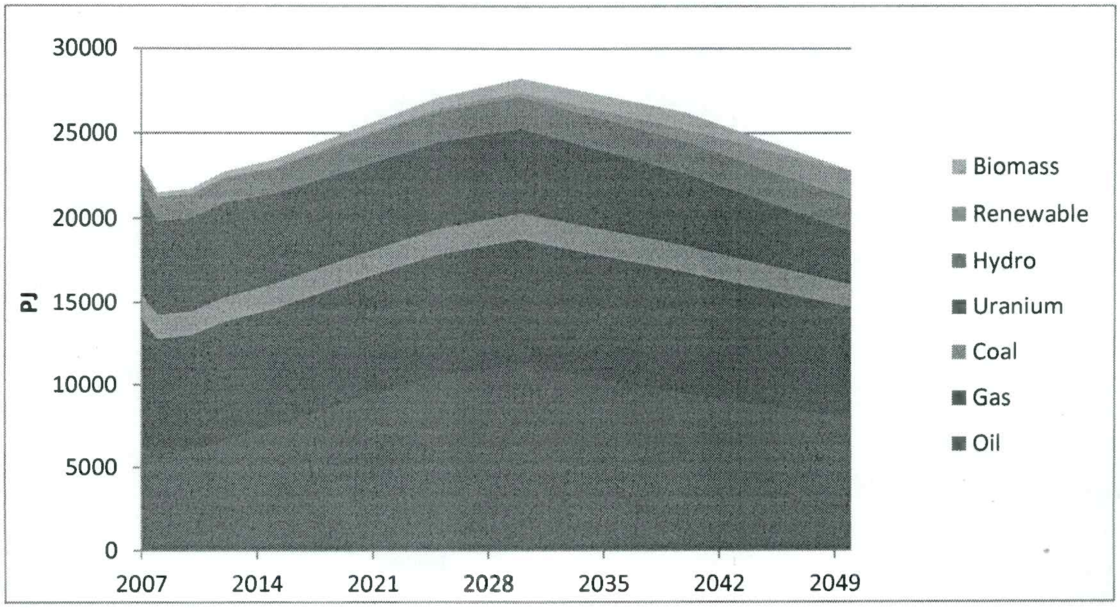

Figure 5.3 : Primary energy projection for BAU

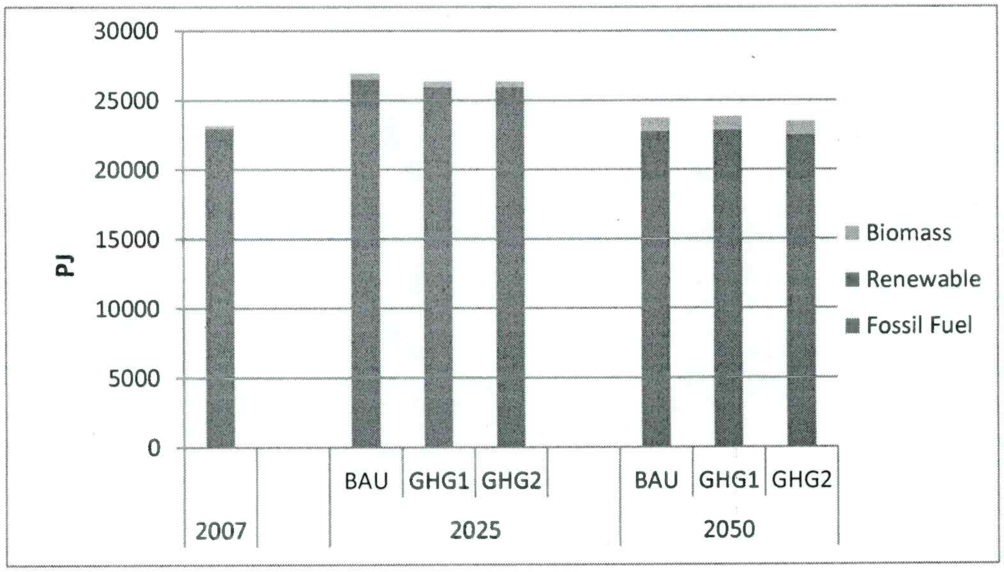

Figure 5.4 : Primary energy production per energy source type for BAU, GHG1 and GHG2

5.2.2 Final energy consumption

Generally speaking, in the BAU scenario, all type of fuel consumption have an increasing trend throughout the time horizon except for coal which a decrease from 434PJ in 2030 to 421PJ in 2040 and 371 PJ in 2050. This comes from decrease in coal consumption as heating source in the Canadian residential sector. Natural gas also has a decreasing trend from 2030 and this also is due to replacement of gas appliances with electric home appliances through the time; electricity has two slight decreases in 2008 and 2015. Oil products have also a decreasing trend from 2030 mostly due to type of technologies chosen by the model and elimination of oil appliances. It can be observed that for the BAU scenario, the share of fossil fuel including natural gas and oil product are still considerable. The natural gas share of the total final energy consumption increases 13% up to 2050. The oil product share decreases by 14% and the electricity share increases 7%. The shares of the other type of fuel are negligible which are 2% for the renewable energies and 7% for the biomass in 2050. The results shows that natural gas and electricity remains the main source of energy in the residential sector in 2050 for the BAU scenario (See figure 5.5).

Figure 5.6 compares the fuel share in our scenarios. For BAU, the biomass share increases 295% up to 2025 and has another big decrease of 607% up to 2050. The fossil fuel share (including coal, natural gas and oil), also increase 227% by 2025 but the growth rate decreased to 157% up to 2050. Electricity share is also increasing 84% up to 2050. The lower growth rate of electricity share is due to higher price of electricity in comparison of other energy carriers.

For GHG1, biomass share increases only 10% up to 2050. Share of fossil fuels has a great increase of 325% up to 2025 and 481% to 2050. Electricity share on the other hand, has a great decrease of 178% up to 2050.

In GHG2, the biomass share growth is even less than GHG1 and is only 4% up to 2050. The fossil fuel share is increasing 350% to 2025 and 485% up to 2050 which is quiet similar to GHG1. Decrease in electricity share is similar to GHG1.

The considerable growth in fossil fuel share in GHG scenarios indicates that climate polices does not lead to decrease of fossil fuel total consumption.

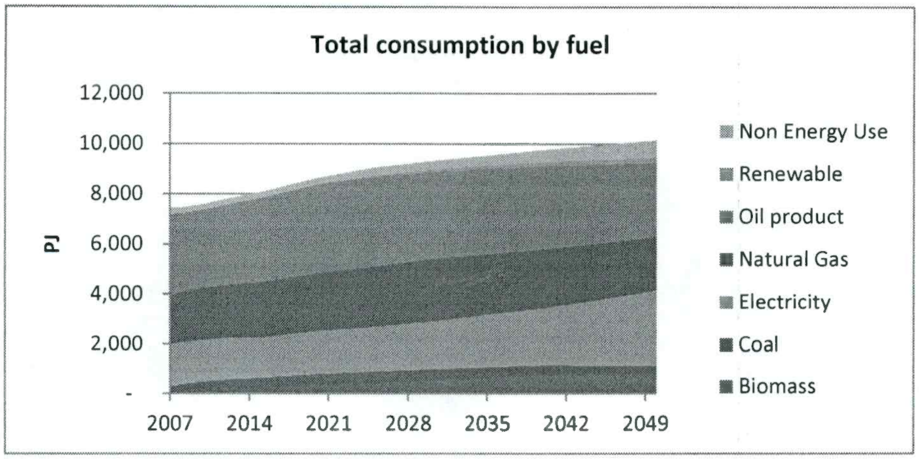

Figure 5.5 - Total energy consumption by fuel type in the BAU

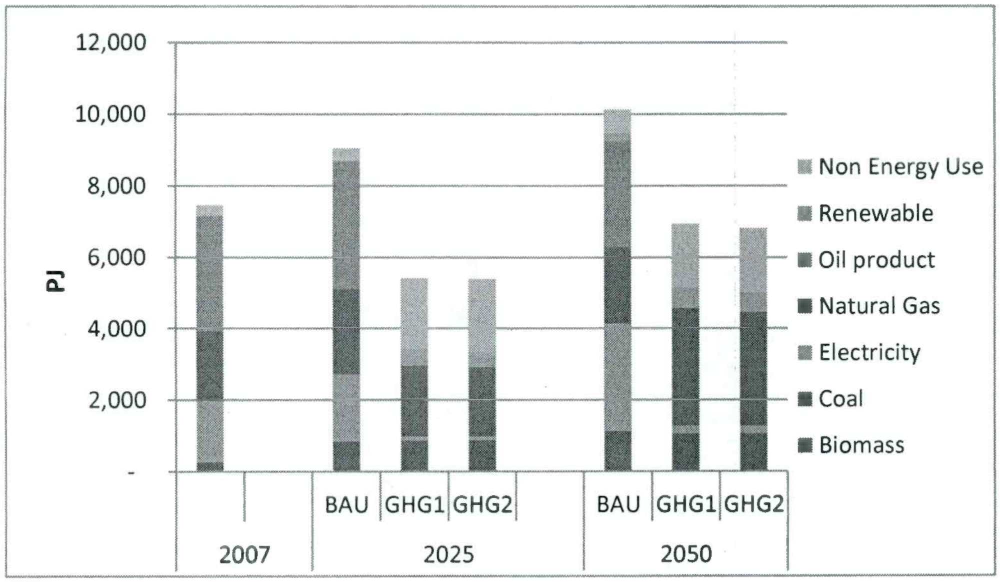

Figure 5.6 - Total energy consumption by fuel type for BAU, GHG1 and GHG2

5.2.3 Final energy consumption in the residential sector

In the BAU scenario, the trend of final energy consumption varies depending on the fuel type. Biomass consumption increases up to 136 PJ in 2012 and then starts the decreasing down to 91 PJ in 2050. In 2007, natural gas dominates the fuel used in this sector by 698 PJ, followed by electricity (556PJ). This will be changed by 2050 such that electricity will be the main source by 2050 with 984 PJ and natural gas will be the second important fuel with 360 PJ. Solar energy also increases from 2 PJ in 2008 to 23 PJ in 2050. On the other hand, oil product consumption will be reduced from 88 PJ in the base year to 62 PJ in 2050. So it can be concluded that only electricity and solar energy have a growth in the consumption trend and the other fuel types generally decline.

In both GHG scenarios, the trends seem to be identical to the BAU, but total consumption decreases by 92 PJ. This decrease affects fuels like natural gas and oil products more than electricity, biomass and solar energy. This is the result of the need to reduce GHG emissions.

It can be seen that the share of electricity has dramatically improved from 2025 to 2040 while the share of natural gas has declined. The solar energy is used more in 2050 comparatively. This result implies that the Canadian energy sector will rely more on clean energies (mostly electricity from clean sources) and less on fossil fuels. It shows also that the total consumption will decrease resulting from the use of more energy efficient appliances.

Comparing the BAU and the GHG scenarios, there will be 679 PJ less final energy consumption in GHG scenarios 45% less in transportation, 12% less in residential, 14% less in industrial, 27% less in commercial and 2% less in the agricultural sector. Note that GHG1 and GHG2 are identical in figure 5-7.

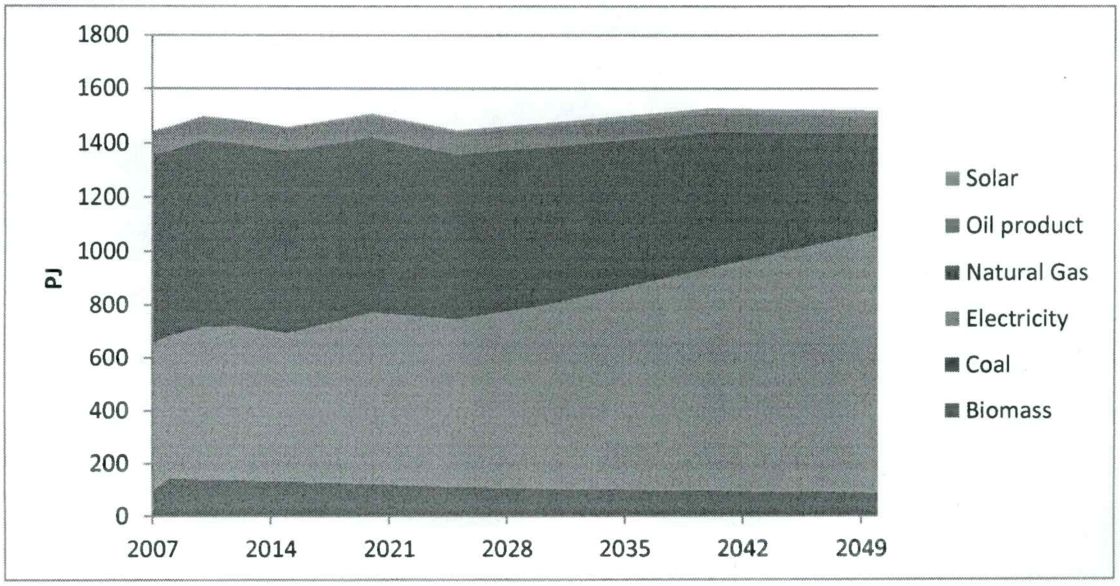

Figure 5.7 : Final residential sector energy consumption projection for BAU

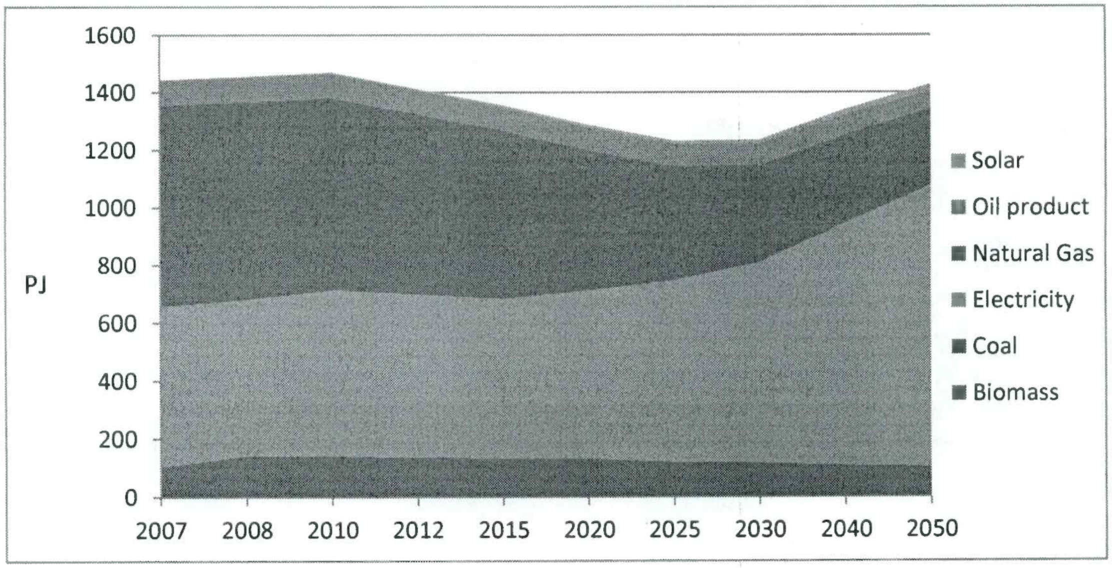

Figure 5.8 : Final residential sector energy consumption projection for the GHG scenarios

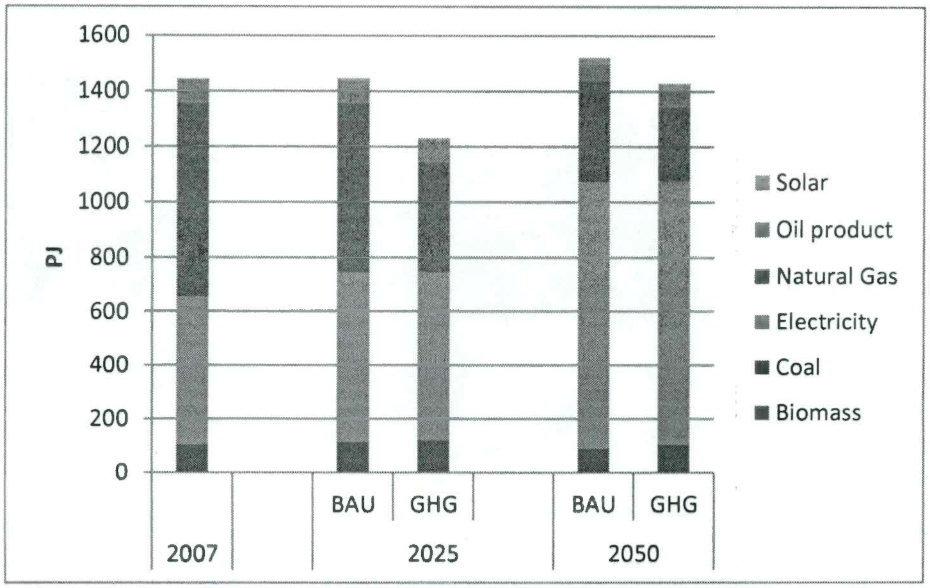

Figure 5.9 : Final energy consumption BAU and GHG scenarios

5.2.4 Electricity generation

As mentioned earlier in this chapter, the electricity share in the final consumption is increasing in all the scenarios, but the growth is higher for the GHG scenarios. The sources of the electricity generation are thermal, hydro, nuclear, biomass and renewable energies.

In the BAU scenario as there is no limitation on the use of any type of sources for the electricity production, there is a growth in the use of all sources except for thermal in which some fluctuations can been noticed. But even for thermal, the general trend is positively growing.

By comparing the three scenarios it can be seen that the renewable energy share in electricity generation has decreased in GHG2 comparing to GHG1 as in GHG2 there is a constraint on keeping the renewable share up to 10% through 2050. It also can be noticed that in GHG2, nuclear is more used by 2050 as GHG limitation should be met by replacing renewable energies with nuclear energy. But as nuclear energy is associated with troubling environmental issues (dangerous radioactive waste disposal as well as social and political problem), replacing renewable energy with nuclear energy is still controversial. Hydro is increasing in both GHG1 and GHG2 though the increase is slightly more for GHG2 due to the constraint on the renewable sources. Biomass is also increasing for both GHG scenarios compared to BAU, but slightly more for GHG2 (for similar reasons).

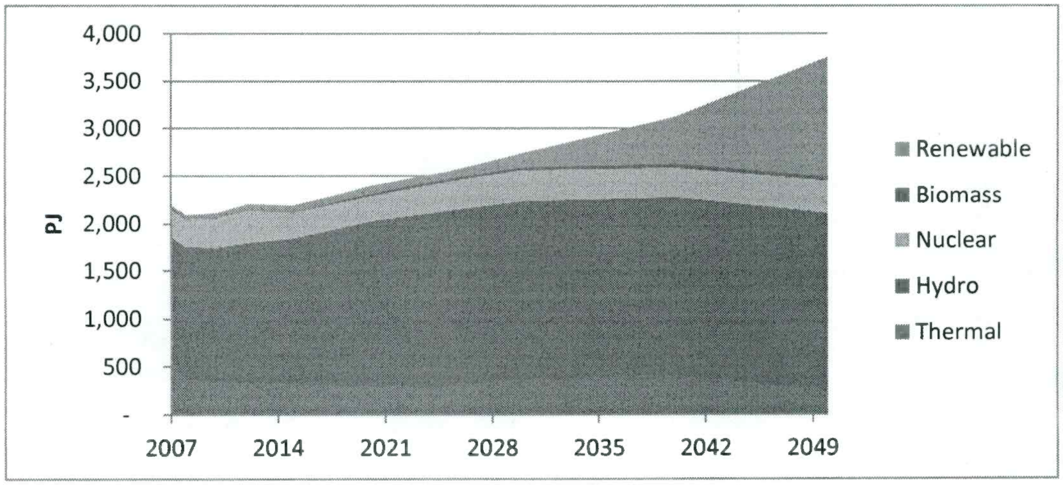

Figure 5.10 : Electricity generation by source projection in the BAU

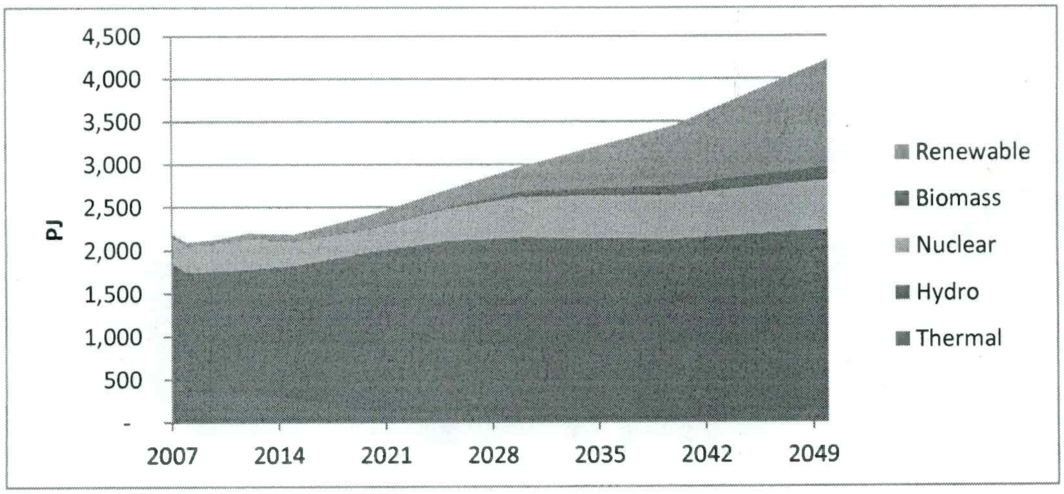

Figure 5.11 : Electricity generation by source projection in the GHG1

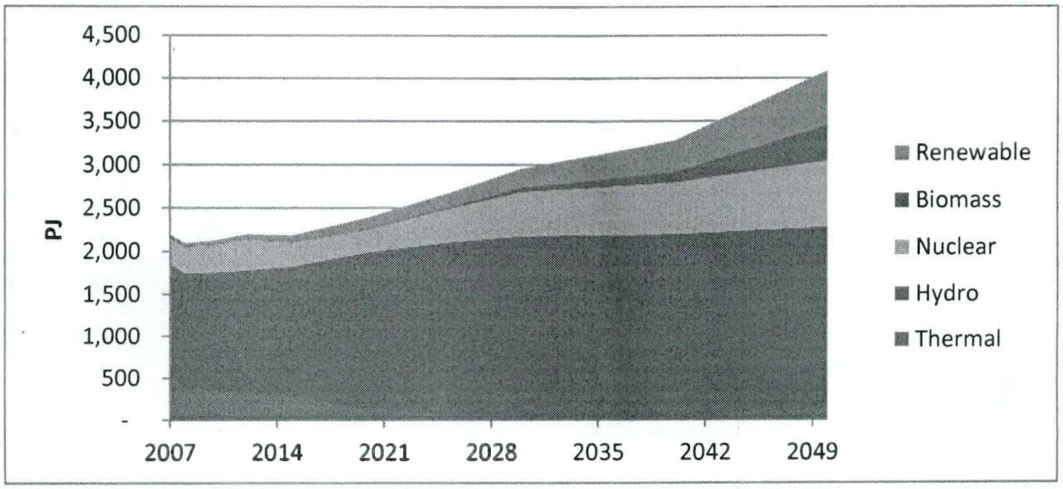

Figure 5.12 : Electricity generation by source projection in GHG2

5.2.5 GHG Emissions

In the base scenario (BAU) in which there is no constraint on GHG emissions or limitation on the renewable penetration for electricity generation, emissions reach 720 Mt in 2030 before decreasing 4.9% by 2050 (compared to 2007). In the climate scenarios, emissions are reduced to meet the imposed targets. This reduction is identical for both GHG1 and GHG2 as the limitation on GHG emissions are assumed to be similar in both climate scenarios.

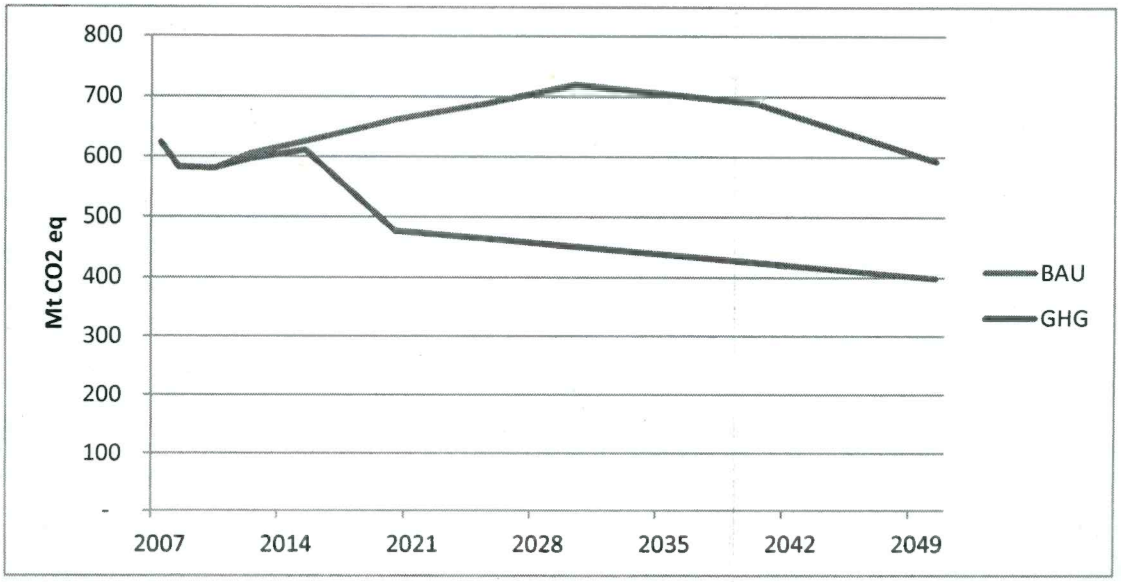

Figure 5.13 - GHG emissions in BAU and GHG scenarios

By reviewing the contribution of the residential sector in GHG emissions trend in our scenarios, it also is observed that although the emissions trend is declining in this sector, the GHG constraint results in 7 Mt less CO_2 emissions. This amount of GHG emissions reduction does not seem very considerable compared to the total emissions reduction in the global model which is 200 Mt.

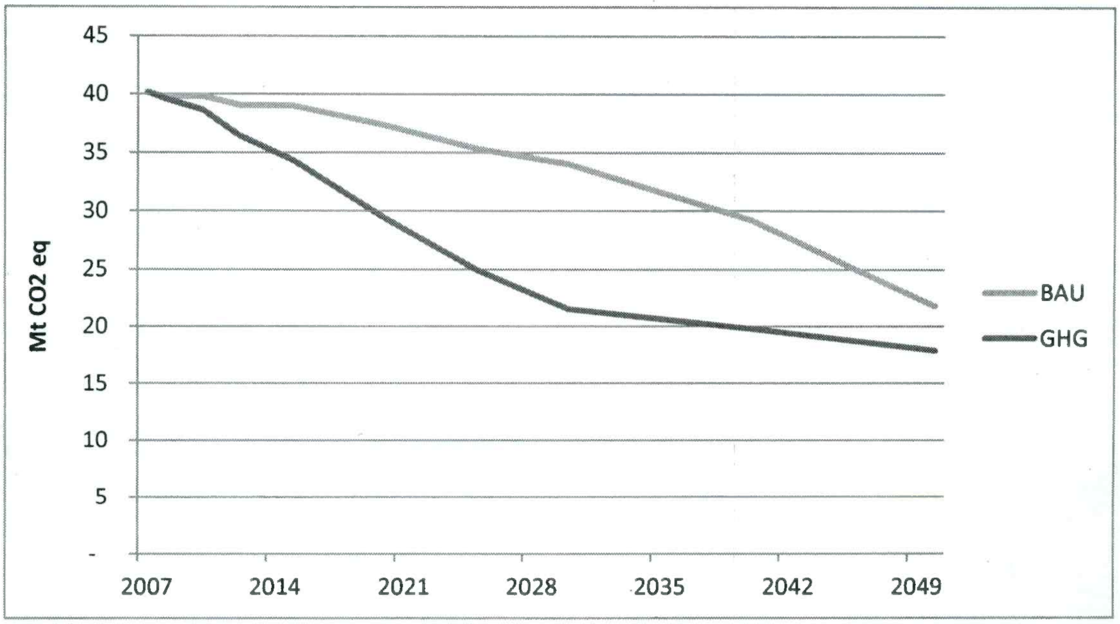

Figure 5.14 - GHG emissions in the residential sector in BAU and GHG scenarios

5.2.6 Demand for residential technologies

Not all the technologies modeled in the data base will selected by TIMES-Canada. Due to constraints imposed in the TIMES model for the optimization of the energy system and for emission reductions in, some of the end-use technologies will not be part of the optimum solution. In this section we are reviewing the energy demand in PJ for technologies available for water heating end- use and observe how TIMES-Canada have chosen them in 2050.

It can be seen that all types of technologies using electricity as commodity-in have not been selected. Increasing cost of electricity could be one of the reasons leading to this result. The exception is the tank-less water heater. This is due to efficiency improvement projection for this technology by 2015. It can also be seen that the demand is 1.1 PJ less in the GHG scenarios.

It also can be seen that among all the technologies using gas as commodity in, only the tank-less water heater will be in demand at 2050. This is the result of the efficiency improvement in this technology. The fact that natural gas produces less emissions comparing to other fossil fuels is another reason for this selection (Natural gas, 2014). The demand in BAU scenario is 0.57 PJ more than GHG1 and 0.89 PJ more than GHG2 where renewable share is constant.

None of the technologies using oil as commodity-in have been selected. This is the result of the efficiency standard improvement by 2050 and the emissions control constraint imposed in the model.

The biomass furnace is one of the technologies selected by the model due to the limited emissions of this type of commodity. The demand is 0.00016 PJ more in GHG scenario demands. It is also noted that the furnace technology is not selected for other commodity types.

The solar collector is also a selected technology by the model as its emissions are limited. The demand is constant at 0.92 PJ in all the scenarios.

The exchanger has not been selected by the model mostly due high investment cost and existing of efficient and less costly substitutions.

Table 5.1 : Demand in PJ by technology for all scenarios at 2050

			Demand (PJ) in 2050		
	Technology Term	Description	BAU	GHG1	GHG2
Electricity	RWDHCOAFURSTD08	COA.Furnace.Standard.	0.00	0.00	0.00
	RWDHELCTAKEST08	ELC.Tankless.Energy Star.	0.00	0.00	0.00
	RWDHELCBASSTD08	ELC.Baseborad.Standard.	0.00	0.00	0.00
	RWDHELCHEPSTD08	ELC.Heat Pump.Standard.	0.00	0.00	0.00
	RWDHELCHEPSTD20	ELC.Heat Pump.Standard.	0.00	0.00	0.00
	RWDHELCTAKMAX20	ELC.Tankless.Max.	84.54	83.53	83.83
GEO	RWDHGEOEXCSTD08	GEO.Exchanger.Standard.	0.00	0.00	0.00
Kerosene	RWDHKERFURSTD08	KER.Furnace.Standard.	0.00	0.00	0.00
Oil	RWDHHFOFURSTD08	HFO.Furnace.Standard.	0.00	0.00	0.00
	RWDHLFOFURSTD08	LFO.Furnace.Standard.	0.00	0.00	0.00
Gas	RWDHNGAFURSTD08	NGA.Furnace.Standard.	0.00	0.00	0.00
	RWDHNGAFURSTD20	NGA.Furnace.Standard.	0.00	0.00	0.00
	RWDHNGASTTEST08	NGA.Storage Tank.Energy Star.	0.00	0.00	0.00
	RWDHNGASTTMAX08	NGA.Storage Tank.Max.	0.00	0.00	0.00
	RWDHNGATAKEST08	NGA.Tankless.Energy Star.	0.00	0.00	0.00
	RWDHNGATAKMAX08	NGA.Tankless.Max.	89.18	88.60	88.28
	RWDHNGLFURSTD08	NGL.Furnace.Standard.	0.00	0.00	0.00
Solid Biomass	RWDHSLDFURSTD08	SLD.Furnace.Standard.	0.01	0.01	0.01
Solar	RWDHSELCCOSTD08	SOL.ELC.Collector with Backup.Standard.	0.00	0.00	0.00
	RWDHSLFCCOSTD08	SOL.LFO.Collector with Backup.Standard.	0.92	0.92	0.92
	RWDHSNGCCOSTD08	SOL.NGA.Collector with Backup.Standard.	0.00	0.00	0.00

Conclusive discussion

In this research, the energy system of the Canadian residential sector has been studied in the time horizon of 2007- 2050 by using TIMES-Canada. The data base has been built for the attributes of the residential technologies for the end services of the space heating, water heating, space cooling, lighting and appliances. This data have been gathered from the federal and provincial reports, customer reviews, product fact sheets as well as the online shopping websites. There has been a great effort to have the best possible data and to build the hypothesis and assumptions as realistic as possible.

Three different scenarios have been used in this study including the base scenario (BAU) in which the demographic changes as well as economic growths were the prominent leading factors. On the other hand, there are two GHG scenarios with limitations on the GHG emissions. But for the GHG1, the maximum penetration share of the renewable energy is from 10% to 25% in 2050. In GHG2, the maximum renewable energy share is constant at 10% through 2050.

The results of the TIMES-Canada demonstrates that using more electricity as the commodity-in for the end-use services in the residential sector rather than the fossil fuel could reduce the GHG emissions in the residential sector. Consequently, this could help meeting the emission reduction target from Copenhagen accord for Canada. In spite of the fact that the share of renewable and biomass energy sources has slightly increases in GHG scenarios, electricity and natural gas will remain the most dominant energy carriers in residential sector.

This study can be improved and continued in many aspects. Regarding the data base there are some data that has been built up by using rational assumptions in absence of reliable data in the literature. The data base could be improved by replacing assumed data by data found in other resources or by having different assumptions which could be more precise. On the other hand this study is limited to 2050 which could be extended in the future. It also can be updated by changing assumptions on energy carriers, energy price and technology definition or by adding more types of end-use technologies such as TV, computer, vacuum cleaner, microwaves, etc.

A. APPENDIX A

The data base built for this research includes all the mentioned end-use technologies and their attributes. The technologies are categorized by the commodity in and commodity out, the performance (Standard, Improved. etc.) and the vintage year. As the data base includes many details which could not be brought in this research, a sample of the home appliance technology, refrigeration, has been displayed in detail in this section.

Table A.1 Definition of RSD commodities (fuel and demand)

	Commodity Name	Commodity Description
NRG	RSDELC	Electricity (RSD)
	RSDHET	Heat (RSD)
	RSDCOA	Coal (RSD)
	RSDNGA	Natural Gas (RSD)
	RSDKER	Kerosene (RSD)
	RSDLFO	Light Fuel Oil (RSD)
	RSDHFO	Heavy Fuel Oil (RSD)

	RSDNGL	Natural Gas Liquids (RSD)
	RSDETH	Ethanol (RSD)
	RSDBSL	Biodiesel (RSD)
	RSDELG	Ethanol Lignocellulosic (RSD)
	RSDSLD	Solid Biomass (RSD)
	RSDBGS	Biogas (RSD)
	RSDGEO	Geothermal (RSD)
	RSDSOL	Solar (RSD)
DEM	RHDH	RSD.SpaceHeat.Detached Houses.
	RHAH	RSD.SpaceHeat.Attached Houses.
	RHAP	RSD.SpaceHeat.Apartments.
	RHMH	RSD.SpaceHeat.Mobile Homes.
	RWDH	RSD.WaterHeat.Detached Houses.
	RWAH	RSD.WaterHeat.Attached Houses.
	RWAP	RSD.WaterHeat.Apartments.
	RWMH	RSD.WaterHeat.Mobile Homes.
	RCDH	RSD.SpaceCool.Detached Houses.

	RCAH	RSD.SpaceCool.Attached Houses.
	RCAP	RSD.SpaceCool.Apartments.
	RCMH	RSD.SpaceCool.Mobile Homes.
	RLIG	RSD.Lighting.
	RREF	RSD.Refrigeration.
	RFRE	RSD.Freezing.
	RDWA	RSD.Dish Washing.
	RCWA	RSD.Cloth Washing.
	RCDR	RSD.Cloth Drying.
	RCOK	RSD.Cooking.
	ROEL	RSD.Other electric equipments.
NRG	RSDHH2	Hydrogen (RSD)

Table A.2 : Technology name and description of the end-use refrigeration

Sets	TechName	TechDesc	TechActUnit	TechCapUnit	Comm-IN	Comm-OUT	EFF	CEFF-O	START
I: Refrigeration									
	RREFELC510STD08	RSD.Refrigeration.All Houses.ELC.510 litres.Standard.	PJ	1000 Units	RSDELC	RREF	1.00		2008
	RREFELC510IMP08	RSD.Refrigeration.All Houses.ELC.510 litres.Improved.	PJ	1000 Units	RSDELC	RREF	2.73		2008
	RREFELC510EST08	RSD.Refrigeration.All Houses.ELC.510 litres.Energy star.	PJ	1000 Units	RSDELC	RREF	4.01		2008
	RREFELCTOPSTD08	RSD.Refrigeration.All Houses.ELC.510 litres.TopFreezer.Standard.	PJ	1000 Units	RSDELC				2008
						RREF		2.73	
						RFRE		2.73	
	RREFELCBOTSTD08	RSD.Refrigeration.All Houses.ELC.510 litres.BottomFreezer.Standard.	PJ	1000 Units	RSDELC				2008
						RREF		2.73	
						RFRE		2.73	
	RREFELCSIDSTD08	RSD.Refrigeration.All Houses.ELC.510 litres.Side by Side.Standard.	PJ	1000 Units	RSDELC				2008
						RREF		2.73	

						RFRE		2.73	
	RREFSOLCMPSTD08	RSD.Refrigeration.All Houses.SOL.134 litres.TopFreezer.Standard.	PJ	1000 Units	RSDSOL				2008
						RREF		2.73	
						RFRE		2.73	
	RREFELC510STD20	RSD.Refrigeration.All Houses.ELC.510 litres.Standard.	PJ	1000 Units	RSDELC	RREF	1.20		2020
	RREFELC510IMP20	RSD.Refrigeration.All Houses.ELC.510 litres.Improved.	PJ	1000 Units	RSDELC	RREF	3.27		2020

Table A.3 : Attributes of the end-use refrigeration I

LIFE	AF	Cap2Act	INVCOST~2008	INVCOST~2010	INVCOST~2020	INVCOST~2050	INVCOST~2100	FIXOM~2008
13	1	1	0.33	0.34	0.34	0.34	0.34	0.00
18	1	1	0.79	0.82	0.82	0.82	0.82	0.01
16	1	1	0.86	0.90	0.90	0.90	0.90	0.01
16	1	1	0.79	0.82	0.82	0.82	0.82	0.01
16	1	1	0.79	0.82	0.82	0.82	0.82	0.01

16	1	1	0.79	0.82	0.82	0.82	0.82	0.01
16	1	1	1.18	1.23	1.23	1.23	1.23	0.01
13	1	1	0.33	0.34	0.34	0.34	0.34	0.00
18	1	1	0.79	0.82	0.82	0.82	0.82	0.01

Table A.4 : Attributes of the end-use refrigeration II

FIXOM~2010	FIXOM~2020	FIXOM~2100	VAROM	Share~LO	Share~LO
0.00	0.00	0.00	0.00		
0.01	0.01	0.01	0.01		
0.01	0.01	0.01	0.01		
0.01	0.01	0.01	0.01		
				0.50	
				0.50	
0.01	0.01	0.01	0.01		
				0.50	
				0.50	
0.01	0.01	0.01	0.01		
				0.50	
				0.50	
0.01	0.01	0.01	0.01		
				0.50	
				0.50	
0.00	0.00	0.00	0.00		
0.01	0.01	0.01	0.01		

B. APPENDIX B

In this appendix we will have the detail of the results we have from TIMES-Canada model which has been described in chapter 5.

Table B.1 : **Sector fuel consumption by commodity for the residential sector**

Table Name: Sector fuel consumption_Bycomm RSD														
Active Unit: PJ														
Scenario	Commodity\Region	AB	BC	MB	NB	NL	NS	NT	NU	ON	PE	QC	SK	YT
238_Base3	RSDCOA												1.24	
238_Base3	RSDELC	32.73	67.07	26.72	19.53	12.75	16.26	0.42	0.22	150.04	0.61	217.28	10.94	0.98
238_Base3	RSDHFO				0.82		0.01							
238_Base3	RSDKER	0.03	0.10		0.03	0.08	0.16			0.83	0.08	2.17	0.34	0.31
238_Base3	RSDLFO	0.02	0.86	0.07	5.73	4.72	12.73	0.88		17.18	3.79	36.64	0.08	0.24
238_Base3	RSDNGA	174.92	80.39	19.75	0.84			0.23		351.40		26.07	29.97	
238_Base3	RSDNGL	1.17	0.89	0.33	0.25	0.27	1.03	0.25		8.71	0.20	1.06	0.30	
238_Base3	RSDSLD	0.41	9.63	2.26	6.46	3.16	3.94	0.39		22.50	0.43	51.30	0.98	
238_Base3	Total	209.28	158.93	49.12	33.66	20.99	34.12	2.16	0.22	550.66	5.12	334.52	43.84	1.54

Table B.2: Sector fuel consumption by commodity

Table Name: Sector fuel consumptionBy comm											
Active Unit: PJ											
Scenario	Commodity Set\Period	2,007	2,008	2,010	2,012	2,015	2,020	2,025	2,030	2,040	2,050
238_Base4	FUEAGR	209	207	207	216	225	236	248	263	261	258
238_Base4	FUECOM	1,563	1,597	1,642	1,715	1,794	1,964	2,202	2,374	2,750	3,060
238_Base4	FUEIND	2,002	1,939	1,905	1,916	1,948	1,992	2,092	2,196	2,399	2,612
238_Base4	FUERSD	1,444	1,462	1,502	1,493	1,472	1,523	1,472	1,500	1,556	1,563
238_Base4	FUETRA	2,245	2,258	2,336	2,464	2,638	2,919	3,039	2,989	2,803	2,648
238_Base4	Total	7,463	7,463	7,592	7,805	8,076	8,633	9,054	9,324	9,769	10,141
238_Base4_GHG1	FUEAGR	209	207	207	216	224	231	243	256	247	242
238_Base4_GHG1	FUECOM	1,563	1,590	1,626	1,684	1,757	1,956	2,136	2,312	2,637	2,874
238_Base4_GHG1	FUEIND	2,002	1,937	1,904	1,914	1,948	1,903	2,007	2,126	2,324	2,516
238_Base4_GHG1	FUERSD	1,444	1,458	1,477	1,426	1,381	1,329	1,290	1,297	1,399	1,484
238_Base4_GHG1	FUETRA	2,251	2,258	2,327	2,452	2,620	2,775	2,813	2,680	2,376	2,346
238_Base4_GHG1	Total	7,470	7,450	7,542	7,691	7,931	8,194	8,489	8,671	8,983	9,462
238_Base4_GHG2	FUEAGR	209	207	207	216	224	231	243	256	247	242
238_Base4_GHG2	FUECOM	1,563	1,590	1,626	1,684	1,758	1,941	2,139	2,304	2,585	2,860
238_Base4_GHG2	FUEIND	2,002	1,937	1,905	1,914	1,948	1,904	2,007	2,124	2,312	2,498
238_Base4_GHG2	FUERSD	1,444	1,458	1,478	1,426	1,380	1,328	1,275	1,275	1,362	1,449
238_Base4_GHG2	FUETRA	2,251	2,258	2,327	2,452	2,620	2,776	2,808	2,662	2,365	2,311
238_Base4_GHG2	Total	7,470	7,450	7,542	7,691	7,931	8,180	8,473	8,621	8,870	9,359

Table B.3: Sector fuel consumption by fuel

Table Name: Sector fuel consumption - BY FUEL											
Active Unit: PJ											
Scenario	CommoditySet\Period	2007	2008	2010	2012	2015	2020	2025	2030	2040	2050
238_Base4	FINAHT		2	4	7	13	16	26	29	29	124
238_Base4	FINBIO	106	150	221	232	246	346	418	511	717	750
238_Base4	FINCOA	145	219	252	299	351	406	427	434	421	371
238_Base4	FINELC	1,713	1,673	1,674	1,716	1,650	1,768	1,830	1,929	2,269	2,893
238_Base4	FINHET	28	25	24	23	20	16	17	19	22	23
238_Base4	FINNEU	273	225	224	231	233	239	314	338	486	668
238_Base4	FINNGA	1,943	2,043	2,068	2,090	2,200	2,292	2,388	2,478	2,333	2,143
238_Base4	FINOIL	3,255	3,125	3,120	3,203	3,357	3,537	3,570	3,491	3,324	2,955
238_Base4	FINRNW		3	4	5	7	14	64	96	168	214
238_Base4	Total	7,463	7,463	7,592	7,805	8,076	8,634	9,055	9,324	9,769	10,141
238_Base4_GHG1	FINAHT		2	7	14	26	42	59	64	60	159
238_Base4_GHG1	FINBIO	106	150	224	247	348	711	799	937	1,002	888
238_Base4_GHG1	FINCOA	145	212	232	254	285	143	130	111	165	228
238_Base4_GHG1	FINELC	1,713	1,673	1,678	1,699	1,625	1,767	1,966	2,155	2,570	3,295
238_Base4_GHG1	FINHET	28	25	24	23	19	15	16	17	19	20
238_Base4_GHG1	FINNEU	273	224	225	231	258	386	443	486	504	562
238_Base4_GHG1	FINNGA	1,943	2,035	2,035	2,016	2,106	2,005	2,018	1,992	1,927	1,792
238_Base4_GHG1	FINOIL	3,262	3,126	3,113	3,203	3,254	3,073	2,971	2,775	2,546	2,294
238_Base4_GHG1	FINRNW		4	5	6	10	52	88	134	190	225
238_Base4_GHG1	Total	7,470	7,451	7,542	7,692	7,931	8,195	8,489	8,671	8,983	9,462
238_Base4_GHG2	FINAHT		2	7	14	26	42	63	70	69	153

238_Base4_GHG2	FINBIO	106	150	224	247	348	709	798	938	1,015	901
238_Base4_GHG2	FINCOA	145	212	232	254	285	144	123	110	175	223
238_Base4_GHG2	FINELC	1,713	1,673	1,678	1,699	1,625	1,749	1,929	2,126	2,408	3,177
238_Base4_GHG2	FINHET	28	25	24	23	19	15	16	17	19	20
238_Base4_GHG2	FINNEU	273	224	225	231	262	386	443	482	501	560
238_Base4_GHG2	FINNGA	1,943	2,035	2,035	2,016	2,105	2,011	2,025	1,987	1,955	1,785
238_Base4_GHG2	FINOIL	3,262	3,126	3,113	3,202	3,251	3,072	2,987	2,775	2,536	2,314
238_Base4_GHG2	FINRNW		4	5	6	10	53	88	117	191	226
238_Base4_GHG2	Total	7,470	7,451	7,542	7,692	7,931	8,180	8,473	8,622	8,870	9,359

Table B.4 :Final consumption for the residential sector for BAU

	2007	2008	2010	2012	2015	2020	2025	2030	2040	2050
Biomass	101	141	139	136	132	123	114	107	98	91
Coal	1	1	1	1	1	0	0	0	0	0
Electricity	556	541	580	586	563	649	634	689	840	984
Natural Gas	698	688	690	677	676	648	610	587	501	360
Oil product	88	87	85	84	83	80	79	77	71	62
Solar	-	2	3	4	5	7	10	12	18	23

Table B.5:Final consumption for the residential sector for GHG

	2007	2008	2010	2012	2015	2020	2025	2030	2040	2050
Biomass	101	141	140	137	132	133	120	117	108	95
Coal	1	1	1	1	1	0	0	0	0	8
Electricity	556	540	575	562	554	581	627	695	838	975
Natural Gas	698	685	667	624	581	486	396	333	305	266
Oil product	88	87	86	84	83	80	79	77	71	61
Solar	-	2	3	4	5	8	10	13	18	23

Table B.6 : Primary production for BAU

	2007	2008	2010	2012	2015	2020	2025	2030	2040	2050
Conventional Oil	3485	2812	2879	2645	2659	3053	3298	2706	1555	850
Oil sands	2698	2804	3178	3978	4851	6077	7280	8444	7901	7071
Natural Gas	5925	5203	4704	4555	4276	4064	3309	3834	1342	1064
Unconventional Gas	1907	1973	2260	2656	2825	3145	4035	3823	6017	5723
Coal	1501	1456	1420	1461	1508	1507	1492	1518	1612	1365
Uranium	6142	5625	5600	5640	5327	5109	5066	4945	4219	3217
Hydro	1,313	1,378	1,399	1,453	1,522	1,740	1,847	1,871	1,871	1,871
Renewable	18	38	55	78	108	118	176	289	698	1,629
Biomass	191	241	248	276	363	447	599	797	995	-

Table B.7:Electricity production type

Table Name: Electricity production by type											
Active Unit: PJ											
Scenario	ProcessSet\Period	2007	2008	2010	2012	2015	2020	2025	2030	2040	2050
238_Base4	ELECOA	361	326	299	294	271	254	241	270	308	190
238_Base4	ELEGEO					2	2	2	38	38	166
238_Base4	ELEHFO	27	28	30	31	32	23	25			
238_Base4	ELEHYD	1,313	1,378	1,399	1,453	1,522	1,740	1,847	1,871	1,871	1,871
238_Base4	ELELFO	2	6	6	8	12	12	21	44	44	1
238_Base4	ELEMUN	2									
238_Base4	ELENGA	152	10	10	7	2	1	1	54	61	52
238_Base4	ELENUC	299	303	318	347	276	265	308	326	304	339
238_Base4	ELESLD	20	6				27	29	26	47	39
238_Base4	ELESOL		0	0	0	0	0	0	0		
238_Base4	ELETDL	0	0	0	0	0	0	0	0		
238_Base4	ELEWIN	17	33	47	66	74	74	71	111	447	1,095
238_Base4	Total	2,193	2,091	2,110	2,207	2,193	2,399	2,546	2,740	3,121	3,753
238_Base4_GHG1	ELEBAM										3
238_Base4_GHG1	ELECOA	361	327	303	274	240	117	60	33	11	74
238_Base4_GHG1	ELEGEO					2	15	38	38	38	117
238_Base4_GHG1	ELEHFO	27	28	30	32	32	17	15			
238_Base4_GHG1	ELEHYD	1,313	1,384	1,413	1,463	1,544	1,855	2,036	2,102	2,103	2,103
238_Base4_GHG1	ELELFO	2	3	6	9	9			7	8	
238_Base4_GHG1	ELEMUN	2									
238_Base4_GHG1	ELENGA	152	10	9	7	2		1	12	7	61

238_Base4_GHG1	ELENUC	299	303	318	347	276	265	371	473	516	579
238_Base4_GHG1	ELESLD	20	6			4	5	16	58	109	159
238_Base4_GHG1	ELESOL		0	0	0	0	0	0	0		
238_Base4_GHG1	ELETDL	0	0	0	0	0	0	0	0		
238_Base4_GHG1	ELEWIN	17	33	47	66	74	136	165	259	665	1,123
238_Base4_GHG1	Total	2,193	2,095	2,127	2,198	2,184	2,410	2,703	2,983	3,457	4,218
238_Base4_GHG2	ELEBAM										48
238_Base4_GHG2	ELECOA	361	327	303	274	240	117	60	33	11	73
238_Base4_GHG2	ELEGEO					2	15	38	38	64	178
238_Base4_GHG2	ELEHFO	27	28	30	32	32	17	15			
238_Base4_GHG2	ELEHYD	1,313	1,384	1,413	1,462	1,543	1,855	2,027	2,125	2,141	2,142
238_Base4_GHG2	ELELFO	2	3	6	9	9			7		
238_Base4_GHG2	ELEMUN	2									
238_Base4_GHG2	ELENGA	152	10	9	7	2			12	45	65
238_Base4_GHG2	ELENUC	299	303	318	347	276	265	384	513	600	772
238_Base4_GHG2	ELESLD	20	6			4	5	13	46	121	357
238_Base4_GHG2	ELESOL		0	0	0	0	0	0	0		
238_Base4_GHG2	ELETDL	0	0	0	0	0	0	0	0		
238_Base4_GHG2	ELEWIN	17	33	47	66	74	116	125	177	297	451
238_Base4_GHG2	Total	2,193	2,095	2,127	2,198	2,184	2,390	2,661	2,952	3,279	4,085

Table B.8 : Emission by sector

Table Name: Emissions_CO2N by sector											
Active Unit: Mt											
Scenario	Commodity\Period	2007	2008	2010	2012	2015	2020	2025	2030	2040	2050
238_Base4	AGRCO2N	12	12	12	12	13	13	14	14	13	13
238_Base4	COMCO2N	55	56	59	62	68	77	84	89	89	90
238_Base4	ELCCO2N	125	100	93	91	84	76	74	78	79	40
238_Base4	INDCO2N	59	69	70	71	76	86	102	114	112	121
238_Base4	RSDCO2N	40	40	40	39	39	37	35	34	29	22
238_Base4	SUPCO2N	112	87	87	98	110	123	133	150	144	121
238_Base4	TRACO2N	150	151	151	159	169	180	183	174	156	127
238_Base4	Total	554	513	511	533	559	592	625	652	623	533
238_Base4_GHG1	AGRCO2N	12	12	12	12	12	12	12	13	12	11
238_Base4_GHG1	COMCO2N	55	55	57	59	62	63	67	71	74	77
238_Base4_GHG1	ELCCO2N	125	100	94	88	78	35	19	12	5	10
238_Base4_GHG1	INDCO2N	59	68	69	71	75	57	56	57	65	65
238_Base4_GHG1	RSDCO2N	40	40	39	36	34	29	25	22	20	18
238_Base4_GHG1	SUPCO2N	112	88	90	100	113	118	127	138	137	117
238_Base4_GHG1	TRACO2N	151	151	151	158	162	154	147	128	104	86
238_Base4_GHG1	Total	554	513	512	524	538	468	454	440	416	384
238_Base4_GHG2	AGRCO2N	11.8	11.7	11.7	12.1	12.4	12.3	12.4	12.9	11.7	11.1
238_Base4_GHG2	COMCO2N	55.5	55.3	56.8	58.8	62	62.6	67.8	71.1	75.5	77.2
238_Base4_GHG2	ELCCO2N	125	99.5	94.3	88.1	78.3	34.9	19.1	11.8	6.26	10.5
238_Base4_GHG2	INDCO2N	59.5	68.2	69.4	70.9	75.5	57.1	55.5	58.7	66.6	66.1
238_Base4_GHG2	RSDCO2N	40.2	39.6	38.6	36.4	34.3	29.4	24.9	21.3	19.5	17.9

238_Base4_GHG2	SUPCO2N	112	87.7	90.2	100	113	118	128	138	137	117
238_Base4_GHG2	TRACO2N	151	151	151	158	162	154	147	127	102	84.8
238_Base4_GHG2	Total	554	513	512	524	538	469	455	440	419	385

Table B.9 :Energy Demand reduction

Table Name: Demands											
Active Unit:											
Scenario	Commodity\Period	2007	2008	2010	2012	2015	2020	2025	2030	2040	2050
238_Base4	RCAH	4	4	4	4	5	5	6	7	9	10
238_Base4	RCAP	4	4	4	4	4	4	5	5	6	7
238_Base4	RCDH	18	18	19	20	20	22	25	27	31	35
238_Base4	RCDR	40	41	42	44	46	50	54	59	69	77
238_Base4	RCMH	0	0	0	0	0	0	0	0	0	0
238_Base4	RCOK	39	39	40	41	43	46	47	49	52	54
238_Base4	RCWA	2	2	3	3	3	3	3	4	4	5
238_Base4	RDWA	2	3	3	3	3	3	3	4	4	5
238_Base4	RFRE	12	13	13	14	14	15	17	18	21	24
238_Base4	RHAH	64	65	66	67	69	72	75	78	81	85
238_Base4	RHAP	104	105	107	109	112	117	121	124	130	135
238_Base4	RHDH	547	552	563	575	593	622	647	667	700	729
238_Base4	RHMH	16	16	17	17	18	19	20	20	21	22
238_Base4	RLIG	152	154	159	165	173	188	208	226	259	289
238_Base4	ROEL	66	67	70	72	75	82	89	97	113	127
238_Base4	RREF	39	40	41	42	44	48	52	57	67	75

238_Base4	RWAH		24	25	25	26	27	29	30	31	32	34
238_Base4	RWAP		56	58	58	60	62	67	69	71	74	77
238_Base4	RWDH		132	138	140	142	148	160	166	171	180	188
238_Base4	RWMH		4	5	5	5	5	6	6	6	6	7
238_Base4_GHG1	RCAH		4	4	4	4	5	5	6	7	9	10
238_Base4_GHG1	RCAP		4	4	4	4	4	4	5	5	6	7
238_Base4_GHG1	RCDH		18	18	19	20	20	22	25	27	31	35
238_Base4_GHG1	RCDR		40	41	42	44	46	50	54	59	69	77
238_Base4_GHG1	RCMH		0	0	0	0	0	0	0	0	0	0
238_Base4_GHG1	RCOK		39	39	40	41	43	46	47	49	51	54
238_Base4_GHG1	RCWA		2	2	3	3	3	3	3	4	4	5
238_Base4_GHG1	RDWA		2	3	3	3	3	3	3	4	4	5
238_Base4_GHG1	RFRE		12	13	13	14	14	15	17	18	21	24
238_Base4_GHG1	RHAH		64	65	66	67	69	72	75	78	81	84
238_Base4_GHG1	RHAP		104	105	107	109	112	117	121	124	130	135
238_Base4_GHG1	RHDH		547	552	563	575	593	622	647	667	700	725
238_Base4_GHG1	RHMH		16	16	17	17	18	19	20	21	21	22
238_Base4_GHG1	RLIG		152	154	159	165	172	188	208	226	259	289
238_Base4_GHG1	ROEL		66	67	70	72	75	82	89	97	113	127
238_Base4_GHG1	RREF		39	40	41	42	44	48	52	57	67	75
238_Base4_GHG1	RWAH		24	25	25	26	27	29	30	30	32	33
238_Base4_GHG1	RWAP		56	58	58	60	62	66	68	70	74	77
238_Base4_GHG1	RWDH		132	138	140	142	148	159	164	169	178	187
238_Base4_GHG1	RWMH		4	5	5	5	5	6	6	6	6	7
238_Base4_GHG2	RCAH		4	4	4	4	5	5	6	7	9	10
238_Base4_GHG2	RCAP		4	4	4	4	4	4	5	5	6	7

238_Base4_GHG2	RCDH		18	18	19	20	20	22	25	27	31	35
238_Base4_GHG2	RCDR		40	41	42	44	46	50	54	59	69	77
238_Base4_GHG2	RCMH		0	0	0	0	0	0	0	0	0	0
238_Base4_GHG2	RCOK		39	39	40	41	43	46	47	49	51	54
238_Base4_GHG2	RCWA		2	2	3	3	3	3	3	4	4	5
238_Base4_GHG2	RDWA		2	3	3	3	3	3	3	4	4	5
238_Base4_GHG2	RFRE		12	13	13	14	14	15	17	18	21	24
238_Base4_GHG2	RHAH		64	65	66	67	69	72	75	78	81	84
238_Base4_GHG2	RHAP		104	105	107	109	112	117	121	124	130	134
238_Base4_GHG2	RHDH		547	552	563	575	593	622	647	667	698	725
238_Base4_GHG2	RHMH		16	16	17	17	18	19	20	21	21	22
238_Base4_GHG2	RLIG		152	154	159	165	172	188	208	226	258	288
238_Base4_GHG2	ROEL		66	67	70	72	75	82	89	97	113	127
238_Base4_GHG2	RREF		39	40	41	42	44	48	52	57	66	75
238_Base4_GHG2	RWAH		24	25	25	26	27	29	30	30	32	33
238_Base4_GHG2	RWAP		56	58	58	60	62	66	68	70	73	77
238_Base4_GHG2	RWDH		132	138	140	142	148	159	164	169	178	186
238_Base4_GHG2	RWMH		4	5	5	5	5	6	6	6	6	7

Table B.10 : Energy demand

Table Name: Demands												
Active Unit:												
Scenario	Commodity	Process\Period	2007	2008	2010	2012	2015	2020	2025	2030	2040	2050
238_Base4	RCAH	RCAHELCCENSTD	3.29	3.02	2.47	1.92	1.10					
238_Base4	RCAH	RCAHELCCENSTD08		1.82E-03	8.59E-03	0.53	1.77	1.77	1.41	-5.44E-07		
238_Base4	RCAH	RCAHELCCENSTD20						1.87	2.85	5.15	5.13	4.49
238_Base4	RCAH	RCAHELCHENIMP08		8.53E-08								
238_Base4	RCAH	RCAHELCHENSTD08		2.54E-06	-1.69E-07		6.35E-07	6.35E-07	1.22E-07	5.93E-07		
238_Base4	RCAH	RCAHELCHENSTD20						6.70E-07	6.70E-07	6.70E-07	2.59E-06	
238_Base4	RCAH	RCAHELCROMSTD	0.73	0.77	0.63	0.49	0.28					
238_Base4	RCAH	RCAHNGAHENSTD08			2.56E-07			7.74E-07		1.35E-06	0.10	0.29
238_Base4	RCAH	RHAHELCCHPSTD08			2.24E-07	3.84E-07						
238_Base4	RCAH	RHAHELCHEPSTD	0.11	0.21	0.92	1.14	0.97	0.58	0.17			
238_Base4	RCAH	RHAHNGACHPSTD08		0.18	0.30	0.39	0.53	0.81	1.15	2.25	3.98	5.13
238_Base4	RCAH	RHAHNGLCHPSTD08		2.13E-04	3.03E-04	3.92E-04	5.35E-04	7.96E-04	1.10E-03	8.71E-03	1.96E-02	3.29E-02
238_Base4	RCAP	RCAPELCCENSTD	2.84	2.60	2.13	1.66	0.95					
238_Base4	RCAP	RCAPELCCENSTD08		5.98E-03	0.29	0.99	1.99	1.98	1.31		-3.15E-07	
238_Base4	RCAP	RCAPELCCENSTD20						1.45	2.53	4.05	4.13	4.02
238_Base4	RCAP	RCAPELCHENSTD08		-6.55E-07	2.80E-07		4.63E-06	1.25E-06	2.43E-07	-3.46E-07		
238_Base4	RCAP	RCAPELCHENSTD20							1.30E-06	1.61E-06	2.88E-06	
238_Base4	RCAP	RCAPELCROMSTD	0.66	0.67	0.55	0.43	0.24					
238_Base4	RCAP	RCAPELCWALSTD08					-5.09E-07				1.66E-07	
238_Base4	RCAP	RCAPNGAHENSTD08		2.18E-07	2.98E-07	1.15E-06	2.74E-02	5.53E-02	7.10E-02	9.44E-02	0.25	0.43
238_Base4	RCAP	RCAPSELCENSTD08				6.05E-07						

238_Base4	RCAP	RHAPELCCHPSTD08		9.95E-08								
238_Base4	RCAP	RHAPELCHEPSTD	7.22E-02	0.34	0.59	0.54	0.45	0.30	8.91E-02			
238_Base4	RCAP	RHAPNGACHPSTD08			0.18	0.26	0.35	0.54	0.78	1.04	1.66	2.38
238_Base4	RCAP	RHAPNGLCHPSTD08		4.29E-04	9.08E-03	1.94E-02	3.36E-02	0.06	0.10	0.14	0.14	0.14
238_Base4	RCDH	RCDHELCCENSTD	14.62	13.40	10.96	8.53	4.87					
238_Base4	RCDH	RCDHELCCENSTD08		5.14E-06	3.48E-06	0.13	0.58	0.58	0.55	9.89E-02		
238_Base4	RCDH	RCDHELCCENSTD20						9.51	15.69	20.22	20.76	21.13
238_Base4	RCDH	RCDHELCHENSTD08		2.56E-07			1.91E-06					
238_Base4	RCDH	RCDHELCROMSTD	2.34	3.14	2.57	2.00	1.14					
238_Base4	RCDH	RCDHELCWALSTD08			6.71E-07	2.48E-06	3.11E-06	1.58E-06			3.03E-07	
238_Base4	RCDH	RCDHNGAHENSTD08		5.59E-07	5.59E-07	5.59E-07	5.59E-07	5.59E-07	0.23	0.35	0.74	0.27
238_Base4	RCDH	RHDHELCCHPSTD08				4.81E-07						
238_Base4	RCDH	RHDHELCHEPSTD	1.08	1.64	5.22	8.63	11.59	8.72	3.41			
238_Base4	RCDH	RHDHNGACHPSTD08				0.13	2.00	3.04	4.38	5.88	9.35	13.39
238_Base4	RCDH	RHDHNGLCHPSTD08		0.10	0.12	0.14	0.18	0.23	0.42	0.51	0.58	0.66
238_Base4	RCDR	RCDRELCCDRIMP	12.34	11.32	9.26	7.20	4.11					
238_Base4	RCDR	RCDRELCCDRIMP08		4.03	11.65	19.16	30.17	28.67	12.25			
238_Base4	RCDR	RCDRELCCDRIMP20						17.49	38.12	55.36	64.84	73.65
238_Base4	RCDR	RCDRELCCDRSTD	24.00	22.00	18.00	14.00	8.00					
238_Base4	RCDR	RCDRNGACDRSTD	3.74	3.42	2.80	2.18	1.25					
238_Base4	RCDR	RCDRNGACDRSTD08		2.21E-04	0.43	1.11	2.09	2.09	1.10			
238_Base4	RCDR	RCDRNGACDRSTD20						1.37	2.49	3.76	3.88	3.81
238_Base4	RCMH	RCMHELCCENSTD	0.11	9.79E-02	8.01E-02	6.23E-02	3.56E-02					
238_Base4	RCMH	RCMHELCCENSTD08		9.17E-03	3.00E-02	0.05	7.85E-02	7.60E-02	3.89E-02			
238_Base4	RCMH	RCMHELCCENSTD20						6.63E-02	0.13	0.21	0.23	0.25
238_Base4	RCMH	RCMHELCHENIMP08				6.40E-08						

238_Base4	RCMH	RCMHELCHENSTD08		-1.91E-07	-5.20E-08		1.79E-07	1.79E-07	2.49E-07	1.69E-07		
238_Base4	RCMH	RCMHELCHENSTD20							5.21E-08	5.21E-08	9.80E-07	5.96E-07
238_Base4	RCMH	RCMHELCROMSTD	4.23E-02	4.17E-02	3.41E-02	2.66E-02	1.52E-02					
238_Base4	RCMH	RCMHELCWALSTD08					-7.28E-08				2.37E-08	
238_Base4	RCMH	RCMHNGAHENSTD08		2.87E-04	4.08E-04	5.28E-04	7.35E-03	1.11E-02	1.52E-02	2.35E-02	3.61E-02	4.40E-02
238_Base4	RCMH	RHMHELCHEPSTD	3.26E-03	6.09E-03	1.69E-02	2.83E-02	0.04	3.81E-02	3.13E-02			
238_Base4	RCMH	RHMHNGLCHPSTD08		1.42E-08	3.73E-08							
238_Base4	RCOK	RCOKELCRANIMP	11.82	10.83	8.86	6.89	3.94					
238_Base4	RCOK	RCOKELCRANIMP08		0.13	4.82	5.65	8.81	8.81	8.33	2.57		
238_Base4	RCOK	RCOKELCRANIMP20						7.69	7.89	17.10	13.12	11.80
238_Base4	RCOK	RCOKELCRANSTD	22.98	21.07	17.24	13.41	7.66					
238_Base4	RCOK	RCOKELCRANSTD08		1.88	3.31	8.49	14.25	14.25	13.24	5.87		
238_Base4	RCOK	RCOKELCRANSTD20						4.47	4.90	7.81	17.80	16.07
238_Base4	RCOK	RCOKNGARANSTD	3.74	3.42	2.80	2.18	1.25					
238_Base4	RCOK	RCOKNGARANSTD08		8.32E-03	0.49	1.15	2.13	2.13	2.08	0.92		
238_Base4	RCOK	RCOKNGARANSTD20						1.34	1.35	2.40	3.10	2.80
238_Base4	RCOK	RCOKNGLRANSTD08		3.88E-02	0.18	0.29	0.49	0.49	0.46	0.18		
238_Base4	RCOK	RCOKSOLRANSTD08		1.73	2.57	3.27	4.37	6.80	9.11	11.98	17.49	23.13
238_Base4	RCWA	RCWAELCCWAIMP	0.82	0.75	0.62	0.48	0.27					
238_Base4	RCWA	RCWAELCCWASTD	1.60	1.46	1.20	0.93	0.53					
238_Base4	RCWA	RCWAELCCWASTD08		0.24	0.73	1.23	1.95	1.58	0.31			
238_Base4	RCWA	RCWAELCCWASTD20						1.42	2.94	3.56	4.14	4.67
238_Base4	RDWA	RDWAELCDWAIMP	0.85	0.77	0.63	0.49	0.28					
238_Base4	RDWA	RDWAELCDWAMAX08		0.21	0.45	0.72	1.12	1.20	1.25	1.00	1.84	0.83
238_Base4	RDWA	RDWAELCDWASTD	1.64	1.51	1.23	0.96	0.55					
238_Base4	RDWA	RDWAELCDWASTD08		4.35E-02	0.29	0.53	0.89	0.82	0.28			

238_Base4	RDWA	RDWAELCDWASTD20						1.06	1.83	2.68	2.44	3.99
238_Base4	RFRE	RFREELCFREIMP	4.24	3.88	3.18	2.47	1.41					
238_Base4	RFRE	RFREELCFREIMP08		1.08	3.18	5.31	9.03	9.03	7.41	1.60		
238_Base4	RFRE	RFREELCFREIMP20						5.28	8.52	16.63	21.27	21.04
238_Base4	RFRE	RFREELCFRESTD	8.24	7.55	6.18	4.81	2.75					
238_Base4	RFRE	RFREELCFRESTD08		0.18	0.59	1.01	1.02	1.02	0.73	5.02E-03		
238_Base4	RFRE	RFREELCFRESTD20						0.13	0.14	0.15	7.64E-02	3.01
238_Base4	RHAH	RHAHCOAFURSTD	1.94E-02	1.84E-02	1.65E-02	1.46E-02	1.16E-02	6.79E-03	1.94E-03			
238_Base4	RHAH	RHAHELCBASSTD	17.31	15.64	14.71	12.98	10.38	6.06	1.73			
238_Base4	RHAH	RHAHELCBASSTD08		0.90	3.97	7.40	12.08	19.95	27.85	33.10	40.29	47.73
238_Base4	RHAH	RHAHELCCHPSTD08			3.36E-07	5.76E-07						
238_Base4	RHAH	RHAHELCHEPSTD	1.59	1.40	0.52	0.13	5.04E-02	1.75E-02	1.13E-03			
238_Base4	RHAH	RHAHHFOFURSTD	1.84E-02	1.75E-02	1.57E-02	1.38E-02	1.11E-02	6.45E-03	1.84E-03			
238_Base4	RHAH	RHAHKERFURSTD	0.18	3.61E-02	3.32E-02	2.42E-02	1.94E-02	1.25E-02	3.58E-03			
238_Base4	RHAH	RHAHLFOCBOSTD08		0.25	0.67	1.10	1.73	2.76	3.74	4.02	3.68	3.28
238_Base4	RHAH	RHAHLFOFURMED	4.08	3.87	3.47	3.06	2.45	1.43	0.41			
238_Base4	RHAH	RHAHLFOFURSTD	0.30	0.28	0.25	0.22	0.18	0.10	2.97E-02			
238_Base4	RHAH	RHAHNGACHPSTD08		0.43	0.69	0.91	1.24	1.89	2.69	5.25	9.29	11.97
238_Base4	RHAH	RHAHNGAFURHIG	11.95	11.35	10.16	8.96	7.17	4.18	1.19			
238_Base4	RHAH	RHAHNGAFURMED	16.70	15.87	14.20	12.53	10.02	5.85	1.67			
238_Base4	RHAH	RHAHNGAFURSTD	7.13	6.77	6.06	5.34	4.28	2.49	0.71			
238_Base4	RHAH	RHAHNGAHEPSTD08		0.30	3.73	7.20	12.26	20.48	28.20	28.41	21.86	16.08
238_Base4	RHAH	RHAHNGLCHPSTD08		3.19E-04	4.54E-04	5.88E-04	8.02E-04	1.19E-03	1.64E-03	1.31E-02	2.93E-02	4.94E-02
238_Base4	RHAH	RHAHNGLFURSTD	0.67	0.64	0.57	0.51	0.40	0.24	6.75E-02			
238_Base4	RHAH	RHAHNGLHEPSTD08		0.38	0.45	0.52	0.62	0.78	0.93	0.96	0.87	0.76
238_Base4	RHAH	RHAHSLDCBOSTD08		2.50	2.90	3.30	3.88	4.82	5.69	5.89	5.40	4.83

238_Base4	RHAH	RHAHSLDSTOSTD	4.05	3.86	3.45	3.05	2.44	1.42	0.41			
238_Base4	RHAP	RHAPCOAFURSTD	4.59E-02	4.37E-02	3.91E-02	3.45E-02	2.76E-02	1.61E-02	4.59E-03			
238_Base4	RHAP	RHAPELCBASSTD	40.75	36.44	34.63	30.56	24.45	14.26	4.07			
238_Base4	RHAP	RHAPELCBASSTD08		1.18	5.27	11.48	20.60	32.72	38.21	44.12	48.32	53.61
238_Base4	RHAP	RHAPELCCHPSTD08		1.49E-07								
238_Base4	RHAP	RHAPELCHEPSTD	0.82	0.51	0.16	0.13	0.08	1.11E-02				
238_Base4	RHAP	RHAPELCHEPSTD20						3.77	13.83	17.21	23.76	29.47
238_Base4	RHAP	RHAPHFOFURSTD	0.03	2.59E-02	2.32E-02	2.04E-02	1.64E-02	9.54E-03	2.73E-03			
238_Base4	RHAP	RHAPKERFURSTD	0.40	3.66E-02	8.09E-02	1.93E-02	0.19	9.88E-03	2.82E-03			
238_Base4	RHAP	RHAPLFOCBOSTD08		1.17	1.43	2.32	3.64	5.81	7.85	8.45	7.73	6.89
238_Base4	RHAP	RHAPLFOFURMED	8.82	7.75	7.50	6.62	5.29	3.09	0.88			
238_Base4	RHAP	RHAPLFOFURSTD	0.41	0.39	0.35	0.31	0.25	0.14	4.13E-02			
238_Base4	RHAP	RHAPNGABOISTD08		1.09	5.06	9.27	15.51	15.51	15.51	13.18	1.12	
238_Base4	RHAP	RHAPNGABOISTD20						10.19	19.79	21.02	17.05	6.31
238_Base4	RHAP	RHAPNGACHPSTD08			0.41	0.60	0.82	1.25	1.81	2.43	3.87	5.55
238_Base4	RHAP	RHAPNGAFURHIG	12.96	12.31	11.01	9.72	7.77	4.53	1.30			
238_Base4	RHAP	RHAPNGAFURMED	20.15	19.14	17.13	15.11	12.09	7.05	2.01			
238_Base4	RHAP	RHAPNGAFURSTD	9.47	9.00	8.05	7.10	5.68	3.31	0.95			
238_Base4	RHAP	RHAPNGAHEPSTD08								3.78	15.40	21.87
238_Base4	RHAP	RHAPNGLCHPSTD08		6.43E-04	1.36E-02	2.90E-02	5.04E-02	8.57E-02	0.15	0.22	0.22	0.21
238_Base4	RHAP	RHAPNGLFURSTD	0.78	0.76	0.68	0.60	0.48	0.28	7.98E-02			
238_Base4	RHAP	RHAPNGLHEPSTD08		0.45	0.52	0.59	0.68	0.84	0.95	0.93	0.84	0.73
238_Base4	RHAP	RHAPSLDCBOSTD08		5.60	6.48	7.36	8.64	10.73	12.62	13.04	11.96	10.68
238_Base4	RHAP	RHAPSLDSTOSTD	9.08	8.64	7.73	6.82	5.46	3.18	0.91			
238_Base4	RHDH	RHDHCOAFURSTD	0.44	0.42	0.37	0.33	0.26	0.15	4.41E-02			
238_Base4	RHDH	RHDHELCBASSTD	136.40	120.90	115.94	102.30	81.84	47.74	13.64			

238_Base4	RHDH	RHDHELCBASSTD08		6.53	29.29	61.04	106.96	177.17	245.31	289.17	350.66	414.32
238_Base4	RHDH	RHDHELCCHPSTD08				7.22E-07						
238_Base4	RHDH	RHDHELCHEPSTD	33.56	31.27	24.23	17.36	9.20	3.40	5.05E-02			
238_Base4	RHDH	RHDHENGHEPSTD08		2.78	2.78	2.78	2.78	2.78	1.75			
238_Base4	RHDH	RHDHHFOFURSTD	0.36	0.34	0.31	0.27	0.22	0.13	3.60E-02			
238_Base4	RHDH	RHDHKERFURSTD	1.56	0.38	0.31	0.19	0.11	0.07	2.31E-02			
238_Base4	RHDH	RHDHLFOCBOSTD08		2.19	5.96	9.77	15.49	24.83	33.68	36.21	33.01	29.35
238_Base4	RHDH	RHDHLFOFURMED	38.63	36.70	32.83	28.97	23.18	13.52	3.86			
238_Base4	RHDH	RHDHLFOFURSTD	1.26	1.14	1.07	0.94	0.75	0.44	0.13			
238_Base4	RHDH	RHDHNGABOISTD08		7.33	36.93	66.48	106.92	106.92	106.92	90.22	7.24	
238_Base4	RHDH	RHDHNGABOISTD20						71.93	140.69	179.09	233.48	129.91
238_Base4	RHDH	RHDHNGACHPSTD08				0.29	4.66	7.08	10.22	13.73	21.82	31.25
238_Base4	RHDH	RHDHNGAFURHIG	87.79	83.40	74.62	65.84	52.67	30.73	8.78			
238_Base4	RHDH	RHDHNGAFURMED	149.34	141.71	126.94	112.00	89.60	52.27	14.93			
238_Base4	RHDH	RHDHNGAFURSTD	57.94	53.08	47.99	43.06	34.77	20.28	5.79			
238_Base4	RHDH	RHDHNGAHEPSTD08										75.57
238_Base4	RHDH	RHDHNGLCHPSTD08		0.15	0.18	0.22	0.26	0.35	0.63	0.76	0.87	0.99
238_Base4	RHDH	RHDHNGLFURSTD	5.13	4.93	4.41	3.89	3.11	1.82	0.52			
238_Base4	RHDH	RHDHNGLHEPSTD08		2.87	3.37	3.86	4.58	5.73	6.62	6.79	6.08	5.25
238_Base4	RHDH	RHDHSLDCBOSTD08		22.28	25.71	29.11	34.15	42.29	49.81	51.45	47.15	42.11
238_Base4	RHDH	RHDHSLDSTOSTD	34.88	33.58	30.05	26.51	21.21	12.37	3.53			
238_Base4	RHMH	RHMHCOAFURSTD	2.04E-02	1.94E-02	1.73E-02	1.53E-02	1.22E-02	7.13E-03	2.04E-03			
238_Base4	RHMH	RHMHELCBASSTD	4.80	4.21	4.08	3.60	2.88	1.68	0.48			
238_Base4	RHMH	RHMHELCBASSTD08		0.03	0.24	0.48	0.48	0.48	0.26	9.20E-04	2.04E-04	
238_Base4	RHMH	RHMHELCHEPSTD	0.41	0.38	0.33	0.28	0.21	0.11	9.67E-03			
238_Base4	RHMH	RHMHELCHEPSTD08		4.44E-03	0.03	0.42	0.92	0.92	0.92	0.58		

238_Base4	RHMH	RHMHELCHEPSTD20						1.88	3.07	4.91	7.06	7.00
238_Base4	RHMH	RHMHHFOFURSTD	2.90E-02	2.76E-02	2.47E-02	2.18E-02	1.74E-02	1.02E-02	2.90E-03			
238_Base4	RHMH	RHMHKERFURSTD	7.67E-02	4.43E-02	6.52E-02	5.76E-02	4.05E-02	2.65E-02	7.26E-03			
238_Base4	RHMH	RHMHLFOCBOSTD08		5.07E-02	0.17	0.29	0.48	0.79	1.09	1.17	1.06	0.94
238_Base4	RHMH	RHMHLFOFURMED	1.23	1.17	1.05	0.92	0.74	0.43	0.12			
238_Base4	RHMH	RHMHLFOFURSTD	9.59E-02	9.05E-02	8.15E-02	7.19E-02	5.75E-02	3.36E-02	9.59E-03			
238_Base4	RHMH	RHMHNGAFURMED	6.09	5.79	5.18	4.57	3.65	2.13	0.61			
238_Base4	RHMH	RHMHNGAFURSTD	2.31	2.19	1.96	1.73	1.38	0.81	4.80E-02			
238_Base4	RHMH	RHMHNGAHEPSTD08		0.39	1.25	2.16	3.96	6.16	8.89	9.72	8.58	7.46
238_Base4	RHMH	RHMHNGLCHPSTD08		2.13E-08	5.59E-08							
238_Base4	RHMH	RHMHNGLFURSTD	0.13	0.11	9.76E-02	8.78E-02	7.03E-02	4.10E-02	1.17E-02			
238_Base4	RHMH	RHMHNGLHEPSTD08		0.25	0.51	0.76	1.16	1.57	2.39	2.28	3.12	2.98
238_Base4	RHMH	RHMHSLDCBOSTD08		0.66	0.76	0.87	1.02	1.27	1.50	1.55	1.42	3.76
238_Base4	RHMH	RHMHSLDSTOSTD	1.10	1.02	0.92	0.81	0.65	0.38	0.11			
238_Base4	RLIG	RLIGELCCFLSTD08		1.43	2.99E-02							
238_Base4	RLIG	RLIGELCFLUIMP08		11.03	24.63	74.02	139.11	1.42				
238_Base4	RLIG	RLIGELCFLUIMP20						115.52	206.70	224.33	256.50	287.82
238_Base4	RLIG	RLIGELCFLUSTD	82.12	65.70	32.85							
238_Base4	RLIG	RLIGELCHALSTD	5.11	4.09	2.04							
238_Base4	RLIG	RLIGELCINCIMP	34.07	17.01								
238_Base4	RLIG	RLIGELCINCIMP08		53.72	98.90	90.16	32.10	69.81	0.46	0.48	0.62	0.65
238_Base4	RLIG	RLIGELCINCSTD	30.42	0.72								
238_Base4	RLIG	RLIGELCINCSTD08				0.18	0.19					
238_Base4	RLIG	RLIGKERLMPSTD08		0.67	0.81	0.67	1.11	1.01	0.96	1.17	1.77	0.28
238_Base4	ROEL	ROELELCOTHSTD	66.04	56.61	37.74	18.87						
238_Base4	ROEL	ROELELCOTHSTD08		10.54	31.78	53.11	75.20	81.73	88.73	97.19	113.03	127.45

238_Base4	RREF	RREFELC510STD08		3.90	11.73	19.66	31.28	29.83	12.92			
238_Base4	RREF	RREFELC510STD20						18.27	39.39	57.35	66.74	75.29
238_Base4	RREF	RREFELCREFIMP	13.20	12.10	9.90	7.70	4.40					
238_Base4	RREF	RREFELCREFSTD	25.66	23.52	19.24	14.97	8.55					
238_Base4	RWAH	RHAHLFOCBOSTD08		0.04	0.12	0.19	0.30	0.49	0.66	0.71	0.65	0.58
238_Base4	RWAH	RHAHSLDCBOSTD08		0.44	0.51	0.58	0.68	0.85	1.00	1.04	0.95	0.85
238_Base4	RWAH	RWAHCOAFURSTD	4.82E-03	4.50E-03	3.85E-03	3.21E-03	2.25E-03	6.42E-04				
238_Base4	RWAH	RWAHELCHEPSTD08		0.27	0.33	0.94	1.90	0.61	1.89	1.50	8.83E-02	
238_Base4	RWAH	RWAHELCHETSTD	4.81	4.21	3.81	3.21	2.24	0.64				
238_Base4	RWAH	RWAHELCTAKMAX20						4.56	5.23	6.30	11.36	15.49
238_Base4	RWAH	RWAHHFOFURSTD	3.95E-03	3.69E-03	3.16E-03	2.64E-03	1.85E-03	5.27E-04				
238_Base4	RWAH	RWAHKERFURSTD	3.32E-02	5.55E-03	5.62E-03	1.32E-02	3.50E-03	8.68E-04				
238_Base4	RWAH	RWAHLFOFURSTD	0.75	0.70	0.60	0.50	0.35	9.96E-02				
238_Base4	RWAH	RWAHNGAFURSTD	17.99	14.41	14.18	1.76	1.38	0.44				
238_Base4	RWAH	RWAHNGATAKMAX08		3.47	4.00	16.72	17.53	19.20	19.59	19.47	19.07	16.57
238_Base4	RWAH	RWAHNGLFURSTD	6.61E-02	6.11E-02	5.23E-02	4.36E-02	3.06E-02	8.37E-03				
238_Base4	RWAH	RWAHNGLSTTMAX08		0.92	1.28	1.63	2.12	1.67	1.31	1.62	9.40E-02	8.43E-02
238_Base4	RWAH	RWAHSLDFURSTD08		1.78E-03	2.31E-03	2.86E-03	3.71E-03	5.23E-03	5.05E-03	4.58E-03	4.30E-03	3.91E-03
238_Base4	RWAH	RWAHSLDSTOSTD	0.17	4.95E-02	5.03E-02	4.17E-02	6.75E-02	1.58E-02				
238_Base4	RWAH	RWAHSLFCCOSTD08		0.12	9.68E-02	0.11	0.14	0.20	0.14	0.11	9.84E-02	8.53E-02
238_Base4	RWAP	RHAPLFOCBOSTD08		0.29	0.36	0.58	0.91	1.45	1.96	2.11	1.93	1.72
238_Base4	RWAP	RHAPSLDCBOSTD08		1.40	1.62	1.84	2.16	2.68	3.15	3.26	2.99	2.67
238_Base4	RWAP	RWAPCOAFURSTD	1.42E-02	1.33E-02	1.14E-02	9.48E-03	6.64E-03	1.90E-03				
238_Base4	RWAP	RWAPELCHEPSTD08		0.91	1.32	3.50	6.86	1.28	6.85	5.34	0.31	
238_Base4	RWAP	RWAPELCHETSTD	16.74	15.09	13.33	11.16	7.81	2.23				
238_Base4	RWAP	RWAPELCTAKMAX20						14.42	13.36	15.95	26.81	35.17

238_Base4	RWAP	RWAPHFOFURSTD	1.32E-02	1.23E-02	1.05E-02	8.79E-03	6.15E-03	1.76E-03				
238_Base4	RWAP	RWAPKERFURSTD	0.10	1.55E-02	1.34E-02	5.24E-02	6.90E-03	1.45E-03				
238_Base4	RWAP	RWAPLFOFURSTD	2.32	2.17	1.86	1.55	1.08	0.31				
238_Base4	RWAP	RWAPNGAFURSTD	35.85	29.61	28.68	4.97	4.19	1.25				
238_Base4	RWAP	RWAPNGATAKMAX08		6.58	8.06	32.47	34.41	39.14	40.62	40.87	41.62	37.22
238_Base4	RWAP	RWAPNGLFURSTD	0.13	0.12	0.10	8.43E-02	0.06	0.02				
238_Base4	RWAP	RWAPNGLSTTMAX08		1.66	2.31	2.94	3.87	2.96	2.23	2.71	0.18	0.16
238_Base4	RWAP	RWAPSLDFURSTD08		9.13E-03	1.10E-02	1.28E-02	1.49E-02	0.02	1.59E-02	1.10E-02	9.82E-03	8.59E-03
238_Base4	RWAP	RWAPSLDSTOSTD	0.40	0.19	0.22	0.19	0.15	0.03				
238_Base4	RWAP	RWAPSLFCCOSTD08		0.21	0.30	0.38	0.50	0.71	0.65	0.56	0.50	0.43
238_Base4	RWDH	RHDHENGHEPSTD08		0.49	0.49	0.49	0.49	0.49	0.31			
238_Base4	RWDH	RHDHLFOCBOSTD08		0.39	1.05	1.72	2.73	4.38	5.94	6.39	5.83	5.18
238_Base4	RWDH	RHDHSLDCBOSTD08		3.93	4.54	5.14	6.03	7.46	8.79	9.08	8.32	7.43
238_Base4	RWDH	RWDHCOAFURSTD	0.07	6.82E-02	0.06	4.87E-02	3.41E-02	9.74E-03				
238_Base4	RWDH	RWDHELCHEPSTD08		2.07	2.69	5.53	11.65	4.01	11.60	8.80	0.56	
238_Base4	RWDH	RWDHELCHETSTD	30.63	26.89	24.24	20.42	14.29	4.08				
238_Base4	RWDH	RWDHELCTAKMAX20						25.87	27.50	33.44	62.58	84.54
238_Base4	RWDH	RWDHHFOFURSTD	6.35E-02	5.93E-02	5.08E-02	4.23E-02	2.96E-02	8.47E-03				
238_Base4	RWDH	RWDHKERFURSTD	0.22	0.06	5.38E-02	3.98E-02	3.16E-02	7.20E-03				
238_Base4	RWDH	RWDHLFOFURSTD	5.92	5.52	4.70	3.76	2.38	0.47				
238_Base4	RWDH	RWDHNGAFURSTD	93.30	76.12	74.64	10.18	8.15	2.49				
238_Base4	RWDH	RWDHNGATAKMAX08		16.55	20.01	85.79	90.59	100.04	102.05	101.80	101.17	89.18
238_Base4	RWDH	RWDHNGLFURSTD	0.33	0.30	0.26	0.21	0.15	3.82E-02				
238_Base4	RWDH	RWDHNGLSTTMAX08		4.48	6.16	7.76	10.09	8.74	8.21	10.28	0.48	0.43
238_Base4	RWDH	RWDHSLDFURSTD08		6.94E-03	8.60E-03	1.10E-02	1.46E-02	2.06E-02	1.84E-02	1.50E-02	0.01	1.22E-02
238_Base4	RWDH	RWDHSLDSTOSTD	1.01	0.14	0.17	0.28	0.33	0.08				

238_Base4	RWDH	RWDHSLFCCOSTD08		0.86	0.74	0.81	1.09	1.60	1.40	1.20	1.06	0.92
238_Base4	RWMH	RHMHLFOCBOSTD08		8.95E-03	2.94E-02	5.16E-02	8.51E-02	0.14	0.19	0.21	0.19	0.17
238_Base4	RWMH	RHMHSLDCBOSTD08		0.12	0.13	0.15	0.18	0.22	0.26	0.27	0.25	0.66
238_Base4	RWMH	RWMHCOAFURSTD	2.34E-03	2.18E-03	1.87E-03	1.56E-03	1.09E-03	3.12E-04				
238_Base4	RWMH	RWMHELCHEPSTD08		0.33	0.32	0.40	0.52	0.16	0.52	0.20	1.17E-02	
238_Base4	RWMH	RWMHELCHETSTD	0.99	0.87	0.76	0.63	0.45	0.13				
238_Base4	RWMH	RWMHELCTAKMAX20						0.78	0.59	0.89	1.91	2.58
238_Base4	RWMH	RWMHHFOFURSTD	4.52E-03	4.22E-03	3.61E-03	3.01E-03	2.11E-03	6.02E-04				
238_Base4	RWMH	RWMHKERFURSTD	8.19E-03	3.17E-03	3.43E-03	3.05E-03	2.40E-03	5.72E-04				
238_Base4	RWMH	RWMHLFOFURSTD	0.25	0.24	0.20	0.17	0.12	2.88E-02				
238_Base4	RWMH	RWMHNGAFURSTD	3.12	2.58	2.49	0.58	0.42	0.13				
238_Base4	RWMH	RWMHNGATAKMAX08		0.63	0.82	2.80	3.10	3.63	3.81	3.82	3.94	3.20
238_Base4	RWMH	RWMHNGLFURSTD	8.18E-03	7.19E-03	6.11E-03	5.07E-03	3.52E-03	8.02E-04				
238_Base4	RWMH	RWMHNGLSTTMAX08		0.13	0.19	0.23	0.31	0.40	0.52	0.66	1.24E-02	1.12E-02
238_Base4	RWMH	RWMHSLDSTOSTD	3.38E-02	9.83E-03	1.48E-02	0.02	9.42E-03	1.23E-03				
238_Base4	RWMH	RWMHSLFCCOSTD08		8.56E-02	7.75E-02	7.49E-02	7.82E-02	0.11	9.74E-02	8.15E-02	7.21E-02	6.26E-02
238_Base4_GHG1	RCAH	RCAHELCCENSTD	3.29	3.02	2.47	1.92	1.10					
238_Base4_GHG1	RCAH	RCAHELCCENSTD08		1.82E-03	8.59E-03	0.53	1.77	1.77	1.41		3.01E-07	
238_Base4_GHG1	RCAH	RCAHELCCENSTD20						1.87	2.85	5.15	5.13	4.50
238_Base4_GHG1	RCAH	RCAHELCHENIMP08		3.89E-07								
238_Base4_GHG1	RCAH	RCAHELCHENSTD08						1.79E-06				
238_Base4_GHG1	RCAH	RCAHELCROMSTD	0.73	0.77	0.63	0.49	0.28					
238_Base4_GHG1	RCAH	RCAHNGAHENSTD08				-5.61E-08		1.38E-07			0.10	0.29
238_Base4_GHG1	RCAH	RHAHELCCHPSTD08		8.53E-08		6.05E-07						
238_Base4_GHG1	RCAH	RHAHELCHEPSTD	0.11	0.21	0.92	1.14	0.97	0.58	0.17			
238_Base4_GHG1	RCAH	RHAHNGACHPSTD08		0.18	0.30	0.39	0.53	0.81	1.15	2.25	3.98	5.13

238_Base4_GHG1	RCAH	RHAHNGLCHPSTD08		2.13E-04	3.03E-04	3.92E-04	5.35E-04	7.96E-04	1.10E-03	8.71E-03	1.96E-02	3.26E-02
238_Base4_GHG1	RCAP	RCAPELCCENSTD	2.84	2.60	2.13	1.66	0.95					
238_Base4_GHG1	RCAP	RCAPELCCENSTD08		5.98E-03	0.29	0.99	1.99	1.98	1.31			
238_Base4_GHG1	RCAP	RCAPELCCENSTD20						1.45	2.53	4.05	4.13	4.02
238_Base4_GHG1	RCAP	RCAPELCHENSTD08		9.95E-08	1.19E-06				-3.69E-08	-5.11E-07		
238_Base4_GHG1	RCAP	RCAPELCROMSTD	0.66	0.67	0.55	0.43	0.24					
238_Base4_GHG1	RCAP	RCAPNGAHENSTD08		9.29E-08			2.74E-02	0.06	7.10E-02	9.44E-02	0.25	0.43
238_Base4_GHG1	RCAP	RCAPSELCENSTD08				7.05E-07						
238_Base4_GHG1	RCAP	RHAPELCHEPSTD	7.22E-02	0.22	0.59	0.54	0.45	0.30	8.91E-02			
238_Base4_GHG1	RCAP	RHAPENGHEPSTD08		4.53E-07								
238_Base4_GHG1	RCAP	RHAPNGACHPSTD08		0.12	0.18	0.26	0.35	0.54	0.78	1.05	1.68	2.41
238_Base4_GHG1	RCAP	RHAPNGLCHPSTD08		4.29E-04	9.08E-03	1.77E-02	3.36E-02	5.72E-02	0.10	0.14	0.12	0.11
238_Base4_GHG1	RCDH	RCDHELCCENSTD	14.62	13.40	10.96	8.53	4.87					
238_Base4_GHG1	RCDH	RCDHELCCENSTD08			1.77E-06	0.13	0.58	0.58	0.55	9.89E-02		
238_Base4_GHG1	RCDH	RCDHELCCENSTD20						9.51	15.68	20.22	20.75	20.21
238_Base4_GHG1	RCDH	RCDHELCHENIMP08		1.17E-06					3.37E-07			
238_Base4_GHG1	RCDH	RCDHELCHENSTD08		2.56E-07	3.75E-06				-4.33E-07	-9.97E-07		
238_Base4_GHG1	RCDH	RCDHELCROMSTD	2.34	3.14	2.57	2.00	1.14					
238_Base4_GHG1	RCDH	RCDHELCWALSTD08			-8.59E-07			3.20E-06	3.40E-06		-9.77E-07	
238_Base4_GHG1	RCDH	RCDHNGAHENSTD08					2.65E-07		0.23	0.35	0.74	1.19
238_Base4_GHG1	RCDH	RHDHELCHEPSTD	1.08	0.95	4.23	7.33	11.37	8.59	3.41			
238_Base4_GHG1	RCDH	RHDHNGACHPSTD08		0.69	0.99	1.42	1.97	3.03	4.38	5.92	9.53	13.71
238_Base4_GHG1	RCDH	RHDHNGLCHPSTD08		0.10	0.12	0.14	0.19	0.30	0.42	0.47	0.40	0.34
238_Base4_GHG1	RCDR	RCDRELCCDRIMP	12.34	11.32	9.26	7.20	4.11					
238_Base4_GHG1	RCDR	RCDRELCCDRIMP08		4.03	11.65	19.16	30.17	28.67	12.25			
238_Base4_GHG1	RCDR	RCDRELCCDRIMP20						17.49	38.08	55.32	64.82	73.53

238_Base4_GHG1	RCDR	RCDRELCCDRSTD	24.00	22.00	18.00	14.00	8.00					
238_Base4_GHG1	RCDR	RCDRNGACDRSTD	3.74	3.42	2.80	2.18	1.25					
238_Base4_GHG1	RCDR	RCDRNGACDRSTD08		2.21E-04	0.43	1.11	2.09	2.09	1.10			
238_Base4_GHG1	RCDR	RCDRNGACDRSTD20						1.37	2.49	3.76	3.88	3.81
238_Base4_GHG1	RCMH	RCMHELCCENSTD	0.11	9.67E-02	8.01E-02	6.23E-02	3.56E-02					
238_Base4_GHG1	RCMH	RCMHELCCENSTD08		1.04E-02	3.01E-02	5.00E-02	0.07	7.01E-02	3.36E-02			
238_Base4_GHG1	RCMH	RCMHELCCENSTD20						4.21E-02	8.60E-02	0.14	0.14	0.19
238_Base4_GHG1	RCMH	RCMHELCHENIMP08		6.48E-08								
238_Base4_GHG1	RCMH	RCMHELCROMSTD	4.23E-02	4.17E-02	3.41E-02	2.66E-02	1.52E-02					
238_Base4_GHG1	RCMH	RCMHNGAHENSTD08		2.87E-04	2.87E-04	5.28E-04	7.35E-03	1.11E-02	1.52E-02	1.99E-02	3.05E-02	4.23E-02
238_Base4_GHG1	RCMH	RHMHELCHEPSTD	3.26E-03	6.09E-03	1.65E-02	2.69E-02	2.34E-02	2.51E-02	1.36E-02			
238_Base4_GHG1	RCMH	RHMHENGHEPSTD08				1.11E-03	2.11E-02	0.12	0.14	0.29	0.23	0.18
238_Base4_GHG1	RCMH	RHMHNGLCHPSTD08		1.42E-08								
238_Base4_GHG1	RCOK	RCOKELCRANIMP	11.82	10.83	8.86	6.89	3.94					
238_Base4_GHG1	RCOK	RCOKELCRANIMP08		1.63	5.70	11.40	17.31	17.31	16.18	6.14		
238_Base4_GHG1	RCOK	RCOKELCRANIMP20						4.67	5.02	15.97	17.21	12.17
238_Base4_GHG1	RCOK	RCOKELCRANSTD	22.98	21.07	17.24	13.41	7.66					
238_Base4_GHG1	RCOK	RCOKELCRANSTD08		0.38	2.43	2.74	5.76	5.76	5.40	2.29		
238_Base4_GHG1	RCOK	RCOKELCRANSTD20						7.49	7.76	8.94	13.71	15.69
238_Base4_GHG1	RCOK	RCOKNGARANSTD	3.74	3.42	2.80	2.18	1.25					
238_Base4_GHG1	RCOK	RCOKNGARANSTD08		9.87E-02	0.49	1.15	2.13	2.13	2.05	0.92		
238_Base4_GHG1	RCOK	RCOKNGARANSTD20						1.34	1.35	2.40	3.10	2.80
238_Base4_GHG1	RCOK	RCOKSOLRANSTD08		1.68	2.74	3.56	4.86	7.29	9.61	12.16	17.48	23.13
238_Base4_GHG1	RCWA	RCWAELCCWAIMP	0.82	0.75	0.62	0.48	0.27					
238_Base4_GHG1	RCWA	RCWAELCCWASTD	1.60	1.46	1.20	0.93	0.53					
238_Base4_GHG1	RCWA	RCWAELCCWASTD08		0.24	0.73	1.23	1.95	1.58	0.31			

238_Base4_GHG1	RCWA	RCWAELCCWASTD20						1.42	2.94	3.56	4.14	4.67
238_Base4_GHG1	RDWA	RDWAELCDWAIMP	0.85	0.77	0.63	0.49	0.28					
238_Base4_GHG1	RDWA	RDWAELCDWAMAX08		0.21	0.61	1.12	1.87	2.65	3.00	3.49	3.12	0.85
238_Base4_GHG1	RDWA	RDWAELCDWASTD	1.64	1.51	1.23	0.96	0.55					
238_Base4_GHG1	RDWA	RDWAELCDWASTD08		4.34E-02	0.13	0.13	0.14	0.10	1.61E-03			
238_Base4_GHG1	RDWA	RDWAELCDWASTD20						0.34	0.35	0.18	1.16	3.98
238_Base4_GHG1	RFRE	RFREELCFREIMP	4.24	3.88	3.18	2.47	1.41					
238_Base4_GHG1	RFRE	RFREELCFREIMP08		1.26	3.75	6.30	10.03	10.03	8.12	1.60		
238_Base4_GHG1	RFRE	RFREELCFREIMP20						5.40	8.64	16.74	21.30	21.04
238_Base4_GHG1	RFRE	RFREELCFRESTD	8.24	7.55	6.18	4.81	2.75					
238_Base4_GHG1	RFRE	RFREELCFRESTD08		2.75E-03	1.24E-02	2.13E-02	0.03	0.03	2.48E-02	3.98E-03		
238_Base4_GHG1	RFRE	RFREELCFRESTD20						1.35E-02	1.97E-02	0.04	4.75E-02	3.00
238_Base4_GHG1	RHAH	RHAHCOABOISTD08										3.98
238_Base4_GHG1	RHAH	RHAHCOAFURSTD	1.94E-02	1.84E-02	1.65E-02	1.46E-02	1.16E-02	6.79E-03	1.94E-03			
238_Base4_GHG1	RHAH	RHAHELCBASSTD	17.31	15.64	14.71	12.98	10.38	6.06	1.73			
238_Base4_GHG1	RHAH	RHAHELCBASSTD08		0.90	3.98	7.40	12.08	16.42	23.72	28.63	36.26	42.21
238_Base4_GHG1	RHAH	RHAHELCCHPSTD08		1.28E-07		9.07E-07						
238_Base4_GHG1	RHAH	RHAHELCHEPSTD	1.59	1.40	0.52	0.13	5.04E-02	1.76E-02	1.13E-03			
238_Base4_GHG1	RHAH	RHAHELCHEPSTD20						2.53	3.39	3.52	3.10	1.12
238_Base4_GHG1	RHAH	RHAHHFOFURSTD	1.84E-02	1.75E-02	1.57E-02	1.38E-02	1.11E-02	6.45E-03	1.84E-03			
238_Base4_GHG1	RHAH	RHAHKERFURSTD	0.18	3.46E-02	3.19E-02	2.31E-02	1.94E-02	4.48E-03	9.32E-04			
238_Base4_GHG1	RHAH	RHAHLFOCBOSTD08		0.25	0.67	1.10	1.73	2.76	3.73	4.02	3.68	3.26
238_Base4_GHG1	RHAH	RHAHLFOFURMED	4.08	3.87	3.47	3.06	2.45	1.43	0.41			
238_Base4_GHG1	RHAH	RHAHLFOFURSTD	0.30	0.28	0.25	0.22	0.18	0.10	2.97E-02			
238_Base4_GHG1	RHAH	RHAHNGACHPSTD08		0.43	0.69	0.91	1.24	1.89	2.69	5.25	9.29	11.96
238_Base4_GHG1	RHAH	RHAHNGAFURHIG	11.95	11.35	10.16	8.96	7.17	4.18	1.19			

238_Base4_GHG1	RHAH	RHAHNGAFURMED	16.70	15.87	14.20	12.53	10.02	5.85	1.67			
238_Base4_GHG1	RHAH	RHAHNGAFURSTD	7.13	6.77	6.06	5.34	4.28	2.49	0.71			
238_Base4_GHG1	RHAH	RHAHNGAHEPSTD08		0.30	3.73	7.20	12.26	20.48	28.20	28.41	21.86	16.02
238_Base4_GHG1	RHAH	RHAHNGLCHPSTD08		3.19E-04	4.54E-04	5.88E-04	8.02E-04	1.19E-03	1.64E-03	1.31E-02	2.93E-02	4.89E-02
238_Base4_GHG1	RHAH	RHAHNGLFURSTD	0.67	0.64	0.57	0.51	0.40	0.23	6.55E-02			
238_Base4_GHG1	RHAH	RHAHNGLHEPSTD08		0.38	0.45	0.52	0.62	0.78	0.93	0.96	0.87	0.76
238_Base4_GHG1	RHAH	RHAHSLDCBOSTD08		2.50	2.90	3.30	3.88	5.83	6.42	6.83	6.32	4.98
238_Base4_GHG1	RHAH	RHAHSLDSTOSTD	4.05	3.86	3.45	3.04	2.44	1.42	0.41			
238_Base4_GHG1	RHAP	RHAPCOAFURSTD	4.59E-02	4.37E-02	3.91E-02	3.45E-02	2.76E-02	1.61E-02	4.59E-03			
238_Base4_GHG1	RHAP	RHAPELCBASSTD	40.75	36.43	34.63	30.56	24.45	14.26	4.07			
238_Base4_GHG1	RHAP	RHAPELCBASSTD08		1.06	5.26	11.34	18.29	29.77	35.80	41.26	46.39	55.56
238_Base4_GHG1	RHAP	RHAPELCHEPSTD	0.82	0.63	0.16	0.13	0.08	1.12E-02				
238_Base4_GHG1	RHAP	RHAPELCHEPSTD08				0.08	2.29	2.29	2.29	1.84		
238_Base4_GHG1	RHAP	RHAPELCHEPSTD20						3.45	13.23	17.36	24.85	27.21
238_Base4_GHG1	RHAP	RHAPENGHEPSTD08		6.80E-07								
238_Base4_GHG1	RHAP	RHAPHFOFURSTD	0.03	2.59E-02	2.32E-02	2.04E-02	1.64E-02	9.54E-03	2.73E-03			
238_Base4_GHG1	RHAP	RHAPKERFURSTD	0.40	3.66E-02	8.09E-02	5.56E-02	0.19	5.19E-03	1.23E-03			
238_Base4_GHG1	RHAP	RHAPLFOCBOSTD08		1.17	1.43	2.32	3.64	5.81	7.85	8.45	7.73	6.89
238_Base4_GHG1	RHAP	RHAPLFOFURMED	8.82	7.75	7.50	6.62	5.29	3.09	0.88			
238_Base4_GHG1	RHAP	RHAPLFOFURSTD	0.41	0.39	0.35	0.31	0.25	0.14	4.13E-02			
238_Base4_GHG1	RHAP	RHAPNGABOISTD08		0.81	2.78	3.81	4.99	4.99	4.99	3.63	0.21	
238_Base4_GHG1	RHAP	RHAPNGABOISTD20						1.94	3.80	5.02	6.78	4.64
238_Base4_GHG1	RHAP	RHAPNGACHPSTD08		0.29	0.41	0.60	0.82	1.25	1.81	2.44	3.91	5.62
238_Base4_GHG1	RHAP	RHAPNGAFURHIG	12.96	12.31	11.01	9.72	7.77	4.53	1.30			
238_Base4_GHG1	RHAP	RHAPNGAFURMED	20.15	19.14	17.13	15.11	12.09	7.05	2.01			
238_Base4_GHG1	RHAP	RHAPNGAFURSTD	9.47	9.00	8.05	7.10	5.68	3.31	0.95			

238_Base4_GHG1	RHAP	RHAPNGAHEPSTD08			2.27	5.46	10.51	18.77	26.51	29.33	26.53	23.38
238_Base4_GHG1	RHAP	RHAPNGLCHPSTD08		6.43E-04	1.36E-02	2.65E-02	5.04E-02	8.57E-02	0.15	0.21	0.19	0.17
238_Base4_GHG1	RHAP	RHAPNGLFURSTD	0.78	0.76	0.68	0.60	0.48	0.28	7.83E-02			
238_Base4_GHG1	RHAP	RHAPNGLHEPSTD08		0.45	0.52	0.59	0.68	0.84	0.95	0.94	0.87	0.78
238_Base4_GHG1	RHAP	RHAPSLDCBOSTD08		5.61	6.49	7.37	8.67	11.71	13.32	13.91	12.79	10.82
238_Base4_GHG1	RHAP	RHAPSLDSTOSTD	9.08	8.64	7.73	6.82	5.46	3.18	0.91			
238_Base4_GHG1	RHDH	RHDHCOABOISTD08										0.24
238_Base4_GHG1	RHDH	RHDHCOAFURSTD	0.44	0.42	0.37	0.33	0.26	0.15	4.41E-02			
238_Base4_GHG1	RHDH	RHDHELCBASSTD	136.40	120.86	115.94	102.30	81.84	47.74	13.64			
238_Base4_GHG1	RHDH	RHDHELCBASSTD08		5.86	28.35	59.79	106.70	174.43	244.45	288.28	349.52	411.84
238_Base4_GHG1	RHDH	RHDHELCHEPSTD	33.56	31.96	25.22	18.65	9.42	3.54	5.13E-02			
238_Base4_GHG1	RHDH	RHDHENGHEPSTD08		2.78	2.78	2.78	2.78	2.78	1.75			
238_Base4_GHG1	RHDH	RHDHHFOFURSTD	0.36	0.34	0.31	0.27	0.22	0.13	3.60E-02			
238_Base4_GHG1	RHDH	RHDHKERFURSTD	1.56	0.36	0.28	0.15	0.14	3.88E-02	1.11E-02			
238_Base4_GHG1	RHDH	RHDHLFOCBOSTD08		2.19	5.96	9.77	15.49	24.82	33.64	36.19	32.99	29.18
238_Base4_GHG1	RHDH	RHDHLFOFURMED	38.63	36.70	32.83	28.97	23.18	13.52	3.86			
238_Base4_GHG1	RHDH	RHDHLFOFURSTD	1.26	1.14	1.07	0.94	0.75	0.44	0.13			
238_Base4_GHG1	RHDH	RHDHNGABOISTD08		4.39	18.03	23.50	29.39	29.39	29.39	20.91	1.06	
238_Base4_GHG1	RHDH	RHDHNGABOISTD20						15.78	28.85	37.31	43.57	25.82
238_Base4_GHG1	RHDH	RHDHNGACHPSTD08		1.62	2.30	3.31	4.60	7.08	10.22	13.81	22.23	31.98
238_Base4_GHG1	RHDH	RHDHNGAFURHIG	87.79	83.40	74.62	65.84	52.67	30.73	8.78			
238_Base4_GHG1	RHDH	RHDHNGAFURMED	149.34	141.71	126.94	112.00	89.60	52.27	14.93			
238_Base4_GHG1	RHDH	RHDHNGAFURSTD	57.94	53.08	47.98	43.06	34.77	20.28	5.79			
238_Base4_GHG1	RHDH	RHDHNGAHEPSTD08		1.35	16.59	39.96	77.59	133.68	189.37	211.02	195.40	178.26
238_Base4_GHG1	RHDH	RHDHNGLCHPSTD08		0.15	0.18	0.22	0.28	0.46	0.63	0.71	0.60	0.51
238_Base4_GHG1	RHDH	RHDHNGLFURSTD	5.13	4.93	4.41	3.89	3.11	1.79	0.50			

238_Base4_GHG1	RHDH	RHDHNGLHEPSTD08		2.87	3.37	3.86	4.56	5.65	6.63	6.84	6.35	5.70
238_Base4_GHG1	RHDH	RHDHSLDCBOSTD08		22.28	25.71	29.11	34.17	44.92	50.58	52.33	47.81	41.80
238_Base4_GHG1	RHDH	RHDHSLDSTOSTD	34.88	33.58	30.05	26.51	21.21	12.37	3.53			
238_Base4_GHG1	RHMH	RHMHCOABOISTD08										1.97
238_Base4_GHG1	RHMH	RHMHCOAFURSTD	2.04E-02	1.94E-02	1.73E-02	1.53E-02	1.22E-02	7.13E-03	2.04E-03			
238_Base4_GHG1	RHMH	RHMHELCBASSTD	4.80	4.20	4.08	3.60	2.88	1.56	0.46			
238_Base4_GHG1	RHMH	RHMHELCBASSTD08		0.02	0.21	0.21	0.21	0.21	0.11			
238_Base4_GHG1	RHMH	RHMHELCHEPSTD	0.41	0.38	0.33	0.28	0.22	0.11	0.03			
238_Base4_GHG1	RHMH	RHMHELCHEPSTD08		1.40E-03	0.21	0.77	1.02	1.02	1.02	0.44		
238_Base4_GHG1	RHMH	RHMHELCHEPSTD20						0.98	2.23	2.94	4.07	3.13
238_Base4_GHG1	RHMH	RHMHENGHEPSTD08				1.67E-03	3.16E-02	0.18	0.20	0.44	0.34	0.26
238_Base4_GHG1	RHMH	RHMHHFOFURSTD	2.90E-02	2.76E-02	2.47E-02	2.18E-02	1.74E-02	1.02E-02	2.90E-03			
238_Base4_GHG1	RHMH	RHMHKERFURSTD	7.67E-02	4.43E-02	6.52E-02	5.76E-02	4.05E-02	1.08E-02	1.68E-03			
238_Base4_GHG1	RHMH	RHMHLFOCBOSTD08		5.07E-02	0.17	0.29	0.48	0.79	1.09	1.17	1.06	0.94
238_Base4_GHG1	RHMH	RHMHLFOFURMED	1.23	1.17	1.05	0.92	0.74	0.43	0.12			
238_Base4_GHG1	RHMH	RHMHLFOFURSTD	9.59E-02	9.05E-02	8.15E-02	7.19E-02	5.75E-02	3.36E-02	9.59E-03			
238_Base4_GHG1	RHMH	RHMHNGAFURMED	6.09	5.79	5.18	4.57	3.65	1.89	0.54			
238_Base4_GHG1	RHMH	RHMHNGAFURSTD	2.31	2.19	1.96	1.73	1.38	0.26	4.80E-02			
238_Base4_GHG1	RHMH	RHMHNGAHEPSTD08		0.50	1.38	2.51	4.84	7.11	8.91	9.63	9.44	9.54
238_Base4_GHG1	RHMH	RHMHNGLCHPSTD08		2.13E-08								
238_Base4_GHG1	RHMH	RHMHNGLFURSTD	0.13	0.11	9.96E-02	8.78E-02	7.31E-02	3.31E-02	9.21E-03			
238_Base4_GHG1	RHMH	RHMHNGLHEPSTD08		0.15	0.22	0.33	0.39	0.57	0.67	0.71	0.73	0.36
238_Base4_GHG1	RHMH	RHMHSLDCBOSTD08		0.66	0.76	0.87	1.02	3.16	3.97	5.38	5.85	6.04
238_Base4_GHG1	RHMH	RHMHSLDSTOSTD	1.10	1.03	0.92	0.81	0.65	0.38	0.11			
238_Base4_GHG1	RLIG	RLIGELCCFLSTD08		1.90	3.98E-02							
238_Base4_GHG1	RLIG	RLIGELCFLUIMP08		11.01	30.65	104.90	147.00	1.45				

238_Base4_GHG1	RLIG	RLIGELCFLUIMP20						185.02	206.79	224.11	256.45	287.98
238_Base4_GHG1	RLIG	RLIGELCFLUSTD	82.12	65.70	32.85							
238_Base4_GHG1	RLIG	RLIGELCHALSTD	5.11	4.00	2.04							
238_Base4_GHG1	RLIG	RLIGELCINCIMP	34.07	16.65								
238_Base4_GHG1	RLIG	RLIGELCINCIMP08		53.63	92.82	59.21	24.29	0.32	0.36	0.37	0.42	0.68
238_Base4_GHG1	RLIG	RLIGELCINCSTD	30.42	0.72								
238_Base4_GHG1	RLIG	RLIGELCINCSTD08				0.18						
238_Base4_GHG1	RLIG	RLIGKERLMPSTD08		0.75	0.88	0.75	1.21	0.93	0.89	1.12	1.87	5.81E-02
238_Base4_GHG1	ROEL	ROELELCOTHSTD	66.04	56.61	37.74	18.87						
238_Base4_GHG1	ROEL	ROELELCOTHSTD08		10.54	31.78	53.11	75.20	81.73	88.73	97.19	113.03	127.45
238_Base4_GHG1	RREF	RREFELC510IMP20						1.19E-02	0.02	3.21E-02	3.85E-02	1.26E-02
238_Base4_GHG1	RREF	RREFELC510STD08		3.90	11.73	19.66	31.28	29.83	12.92			
238_Base4_GHG1	RREF	RREFELC510STD20						18.13	39.14	57.16	66.66	75.13
238_Base4_GHG1	RREF	RREFELCREFIMP	13.20	12.10	9.90	7.70	4.40					
238_Base4_GHG1	RREF	RREFELCREFSTD	25.66	23.52	19.24	14.97	8.55					
238_Base4_GHG1	RWAH	RHAHLFOCBOSTD08		0.04	0.12	0.19	0.30	0.49	0.66	0.71	0.65	0.58
238_Base4_GHG1	RWAH	RHAHSLDCBOSTD08		0.44	0.51	0.58	0.68	1.03	1.13	1.21	1.12	0.88
238_Base4_GHG1	RWAH	RWAHCOAFURSTD	4.82E-03	4.50E-03	3.85E-03	3.21E-03	2.25E-03	6.42E-04				
238_Base4_GHG1	RWAH	RWAHELCHEPSTD08		0.25	0.31	0.93	1.90	1.89	1.89	1.52	8.87E-02	
238_Base4_GHG1	RWAH	RWAHELCHETSTD	4.81	4.23	3.84	3.21	2.24	0.64				
238_Base4_GHG1	RWAH	RWAHELCTAKMAX20						4.22	5.69	8.20	12.34	15.41
238_Base4_GHG1	RWAH	RWAHHFOFURSTD	3.95E-03	3.69E-03	3.16E-03	2.64E-03	1.85E-03	5.27E-04				
238_Base4_GHG1	RWAH	RWAHKERFURSTD	3.32E-02	5.55E-03	1.36E-02	4.79E-03	3.50E-03	4.17E-04				
238_Base4_GHG1	RWAH	RWAHLFOFURSTD	0.75	0.70	0.60	0.50	0.35	9.96E-02				
238_Base4_GHG1	RWAH	RWAHNGAFURSTD	17.99	14.62	14.39	2.12	2.14	6.98E-02				
238_Base4_GHG1	RWAH	RWAHNGATAKMAX08		3.26	3.82	16.64	17.45	18.86	18.65	18.27	17.48	16.45

238_Base4_GHG1	RWAH	RWAHNGLFURSTD	6.61E-02	6.11E-02	5.23E-02	4.37E-02	3.06E-02	1.60E-03				
238_Base4_GHG1	RWAH	RWAHNGLSTTMAX08		0.92	1.18	1.28	1.44	1.04	1.34	0.33	0.20	8.72E-02
238_Base4_GHG1	RWAH	RWAHSLDFURSTD08		1.78E-03	2.31E-03	2.64E-03	3.16E-03	3.16E-03	3.16E-03	9.45E-04	4.97E-05	1.43E-03
238_Base4_GHG1	RWAH	RWAHSLDSTOSTD	0.17	4.95E-02	0.10	0.11	6.75E-02	1.90E-02				
238_Base4_GHG1	RWAH	RWAHSLFCCOSTD08		0.12	9.68E-02	0.11	0.14	0.20	0.14	0.11	9.81E-02	8.46E-02
238_Base4_GHG1	RWAP	RHAPLFOCBOSTD08		0.29	0.36	0.58	0.91	1.45	1.96	2.11	1.93	1.72
238_Base4_GHG1	RWAP	RHAPSLDCBOSTD08		1.40	1.62	1.84	2.17	2.93	3.33	3.48	3.20	2.71
238_Base4_GHG1	RWAP	RWAPCOAFURSTD	1.42E-02	1.33E-02	1.14E-02	9.48E-03	6.64E-03	1.90E-03				
238_Base4_GHG1	RWAP	RWAPELCHEPSTD08		0.88	1.28	3.50	6.86	6.86	6.86	5.37	0.31	
238_Base4_GHG1	RWAP	RWAPELCHETSTD	16.74	15.12	13.38	11.16	7.81	2.23				
238_Base4_GHG1	RWAP	RWAPELCTAKMAX20						10.06	13.80	18.81	29.68	35.02
238_Base4_GHG1	RWAP	RWAPHFOFURSTD	1.32E-02	1.23E-02	1.05E-02	8.79E-03	6.15E-03	1.76E-03				
238_Base4_GHG1	RWAP	RWAPKERFURSTD	0.10	1.55E-02	2.89E-02	9.75E-03	6.90E-03	1.27E-03				
238_Base4_GHG1	RWAP	RWAPLFOFURSTD	2.32	2.17	1.86	1.55	1.08	0.31				
238_Base4_GHG1	RWAP	RWAPNGAFURSTD	35.85	29.63	28.68	5.66	5.56	1.15				
238_Base4_GHG1	RWAP	RWAPNGATAKMAX08		6.56	8.10	32.34	34.28	38.51	38.51	38.22	37.56	36.79
238_Base4_GHG1	RWAP	RWAPNGLFURSTD	0.13	0.12	0.10	8.44E-02	0.06	3.76E-03				
238_Base4_GHG1	RWAP	RWAPNGLSTTMAX08		1.66	2.20	2.36	2.63	1.79	3.00	1.39	0.42	0.17
238_Base4_GHG1	RWAP	RWAPSLDFURSTD08		6.82E-03	8.10E-03	8.73E-03	9.03E-03	9.03E-03	7.23E-03	1.70E-03	1.03E-03	6.06E-03
238_Base4_GHG1	RWAP	RWAPSLDSTOSTD	0.40	0.19	0.24	0.25	0.15	4.21E-02				
238_Base4_GHG1	RWAP	RWAPSLFCCOSTD08		0.21	0.30	0.38	0.50	0.71	0.65	0.55	0.49	0.43
238_Base4_GHG1	RWDH	RHDHENGHEPSTD08		0.49	0.49	0.49	0.49	0.49	0.31			
238_Base4_GHG1	RWDH	RHDHLFOCBOSTD08		0.39	1.05	1.72	2.73	4.38	5.94	6.39	5.82	5.15
238_Base4_GHG1	RWDH	RHDHSLDCBOSTD08		3.93	4.54	5.14	6.03	7.93	8.93	9.23	8.44	7.38
238_Base4_GHG1	RWDH	RWDHCOAFURSTD	0.07	6.82E-02	0.06	4.87E-02	3.41E-02	9.74E-03				
238_Base4_GHG1	RWDH	RWDHELCHEPSTD08		2.05	2.53	5.52	11.65	11.64	11.61	8.82	0.56	

238_Base4_GHG1	RWDH	RWDHELCHETSTD	30.63	26.90	24.47	20.42	14.29	4.08				
238_Base4_GHG1	RWDH	RWDHELCTAKMAX20						19.42	28.12	43.72	65.32	83.53
238_Base4_GHG1	RWDH	RWDHHFOFURSTD	6.35E-02	5.93E-02	5.08E-02	4.23E-02	2.96E-02	8.47E-03				
238_Base4_GHG1	RWDH	RWDHKERFURSTD	0.22	0.06	8.61E-02	4.51E-02	3.16E-02	4.36E-03				
238_Base4_GHG1	RWDH	RWDHLFOFURSTD	5.92	5.52	4.73	3.76	2.38	0.47				
238_Base4_GHG1	RWDH	RWDHNGAFURSTD	93.30	76.17	74.64	11.64	11.18	1.54				
238_Base4_GHG1	RWDH	RWDHNGATAKMAX08		16.50	19.95	85.49	90.28	100.13	98.94	98.32	92.78	88.60
238_Base4_GHG1	RWDH	RWDHNGLFURSTD	0.33	0.30	0.26	0.22	0.15	1.04E-02				
238_Base4_GHG1	RWDH	RWDHNGLSTTMAX08		4.48	5.68	6.32	7.36	6.98	8.97	1.12	4.07	1.04
238_Base4_GHG1	RWDH	RWDHSLDFURSTD08		6.94E-03	8.60E-03	1.10E-02	1.10E-02	1.10E-02	1.10E-02	2.70E-03	1.24E-02	1.24E-02
238_Base4_GHG1	RWDH	RWDHSLDSTOSTD	1.01	0.14	0.57	0.56	0.33	9.47E-02				
238_Base4_GHG1	RWDH	RWDHSLFCCOSTD08		0.86	0.74	0.81	1.09	1.60	1.40	1.20	1.06	0.92
238_Base4_GHG1	RWMH	RHMHLFOCBOSTD08		8.95E-03	2.94E-02	5.16E-02	8.51E-02	0.14	0.19	0.21	0.19	0.17
238_Base4_GHG1	RWMH	RHMHSLDCBOSTD08		0.12	0.13	0.15	0.18	0.56	0.70	0.95	1.03	1.07
238_Base4_GHG1	RWMH	RWMHCOAFURSTD	2.34E-03	2.18E-03	1.87E-03	1.56E-03	1.09E-03	3.12E-04				
238_Base4_GHG1	RWMH	RWMHELCHEPSTD08		0.32	0.32	0.40	0.52	0.52	0.52	0.20	1.18E-02	
238_Base4_GHG1	RWMH	RWMHELCHETSTD	0.99	0.87	0.76	0.63	0.45	0.13				
238_Base4_GHG1	RWMH	RWMHELCTAKMAX20						0.38	0.55	1.02	1.29	2.15
238_Base4_GHG1	RWMH	RWMHHFOFURSTD	4.52E-03	4.22E-03	3.61E-03	3.01E-03	2.11E-03	6.02E-04				
238_Base4_GHG1	RWMH	RWMHKERFURSTD	8.19E-03	3.17E-03	3.10E-03	2.56E-03	2.40E-03	2.71E-04				
238_Base4_GHG1	RWMH	RWMHLFOFURSTD	0.25	0.24	0.20	0.17	0.12	2.93E-02				
238_Base4_GHG1	RWMH	RWMHNGAFURSTD	3.12	2.58	2.49	0.58	0.41	1.05E-02				
238_Base4_GHG1	RWMH	RWMHNGATAKMAX08		0.63	0.82	2.80	3.12	3.72	3.68	3.61	3.31	3.16
238_Base4_GHG1	RWMH	RWMHNGLFURSTD	8.18E-03	7.19E-03	6.11E-03	5.08E-03	3.52E-03	6.03E-04				
238_Base4_GHG1	RWMH	RWMHNGLSTTMAX08		0.13	0.18	0.23	0.30	0.22	0.27	2.58E-02	0.40	2.45E-02
238_Base4_GHG1	RWMH	RWMHSLDSTOSTD	3.38E-02	9.83E-03	1.72E-02	1.72E-02	9.42E-03	1.94E-03				

238_Base4_GHG1	RWMH	RWMHSLFCCOSTD08		8.56E-02	7.75E-02	7.49E-02	7.82E-02	0.11	9.69E-02	8.07E-02	7.19E-02	6.23E-02
238_Base4_GHG2	RCAH	RCAHELCCENSTD	3.292060717	3.017722	2.469046	1.920369	1.097354					
238_Base4_GHG2	RCAH	RCAHELCCENSTD08		1.82E-03	8.59E-03	0.530801	1.771865	1.771364	1.407894		7.67E-07	
238_Base4_GHG2	RCAH	RCAHELCCENSTD20						1.873118	2.845894	5.148365	5.125982	4.494007
238_Base4_GHG2	RCAH	RCAHELCHENIMP08		3.36E-06								
238_Base4_GHG2	RCAH	RCAHELCHENIMP20						1.77E-06				
238_Base4_GHG2	RCAH	RCAHELCROMSTD	0.728038739	0.765556	0.626364	0.487172	0.278384					
238_Base4_GHG2	RCAH	RCAHNGAHENSTD08				-5.61E-08					0.108367	0.289128
238_Base4_GHG2	RCAH	RHAHELCCHPSTD08		8.53E-08		6.05E-07						
238_Base4_GHG2	RCAH	RHAHELCHEPSTD	0.10711323	0.209037	0.921573	1.142694	0.967309	0.576101	0.168488			
238_Base4_GHG2	RCAH	RHAHNGACHPSTD08		0.183525	0.295548	0.388167	0.53235	0.80851	1.153906	2.248586	3.979584	5.12631
238_Base4_GHG2	RCAH	RHAHNGLCHPSTD08		2.13E-04	3.03E-04	3.92E-04	5.35E-04	7.96E-04	1.10E-03	8.71E-03	0.019221	3.26E-02
238_Base4_GHG2	RCAP	RCAPELCCENSTD	2.839031535	2.602446	2.129274	1.656102	0.946344					
238_Base4_GHG2	RCAP	RCAPELCCENSTD08		5.98E-03	0.29282	0.985098	1.985195	1.983552	1.309864			
238_Base4_GHG2	RCAP	RCAPELCCENSTD20						1.44819	2.531108	4.053384	4.13233	4.01698
238_Base4_GHG2	RCAP	RCAPELCHENIMP08		2.36E-07								
238_Base4_GHG2	RCAP	RCAPELCHENIMP20						3.78E-06				
238_Base4_GHG2	RCAP	RCAPELCHENSTD08		9.95E-08	-4.06E-07	4.47E-07			-3.69E-08			
238_Base4_GHG2	RCAP	RCAPELCROMSTD	0.661443067	0.672502	0.550229	0.427956	0.244546					
238_Base4_GHG2	RCAP	RCAPELCWALSTD08			1.59E-06	1.59E-06	2.80E-06	2.73E-06				
238_Base4_GHG2	RCAP	RCAPNGAHENSTD08		3.10E-07			2.74E-02	0.05526	7.10E-02	9.44E-02	0.249787	0.429922
238_Base4_GHG2	RCAP	RHAPELCHEPSTD	7.22E-02	0.215242	0.593552	0.540337	0.453776	0.30058	8.91E-02			
238_Base4_GHG2	RCAP	RHAPNGACHPSTD08		0.122306	0.177394	0.256487	0.352007	0.53603	0.775034	1.045989	1.676992	2.40991
238_Base4_GHG2	RCAP	RHAPNGLCHPSTD08		4.29E-04	9.08E-03	1.77E-02	3.36E-02	5.72E-02	0.100466	0.139851	0.124598	0.109503
238_Base4_GHG2	RCDH	RCDHELCCENSTD	14.61741059	13.39929	10.96306	8.526823	4.87247					
238_Base4_GHG2	RCDH	RCDHELCCENSTD08		9.78E-07	4.04E-06	0.126653	0.576101	0.576101	0.553178	0.098868		

238_Base4_GHG2	RCDH	RCDHELCCENSTD20						9.513607	15.68404	20.21643	20.75606	20.20683
238_Base4_GHG2	RCDH	RCDHELCHENIMP08		1.17E-06								
238_Base4_GHG2	RCDH	RCDHELCHENSTD08		2.56E-07	6.96E-07				1.77E-06	3.36E-06		
238_Base4_GHG2	RCDH	RCDHELCHENSTD20							3.10E-06		-8.96E-07	
238_Base4_GHG2	RCDH	RCDHELCROMSTD	2.344752956	3.141992	2.570721	1.999449	1.142542					
238_Base4_GHG2	RCDH	RCDHELCWALSTD08				1.17E-06	2.13E-06	5.30E-06	1.08E-06			
238_Base4_GHG2	RCDH	RCDHNGAHENSTD08					2.88E-07		0.228308	0.346439	0.743615	1.193107
238_Base4_GHG2	RCDH	RHDHELCCHPSTD08				1.15E-06	1.45E-06					
238_Base4_GHG2	RCDH	RHDHELCHEPSTD	1.082874477	0.949734	4.227701	7.333063	11.37144	8.587681	3.41369			
238_Base4_GHG2	RCDH	RHDHNGACHPSTD08		0.693616	0.987799	1.419048	1.97215	3.033783	4.380388	5.918645	9.530841	13.70642
238_Base4_GHG2	RCDH	RHDHNGLCHPSTD08		0.10047	0.122152	0.143612	0.185845	0.302221	0.420782	0.472324	0.395376	0.344202
238_Base4_GHG2	RCDR	RCDRELCCDRIMP	12.34382094	11.31517	9.257866	7.200562	4.114607					
238_Base4_GHG2	RCDR	RCDRELCCDRIMP08		4.034971	11.64654	19.15741	30.17015	28.67319	12.24546			
238_Base4_GHG2	RCDR	RCDRELCCDRIMP20						17.49426	38.08103	55.32334	64.71589	73.49413
238_Base4_GHG2	RCDR	RCDRELCCDRSTD	24.00187405	22.00172	18.00141	14.00109	8.000625					
238_Base4_GHG2	RCDR	RCDRNGACDRSTD	3.7357266	3.424416	2.801795	2.179174	1.245242					
238_Base4_GHG2	RCDR	RCDRNGACDRSTD08		2.21E-04	0.426336	1.110589	2.090559	2.090477	1.096491			
238_Base4_GHG2	RCDR	RCDRNGACDRSTD20						1.36912	2.490654	3.756537	3.881798	3.805067
238_Base4_GHG2	RCMH	RCMHELCCENSTD	0.106813157	9.67E-02	8.01E-02	6.23E-02	3.56E-02					
238_Base4_GHG2	RCMH	RCMHELCCENSTD08		1.04E-02	3.01E-02	5.00E-02	0.072915	7.01E-02	3.36E-02		2.77E-07	
238_Base4_GHG2	RCMH	RCMHELCCENSTD20						4.21E-02	8.62E-02	0.13616	0.143951	0.142889
238_Base4_GHG2	RCMH	RCMHELCHENIMP08		6.48E-08								
238_Base4_GHG2	RCMH	RCMHELCHENSTD08		1.42E-08								
238_Base4_GHG2	RCMH	RCMHELCROMSTD	4.23E-02	4.17E-02	3.41E-02	2.66E-02	1.52E-02					
238_Base4_GHG2	RCMH	RCMHNGAHENSTD08		2.87E-04	2.87E-04	5.28E-04	7.35E-03	1.11E-02	1.52E-02	1.99E-02	0.030388	4.23E-02
238_Base4_GHG2	RCMH	RHMHELCHEPSTD	3.26E-03	6.09E-03	1.65E-02	2.69E-02	2.34E-02	2.51E-02	1.36E-02			

238_Base4_GHG2	RCMH	RHMHENGHEPSTD08				1.11E-03	2.11E-02	0.11857	0.13642	0.290292	0.225104	0.224024
238_Base4_GHG2	RCOK	RCOKELCRANIMP	11.8183617	10.8335	8.863771	6.894044	3.939454					
238_Base4_GHG2	RCOK	RCOKELCRANIMP08		0.839776	3.177057	7.741119	11.82798	11.82798	11.22475	4.451582		
238_Base4_GHG2	RCOK	RCOKELCRANIMP20						9.675205	9.731028	12.02626	11.36412	12.84428
238_Base4_GHG2	RCOK	RCOKELCRANSTD	22.98014775	21.06514	17.23511	13.40509	7.660049					
238_Base4_GHG2	RCOK	RCOKELCRANSTD08		1.167541	4.959631	6.391442	11.23555	11.23555	10.34838	3.979586		
238_Base4_GHG2	RCOK	RCOKELCRANSTD20						2.485358	3.05301	12.88526	19.50494	14.97512
238_Base4_GHG2	RCOK	RCOKNGARANSTD	3.7357266	3.424416	2.801795	2.179174	1.245242					
238_Base4_GHG2	RCOK	RCOKNGARANSTD08		9.87E-02	0.493503	1.152147	2.128272	2.128272	2.04664	0.922579		
238_Base4_GHG2	RCOK	RCOKNGARANSTD20						1.339142	1.354733	2.39998	3.095699	2.7998
238_Base4_GHG2	RCOK	RCOKSOLRANSTD08		1.68141	2.742419	3.561806	4.861814	7.291608	9.608251	12.15975	17.4599	23.09869
238_Base4_GHG2	RCWA	RCWAELCCWAIMP	0.82146888	0.753013	0.616102	0.47919	0.273823					
238_Base4_GHG2	RCWA	RCWAELCCWASTD	1.5973006	1.464192	1.197975	0.931759	0.532434					
238_Base4_GHG2	RCWA	RCWAELCCWASTD08		0.243009	0.732133	1.225917	1.949702	1.578685	0.310849			
238_Base4_GHG2	RCWA	RCWAELCCWASTD20						1.417968	2.94478	3.563952	4.140727	4.665144
238_Base4_GHG2	RDWA	RDWAELCDWAIMP	0.84541644	0.774965	0.634062	0.49316	0.281805					
238_Base4_GHG2	RDWA	RDWAELCDWAMAX08		0.208364	0.613326	1.12166	1.865076	2.431083	2.64468	2.938862	4.050436	3.308884
238_Base4_GHG2	RDWA	RDWAELCDWASTD	1.6438653	1.506877	1.232899	0.958921	0.547955					
238_Base4_GHG2	RDWA	RDWAELCDWASTD08		4.34E-02	0.133431	0.134766	0.136861	0.095808	1.61E-03			
238_Base4_GHG2	RDWA	RDWAELCDWASTD20						0.555885	0.70769	0.739626	0.229949	1.518766
238_Base4_GHG2	RFRE	RFREELCFREIMP	4.23708624	3.883996	3.177815	2.471634	1.412362					
238_Base4_GHG2	RFRE	RFREELCFREIMP08		1.256054	3.7503	6.295369	10.02565	10.02565	8.120539	1.602071		
238_Base4_GHG2	RFRE	RFREELCFREIMP20						5.398202	8.637845	16.76098	21.3086	23.96105
238_Base4_GHG2	RFRE	RFREELCFRESTD	8.2387788	7.552214	6.179084	4.805954	2.74626					
238_Base4_GHG2	RFRE	RFREELCFRESTD08		2.75E-03	1.24E-02	2.13E-02	0.030574	0.030574	2.48E-02	3.98E-03		
238_Base4_GHG2	RFRE	RFREELCFRESTD20						1.35E-02	1.97E-02	1.97E-02	4.26E-03	4.55E-02

238_Base4_GHG2	RHAH	RHAHCOABOISTD08										3.999228
238_Base4_GHG2	RHAH	RHAHCOAFURSTD	1.94E-02	1.84E-02	1.65E-02	1.46E-02	1.16E-02	6.79E-03	1.94E-03			
238_Base4_GHG2	RHAH	RHAHELCBASSTD	17.30655517	15.64124	14.71057	12.97992	10.38393	6.057294	1.730656			
238_Base4_GHG2	RHAH	RHAHELCBASSTD08		0.897036	3.97676	7.404779	12.07686	16.41754	17.6858	22.59716	32.38501	42.16956
238_Base4_GHG2	RHAH	RHAHELCCHPSTD08		1.28E-07		9.07E-07						
238_Base4_GHG2	RHAH	RHAHELCHEPSTD	1.589056371	1.402324	0.520171	0.129433	5.04E-02	1.76E-02	1.13E-03			
238_Base4_GHG2	RHAH	RHAHELCHEPSTD20						2.525666	9.429296	9.556518	6.860155	1.121899
238_Base4_GHG2	RHAH	RHAHHFOFURSTD	1.84E-02	1.75E-02	1.57E-02	1.38E-02	1.11E-02	6.45E-03	1.84E-03			
238_Base4_GHG2	RHAH	RHAHKERFURSTD	0.184884273	3.46E-02	3.19E-02	2.31E-02	1.94E-02	4.48E-03	9.32E-04			
238_Base4_GHG2	RHAH	RHAHLFOCBOSTD08		0.251964	0.67203	1.096283	1.72609	2.755645	3.733153	4.02189	3.660824	3.260429
238_Base4_GHG2	RHAH	RHAHLFOFURMED	4.077603492	3.873723	3.465963	3.058203	2.446562	1.427161	0.40776			
238_Base4_GHG2	RHAH	RHAHLFOFURSTD	0.296740226	0.280718	0.252229	0.222555	0.178044	0.103859	2.97E-02			
238_Base4_GHG2	RHAH	RHAHNGACHPSTD08		0.428226	0.689613	0.905723	1.24215	1.886524	2.692448	5.2467	9.285696	11.96139
238_Base4_GHG2	RHAH	RHAHNGAFURHIG	11.94845547	11.35103	10.15619	8.961342	7.169073	4.181959	1.194846			
238_Base4_GHG2	RHAH	RHAHNGAFURMED	16.70186715	15.86677	14.19659	12.5264	10.02112	5.845654	1.670187			
238_Base4_GHG2	RHAH	RHAHNGAFURSTD	7.125985671	6.769686	6.055938	5.344489	4.275591	2.494095	0.712599			
238_Base4_GHG2	RHAH	RHAHNGAHEPSTD08		0.302866	3.73062	7.195834	12.25918	20.4803	28.19886	28.41024	21.85596	16.01454
238_Base4_GHG2	RHAH	RHAHNGLCHPSTD08		3.19E-04	4.54E-04	5.88E-04	8.02E-04	1.19E-03	1.64E-03	1.31E-02	2.88E-02	4.89E-02
238_Base4_GHG2	RHAH	RHAHNGLFURSTD	0.667398943	0.64091	0.573446	0.505982	0.404785	0.234644	6.70E-02			
238_Base4_GHG2	RHAH	RHAHNGLHEPSTD08		0.384419	0.453723	0.522021	0.62069	0.782521	0.933422	0.961228	0.868681	0.755228
238_Base4_GHG2	RHAH	RHAHSLDCBOSTD08		2.503105	2.902786	3.299726	3.881587	5.826544	6.416538	6.829276	6.294125	4.979115
238_Base4_GHG2	RHAH	RHAHSLDSTOSTD	4.054424887	3.857734	3.451657	3.044348	2.436463	1.42127	0.406077			
238_Base4_GHG2	RHAP	RHAPCOAFURSTD	4.59E-02	4.37E-02	3.91E-02	3.45E-02	2.76E-02	1.61E-02	4.59E-03			
238_Base4_GHG2	RHAP	RHAPELCBASSTD	40.7460474	36.43454	34.63414	30.55954	24.44763	14.26112	4.074605			
238_Base4_GHG2	RHAP	RHAPELCBASSTD08		1.057101	5.25841	10.00517	16.95059	28.43809	20.52253	16.71957	6.241967	11.54146
238_Base4_GHG2	RHAP	RHAPELCHEPSTD	0.818562127	0.630977	0.163592	0.127731	0.080678	0.011185				

238_Base4_GHG2	RHAP	RHAPELCHEPSTD08				1.42177	3.629676	3.629676	3.629676	2.418948		
238_Base4_GHG2	RHAP	RHAPELCHEPSTD20						3.453618	27.17293	41.17614	64.79439	70.76067
238_Base4_GHG2	RHAP	RHAPHFOFURSTD	0.027259136	2.59E-02	2.32E-02	2.04E-02	1.64E-02	9.54E-03	2.73E-03			
238_Base4_GHG2	RHAP	RHAPKERFURSTD	0.402709159	3.66E-02	8.09E-02	5.90E-02	0.187398	5.19E-03	1.23E-03			
238_Base4_GHG2	RHAP	RHAPLFOCBOSTD08		1.172612	1.429742	2.319844	3.642972	5.808967	7.851486	8.447809	7.727566	6.836669
238_Base4_GHG2	RHAP	RHAPLFOFURMED	8.820706969	7.748201	7.497601	6.61553	5.292424	3.087247	0.882071			
238_Base4_GHG2	RHAP	RHAPLFOFURSTD	0.412673918	0.390461	0.350773	0.309505	0.247604	0.144436	4.13E-02			
238_Base4_GHG2	RHAP	RHAPNGABOISTD08		0.807007	2.783522	3.805865	4.99225	4.99225	4.99225	3.629481	0.212529	
238_Base4_GHG2	RHAP	RHAPNGABOISTD20						1.939608	3.800983	5.019242	6.738233	4.568451
238_Base4_GHG2	RHAP	RHAPNGACHPSTD08		0.28538	0.41392	0.59847	0.821349	1.250736	1.808413	2.44064	3.912981	5.623123
238_Base4_GHG2	RHAP	RHAPNGAFURHIG	12.9568299	12.30899	11.01331	9.717622	7.774098	4.53489	1.295683			
238_Base4_GHG2	RHAP	RHAPNGAFURMED	20.14963139	19.14215	17.12719	15.11222	12.08978	7.052371	2.014963			
238_Base4_GHG2	RHAP	RHAPNGAFURSTD	9.468471005	8.995047	8.0482	7.101353	5.681083	3.313965	0.946847			
238_Base4_GHG2	RHAP	RHAPNGAHEPSTD08			2.271931	5.459794	10.51399	18.76767	26.50635	29.33037	26.53427	23.41913
238_Base4_GHG2	RHAP	RHAPNGLCHPSTD08		6.43E-04	1.36E-02	2.65E-02	5.04E-02	8.57E-02	0.150698	0.209777	0.186897	0.164254
238_Base4_GHG2	RHAP	RHAPNGLFURSTD	0.784612519	0.757667	0.677913	0.598158	0.478527	0.276823	7.91E-02			
238_Base4_GHG2	RHAP	RHAPNGLHEPSTD08		0.452431	0.52072	0.588056	0.680776	0.837525	0.949671	0.935685	0.867565	0.778885
238_Base4_GHG2	RHAP	RHAPSLDCBOSTD08		5.613636	6.494823	7.371483	8.665373	11.70501	13.32402	14.05827	12.93677	10.77584
238_Base4_GHG2	RHAP	RHAPSLDSTOSTD	9.077421989	8.635708	7.731173	6.822721	5.459948	3.18497	0.909991			
238_Base4_GHG2	RHDH	RHDHCOABOISTD08										0.241768
238_Base4_GHG2	RHDH	RHDHCOAFURSTD	0.44086266	0.41882	0.374733	0.330647	0.264518	0.154302	4.41E-02			
238_Base4_GHG2	RHDH	RHDHELCBASSTD	136.3982659	120.8572	115.9385	102.2987	81.83896	47.73939	13.63983			
238_Base4_GHG2	RHDH	RHDHELCBASSTD08		5.861366	28.34614	59.78672	106.6995	174.4326	244.4555	288.1458	348.278	411.6209
238_Base4_GHG2	RHDH	RHDHELCCHPSTD08				1.73E-06	2.18E-06					
238_Base4_GHG2	RHDH	RHDHELCHEPSTD	33.56061725	31.96158	25.21927	18.64956	9.414659	3.537541	5.07E-02			
238_Base4_GHG2	RHDH	RHDHENGHEPSTD08		2.781523	2.781523	2.781523	2.781523	2.781523	1.749582			

238_Base4_GHG2	RHDH	RHDHHFOFURSTD	0.360289615	0.342275	0.306246	0.270217	0.216174	0.126101	3.60E-02			
238_Base4_GHG2	RHDH	RHDHKERFURSTD	1.55583067	0.359103	0.278983	0.154917	0.13832	3.88E-02	1.11E-02			
238_Base4_GHG2	RHDH	RHDHLFOCBOSTD08		2.193466	5.958738	9.773041	15.4883	24.81604	33.6408	36.19289	32.81839	29.14425
238_Base4_GHG2	RHDH	RHDHLFOFURMED	38.62676553	36.69543	32.83275	28.97007	23.17606	13.51937	3.862677			
238_Base4_GHG2	RHDH	RHDHLFOFURSTD	1.255574906	1.137281	1.067239	0.941681	0.753345	0.439451	0.125557			
238_Base4_GHG2	RHDH	RHDHNGABOISTD08		4.394362	18.03376	23.49901	29.39396	29.39396	29.39396	20.90606	1.05602	
238_Base4_GHG2	RHDH	RHDHNGABOISTD20						15.78175	28.84911	37.30764	43.4884	26.04532
238_Base4_GHG2	RHDH	RHDHNGACHPSTD08		1.618438	2.304864	3.311112	4.601683	7.078826	10.2209	13.81017	22.23863	31.98165
238_Base4_GHG2	RHDH	RHDHNGAFURHIG	87.78585623	83.39656	74.61798	65.83939	52.67151	30.72505	8.778586			
238_Base4_GHG2	RHDH	RHDHNGAFURMED	149.3383986	141.7062	126.9376	112.0038	89.60304	52.26844	14.93384			
238_Base4_GHG2	RHDH	RHDHNGAFURSTD	57.94377119	53.07858	47.98228	43.06018	34.76626	20.28032	5.794377			
238_Base4_GHG2	RHDH	RHDHNGAHEPSTD08		1.353739	16.58919	39.96329	77.58849	133.6755	189.3717	211.0219	195.3922	178.0339
238_Base4_GHG2	RHDH	RHDHNGLCHPSTD08		0.150706	0.183228	0.215418	0.278768	0.453331	0.631172	0.708487	0.593064	0.516304
238_Base4_GHG2	RHDH	RHDHNGLFURSTD	5.125258886	4.928408	4.409628	3.890849	3.112679	1.78897	0.511134			
238_Base4_GHG2	RHDH	RHDHNGLHEPSTD08		2.873806	3.370028	3.8613	4.560669	5.652809	6.623542	6.838082	6.345797	5.697282
238_Base4_GHG2	RHDH	RHDHSLDCBOSTD08		22.28427	25.7057	29.11211	34.16632	44.92055	50.57912	52.46191	47.6929	41.75854
238_Base4_GHG2	RHDH	RHDHSLDSTOSTD	34.88197945	33.58056	30.04576	26.51097	21.20877	12.37178	3.534796			
238_Base4_GHG2	RHMH	RHMHCOABOISTD08										1.940177
238_Base4_GHG2	RHMH	RHMHCOAFURSTD	2.04E-02	1.94E-02	1.73E-02	1.53E-02	1.22E-02	7.13E-03	2.04E-03			
238_Base4_GHG2	RHMH	RHMHELCBASSTD	4.801048352	4.199045	4.080891	3.600786	2.880629	1.55582	0.457262			
238_Base4_GHG2	RHMH	RHMHELCBASSTD08		2.27E-02	0.210677	0.214697	0.214697	0.209938	0.112867			
238_Base4_GHG2	RHMH	RHMHELCHEPSTD	0.405985093	0.382691	0.331401	0.280023	0.22214	0.111627	2.73E-02			
238_Base4_GHG2	RHMH	RHMHELCHEPSTD08		1.40E-03	0.214409	0.842728	1.019883	1.019883	1.019366	0.414943		
238_Base4_GHG2	RHMH	RHMHELCHEPSTD20						0.982905	2.153007	2.971109	4.140392	3.099332
238_Base4_GHG2	RHMH	RHMHENGHEPSTD08				1.67E-03	3.16E-02	0.177855	0.204631	0.435437	0.337656	0.336036
238_Base4_GHG2	RHMH	RHMHHFOFURSTD	2.90E-02	2.76E-02	2.47E-02	2.18E-02	1.74E-02	1.02E-02	2.90E-03			

238_Base4_GHG2	RHMH	RHMHKERFURSTD	7.67E-02	4.43E-02	6.52E-02	5.76E-02	4.05E-02	1.08E-02	1.68E-03			
238_Base4_GHG2	RHMH	RHMHLFOCBOSTD08		5.07E-02	0.166625	0.292486	0.482205	0.794447	1.087023	1.17134	1.06294	0.941024
238_Base4_GHG2	RHMH	RHMHLFOFURMED	1.232731323	1.171095	1.047822	0.924548	0.739639	0.431456	0.123273			
238_Base4_GHG2	RHMH	RHMHLFOFURSTD	9.59E-02	9.05E-02	8.15E-02	7.19E-02	5.75E-02	3.36E-02	9.59E-03			
238_Base4_GHG2	RHMH	RHMHNGAFURMED	6.089508376	5.785033	5.176082	4.567131	3.653705	1.893397	0.540971			
238_Base4_GHG2	RHMH	RHMHNGAFURSTD	2.307020879	2.19167	1.960968	1.730266	1.384213	0.258802	4.80E-02			
238_Base4_GHG2	RHMH	RHMHNGAHEPSTD08		0.508665	1.390207	2.508914	4.838226	7.109044	8.909263	9.71147	9.78499	9.276872
238_Base4_GHG2	RHMH	RHMHNGLFURSTD	0.126852327	0.111309	9.96E-02	8.78E-02	7.31E-02	3.31E-02	9.21E-03			
238_Base4_GHG2	RHMH	RHMHNGLHEPSTD08		0.144853	0.216753	0.255301	0.394759	0.5655	0.864791	1.005772	0.668796	0.505509
238_Base4_GHG2	RHMH	RHMHSLDCBOSTD08		0.65947	0.761876	0.866069	1.022813	3.162379	3.856359	5.005735	5.496605	6.169849
238_Base4_GHG2	RHMH	RHMHSLDSTOSTD	1.095736321	1.025253	0.91813	0.810114	0.648092	0.378053	0.108015			
238_Base4_GHG2	RLIG	RLIGELCCFLSTD08		1.896153	3.98E-02							
238_Base4_GHG2	RLIG	RLIGELCFLUIMP08		11.01384	30.60344	103.67	147.4191	1.458802				
238_Base4_GHG2	RLIG	RLIGELCFLUIMP20						185.0121	206.6955	224.0126	256.7528	287.0272
238_Base4_GHG2	RLIG	RLIGELCFLUSTD	82.12354425	65.69884	32.84942							
238_Base4_GHG2	RLIG	RLIGELCHALSTD	5.10990942	3.996945	2.043964							
238_Base4_GHG2	RLIG	RLIGELCINCIMP	34.0660628	16.65394								
238_Base4_GHG2	RLIG	RLIGELCINCIMP08		53.63437	92.86826	60.43636	23.87031	0.315175	0.356244	0.372995	0.406923	0.429261
238_Base4_GHG2	RLIG	RLIGELCINCSTD	30.4161275	0.720973								
238_Base4_GHG2	RLIG	RLIGELCINCSTD08				0.178508						
238_Base4_GHG2	RLIG	RLIGKERLMPSTD08		0.752115	0.882839	0.745042	1.205304	0.925478	0.981112	1.217895	0.494877	5.81E-02
238_Base4_GHG2	ROEL	ROELELCOTHSTD	66.040422	56.60608	37.73738	18.86869						
238_Base4_GHG2	ROEL	ROELELCOTHSTD08		10.53825	31.77626	53.10561	75.19541	81.72585	88.72886	97.18779	113.0319	127.4457
238_Base4_GHG2	RREF	RREFELC510IMP20						1.19E-02	0.022276	3.21E-02	3.85E-02	4.40E-02
238_Base4_GHG2	RREF	RREFELC510STD08		3.900028	11.72583	19.66488	31.28078	29.83388	12.92335			
238_Base4_GHG2	RREF	RREFELC510STD20						18.12518	39.13778	57.16188	66.34436	74.92659

238_Base4_GHG2	RREF	RREFELCREFIMP	13.195998	12.09633	9.896999	7.697666	4.398666					
238_Base4_GHG2	RREF	RREFELCREFSTD	25.658885	23.52064	19.24416	14.96768	8.552962					
238_Base4_GHG2	RWAH	RHAHLFOCBOSTD08		0.044464	0.118594	0.193462	0.304604	0.48629	0.658792	0.709745	0.646028	0.57537
238_Base4_GHG2	RWAH	RHAHSLDCBOSTD08		0.441724	0.512256	0.582305	0.684986	1.028214	1.13233	1.205166	1.110728	0.878667
238_Base4_GHG2	RWAH	RWAHCOAFURSTD	4.82E-03	4.50E-03	3.85E-03	3.21E-03	2.25E-03	6.42E-04				
238_Base4_GHG2	RWAH	RWAHELCHEPSTD08		0.246573	0.31043	0.932821	1.895033	1.893438	1.889923	1.518255	8.89E-02	
238_Base4_GHG2	RWAH	RWAHELCHETSTD	4.808689207	4.232061	3.826857	3.205793	2.244055	0.639363				
238_Base4_GHG2	RWAH	RWAHELCTAKMAX20						3.973834	5.717295	8.228768	11.30934	14.10309
238_Base4_GHG2	RWAH	RWAHHFOFURSTD	3.95E-03	3.69E-03	3.16E-03	2.64E-03	1.85E-03	5.27E-04				
238_Base4_GHG2	RWAH	RWAHKERFURSTD	3.32E-02	5.55E-03	1.36E-02	4.79E-03	3.50E-03	4.17E-04				
238_Base4_GHG2	RWAH	RWAHLFOFURSTD	0.747149204	0.697328	0.597696	0.498099	0.34867	9.96E-02				
238_Base4_GHG2	RWAH	RWAHNGAFURSTD	17.98812969	14.61739	14.38905	2.10618	2.124582	0.341544				
238_Base4_GHG2	RWAH	RWAHNGATAKMAX08		3.260613	3.816912	16.64586	17.45006	18.83175	18.62839	18.26531	17.46177	16.40224
238_Base4_GHG2	RWAH	RWAHNGLFURSTD	6.61E-02	6.11E-02	5.23E-02	4.37E-02	3.06E-02	1.60E-03				
238_Base4_GHG2	RWAH	RWAHNGLSTTMAX08		0.918997	1.196864	1.293297	1.455237	1.04234	1.335597	0.309672	1.201438	1.354838
238_Base4_GHG2	RWAH	RWAHSLDFURSTD08		1.78E-03	2.31E-03	2.64E-03	3.16E-03	3.16E-03	3.16E-03	9.45E-04		1.40E-03
238_Base4_GHG2	RWAH	RWAHSLDSTOSTD	0.172057931	4.95E-02	0.103758	0.111238	6.75E-02	1.90E-02				
238_Base4_GHG2	RWAH	RWAHSLFCCOSTD08		0.115156	9.68E-02	0.11235	0.14093	0.195388	0.139837	0.111195	9.79E-02	8.48E-02
238_Base4_GHG2	RWAP	RHAPLFOCBOSTD08		0.293153	0.357436	0.579961	0.910743	1.452242	1.962871	2.111952	1.931892	1.709167
238_Base4_GHG2	RWAP	RHAPSLDCBOSTD08		1.403409	1.623706	1.842871	2.166343	2.926253	3.331005	3.514567	3.234193	2.693961
238_Base4_GHG2	RWAP	RWAPCOAFURSTD	1.42E-02	1.33E-02	1.14E-02	9.48E-03	6.64E-03	1.90E-03				
238_Base4_GHG2	RWAP	RWAPELCHEPSTD08		0.875482	1.2835	3.492318	6.858105	6.857236	6.857764	5.366974	0.309325	
238_Base4_GHG2	RWAP	RWAPELCHETSTD	16.73884185	15.12493	13.35201	11.15923	7.81146	2.230024				
238_Base4_GHG2	RWAP	RWAPELCTAKMAX20						10.39663	14.19453	19.59335	29.09988	34.85849
238_Base4_GHG2	RWAP	RWAPHFOFURSTD	1.32E-02	1.23E-02	1.05E-02	8.79E-03	6.15E-03	1.76E-03				
238_Base4_GHG2	RWAP	RWAPKERFURSTD	0.102224251	1.55E-02	2.89E-02	9.75E-03	6.90E-03	1.27E-03				

238_Base4_GHG2	RWAP	RWAPLFOFURSTD	2.324662459	2.16964	1.85965	1.549775	1.084824	0.309769			
238_Base4_GHG2	RWAP	RWAPNGAFURSTD	35.85278253	29.62652	28.68223	5.628599	5.52602	1.153668			
238_Base4_GHG2	RWAP	RWAPNGATAKMAX08		6.558835	8.100347	32.34636	34.27806	38.17863	38.16999	37.82163	37.45817	36.64315
238_Base4_GHG2	RWAP	RWAPNGLFURSTD	0.12820031	0.118043	0.10079	8.44E-02	0.059072	3.76E-03			
238_Base4_GHG2	RWAP	RWAPNGLSTTMAX08		1.661388	2.232087	2.392861	2.66325	1.794968	2.94239	0.965924	0.870845	0.168466
238_Base4_GHG2	RWAP	RWAPSLDFURSTD08		6.82E-03	8.10E-03	8.73E-03	9.03E-03	9.03E-03	7.23E-03	1.70E-03	1.03E-03	5.97E-03
238_Base4_GHG2	RWAP	RWAPSLDSTOSTD	0.398383997	0.193412	0.241781	0.254027	0.147339	4.21E-02			
238_Base4_GHG2	RWAP	RWAPSLFCCOSTD08		0.205532	0.30118	0.376747	0.49749	0.710297	0.646199	0.553256	0.489515	0.428784
238_Base4_GHG2	RWDH	RHDHENGHEPSTD08		0.490857	0.490857	0.490857	0.490857	0.490857	0.30875			
238_Base4_GHG2	RWDH	RHDHLFOCBOSTD08		0.387082	1.051542	1.724654	2.73323	4.379301	5.936611	6.38698	5.79148	5.143102
238_Base4_GHG2	RWDH	RHDHSLDCBOSTD08		3.932518	4.5363	5.137431	6.029351	7.927155	8.925726	9.257984	8.416395	7.369154
238_Base4_GHG2	RWDH	RWDHCOAFURSTD	0.073026986	6.82E-02	0.058422	4.87E-02	3.41E-02	9.74E-03			
238_Base4_GHG2	RWDH	RWDHELCHEPSTD08		2.035791	2.530983	5.518951	11.64865	11.63624	11.61376	8.834959	0.565368	
238_Base4_GHG2	RWDH	RWDHELCHETSTD	30.62861851	26.91939	24.39988	20.41908	14.29336	4.076437			
238_Base4_GHG2	RWDH	RWDHELCTAKMAX20						19.46693	28.81024	46.09688	67.90443	83.82942
238_Base4_GHG2	RWDH	RWDHHFOFURSTD	6.35E-02	5.93E-02	5.08E-02	4.23E-02	2.96E-02	8.47E-03			
238_Base4_GHG2	RWDH	RWDHKERFURSTD	0.215578452	0.058302	8.61E-02	4.51E-02	3.16E-02	4.36E-03			
238_Base4_GHG2	RWDH	RWDHLFOFURSTD	5.916774301	5.520149	4.729447	3.7554	2.382732	0.471835			
238_Base4_GHG2	RWDH	RWDHNGAFURSTD	93.30192779	76.16581	74.64154	11.56757	11.11187	2.183338			
238_Base4_GHG2	RWDH	RWDHNGATAKMAX08		16.50165	19.95345	85.49007	90.28102	99.43769	98.24156	95.57286	92.70861	88.28218
238_Base4_GHG2	RWDH	RWDHNGLFURSTD	0.330642752	0.300973	0.257524	0.215129	0.150837	1.04E-02			
238_Base4_GHG2	RWDH	RWDHNGLSTTMAX08		4.479556	5.753449	6.388248	7.434438	6.978312	8.976525	1.446083	1.297422	0.43741
238_Base4_GHG2	RWDH	RWDHSLDFURSTD08		6.94E-03	8.60E-03	1.10E-02	1.10E-02	1.10E-02	1.10E-02	2.70E-03	1.24E-02	1.24E-02
238_Base4_GHG2	RWDH	RWDHSLDSTOSTD	1.012664574	0.137848	0.566391	0.562773	0.331552	9.47E-02			
238_Base4_GHG2	RWDH	RWDHSLFCCOSTD08		0.861709	0.738579	0.805253	1.086338	1.59922	1.395705	1.200731	1.057754	0.920519
238_Base4_GHG2	RWMH	RHMHLFOCBOSTD08		8.95E-03	2.94E-02	5.16E-02	8.51E-02	0.140197	0.191828	0.206707	0.187578	0.166063

238_Base4_GHG2	RWMH	RHMHSLDCBOSTD08		0.116377	0.134449	0.152836	0.180496	0.558067	0.680534	0.883365	0.969989	1.088797
238_Base4_GHG2	RWMH	RWMHCOAFURSTD	2.34E-03	2.18E-03	1.87E-03	1.56E-03	1.09E-03	3.12E-04				
238_Base4_GHG2	RWMH	RWMHELCHEPSTD08		0.339403	0.320856	0.398596	0.522792	0.521164	0.517874	0.187188	1.18E-02	
238_Base4_GHG2	RWMH	RWMHELCHETSTD	0.987849427	0.857522	0.76315	0.631072	0.451647	0.130545				
238_Base4_GHG2	RWMH	RWMHELCTAKMAX20						0.378266	0.561867	1.231224	1.727629	2.128053
238_Base4_GHG2	RWMH	RWMHHFOFURSTD	4.52E-03	4.22E-03	3.61E-03	3.01E-03	2.11E-03	6.02E-04				
238_Base4_GHG2	RWMH	RWMHKERFURSTD	8.19E-03	3.17E-03	3.10E-03	2.56E-03	2.40E-03	2.71E-04				
238_Base4_GHG2	RWMH	RWMHLFOFURSTD	0.254371523	0.23741	0.203478	0.169571	0.118554	2.93E-02				
238_Base4_GHG2	RWMH	RWMHNGAFURSTD	3.120521582	2.578817	2.486563	0.583166	0.414463	1.05E-02				
238_Base4_GHG2	RWMH	RWMHNGATAKMAX08		0.62692	0.818232	2.804773	3.11838	3.722015	3.680643	3.473775	3.306197	3.146733
238_Base4_GHG2	RWMH	RWMHNGLFURSTD	8.18E-03	7.19E-03	6.11E-03	5.08E-03	3.52E-03	6.03E-04				
238_Base4_GHG2	RWMH	RWMHNGLSTTMAX08		0.133154	0.182819	0.228154	0.297362	0.219798	0.278297	2.83E-02	1.80E-02	1.12E-02
238_Base4_GHG2	RWMH	RWMHSLDSTOSTD	3.38E-02	9.83E-03	1.72E-02	1.72E-02	9.42E-03	1.94E-03				
238_Base4_GHG2	RWMH	RWMHSLFCCOSTD08		8.56E-02	7.75E-02	7.49E-02	7.82E-02	0.108535	9.69E-02	8.07E-02	7.16E-02	6.23E-02

Please note that the references of this research are not necessary scientific reports and papers. Many of the attributes of the house-hold appliance have been founded in customer review pages, web stores and buying guides and this is due to the absence of scientific reliable data in literature for technology attribute in the residential sector.

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