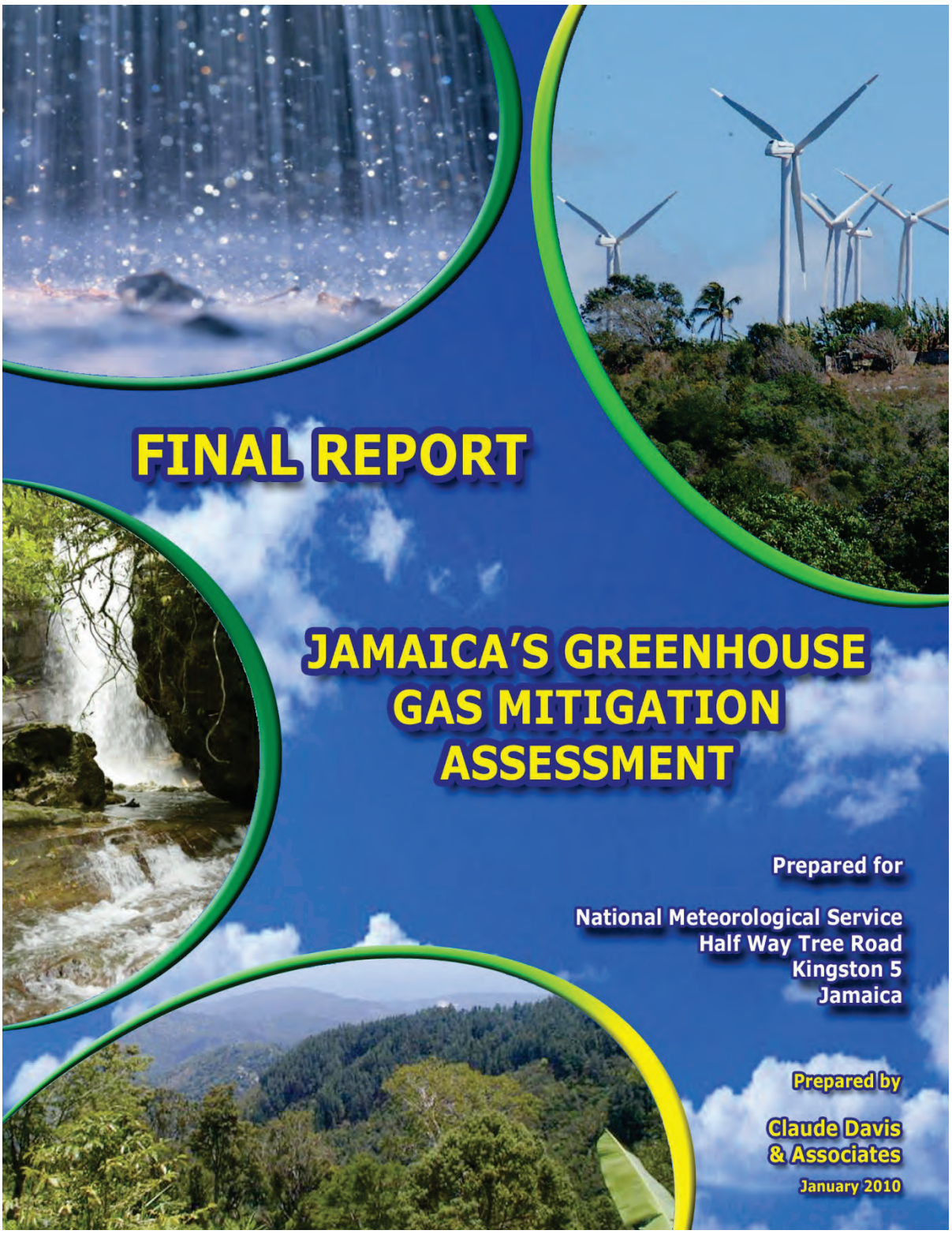

FINAL REPORT

JAMAICA'S GREENHOUSE GAS MITIGATION ASSESSMENT

Prepared for

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EXECUTIVE SUMMARY

This report presents Jamaica's greenhouse gas mitigation assessment. It provides a national-level analysis of the potential costs and impacts of various technologies and practices that have the capacity to affect energy demand and supply and hence greenhouse gas (GHG) emissions.

The mitigation assessment covers projections of selected GHGs for the period 2009 to 2035 and uses historical data for the period 2000 (the base year) to 2008 in order to calibrate where appropriate, the bases for the projections. *Vision 2030 Jamaica: National Development Plan* provides the overarching context for the assessment. Vision 2030 articulates four national goals, 15 national outcomes and over 50 national strategies all aimed at putting Jamaica in a position to achieve developed country status by the year 2030. The National Energy Policy 2009-2030 together with National Transport Policy (Draft) and Forestry Department's Strategic Forest Management Plan: 2009 – 2013 provide key direction and policy contexts for the mitigation assessment which also recognises the directions outlined in Jamaica's energy sector as well as the transport and forestry sector circumstances.

With no known petroleum or coal resources, most (86% in 2008) of Jamaica's energy needs are met by imported fuels and the remainder by biomass (bagasse), hydroelectric, wind and solar energy. Electricity is generated primarily by oil-fired steam, engine driven and gas turbine units. Smaller amounts of electricity are generated by hydroelectric and wind power. Use of solar energy is negligible and is limited to a few solar water heaters and solar crop dryers. The bauxite and alumina industry uses the highest percentage of energy (37.4% in 2008) followed by electricity generation (25%), transportation (20.4%) and the sugar industry (12.2%).

The government owned Petrojam refinery provides some of the refined petroleum products and the remainder is imported. The Jamaica Public Service Company Limited (JPS) with 80.1% private ownership and the remainder government owned, is the sole distributor of electricity. Electricity is generated by JPS and independent power producers.

Methodology

The Long-Range Energy Alternatives Planning System (LEAP) model was used to make projections for four emissions-related categories (modules): energy demand, energy transformation, energy resources and non-energy sector effects. The base year used (2000) is the same base year used for compilation of the national GHG emission inventory and is the year preferred by the United Nations Framework Convention on Climate Change (UNFCCC) for reporting national communications. The first projection year was 2009 and the last 2035. Historical data between 2000 and 2008 were used to calibrate the model. A fifth category – the key category – uses macroeconomic, demographic and other data that were used in the analysis. Projections for the years 2009 to 2035 were made for three sets of scenarios: the Reference Scenario and two others called Scenario 2 and Scenario 3. The various subcategories used (see Table 1) were determined by the level of detailed data that were available.

Table 1Subcategories in the Five Categories in the LEAP Model Input Data

Key Assumptions	**Demand**	**Transformation**	**Natural Resources**	**Non-Energy Sector Effects**
Population Household Size GDP in J2003$ Population growth rate GDP Growth Rate Transportation Emission factors (for 11 pollutants in 8 vehicle classes)	Household Refrigeration Lighting Cooking Fans Stereo Air conditioners Computer equipment Washing machines Clothes iron Television All other Industry Cement (Clinker, cement mills) Bauxite mining* Bayer Process Alumina Kilns Lime kilns Sugar Sugar (Private) Sugar (SCJ) Government Hospitals National Water Commission (NWC) Other Government Municipal (Rate 60) Rate 20, Rate 40A#, Rate 50 Road Transport (8 vehicle classes)	Transmission & Distribution Oil Refining Electricity Generation Charcoal making Coal gasification	Primary Wind Hydro Wood Bagasse Municipal Waste Peat Secondary Output fuels	Landfill emissions Agriculture Animals Soils Rice Production Forestry Industry Lime kilns Cement Pet Coke limestone

The JPS defined Rate 40 was adapted and redefined as Rate 40A to avoid double counting. * Includes rail transport in the bauxite alumina sector

Historical and projected gross domestic product (GDP) and socioeconomic data were obtained from the Planning Institute of Jamaica (PIOJ) and Bank of Jamaica publications. The population and household data were obtained or derived from information published by the Statistical Institute of Jamaica (STATIN) and in annual Economic and Social Survey Jamaica (ESSJ) reports or Bank of Jamaica Reports. The projections require activity and emission factor data. Most of the activity data were obtained from government agencies. Emission factors contained in LEAP were used but vehicle emission factors were calculated from a model of the Jamaican fleet. Electricity generation, consumption and related data were obtained from the Office of Utility Regulation (OUR). Petrojam provided data for the Refinery and charcoal data were derived from the Ministry of Energy and Mining (MEM) and from Economic and Social Survey Jamaica (ESSJ) reports.

Scenarios

Three sets of scenarios are developed to project emissions – a Reference Scenario (Ref) and two other sets of scenarios - Scenario 2 (*S2*) and Scenario 3 (*S3*) - characterised primarily by different rates of growth for the gross domestic product (GDP). The Reference Scenario is linked to the Vision 2030 Jamaica-GDP and population growth targets and does not include any initiatives to mitigate GHG emissions. *S2* and *S3* assumed more aggressive GDP growth rates but lower population growth rates. Both of the scenarios *S2* and *S3* have mitigation options. The bases for the scenario options are described below and Table 2 summarises the Scenario options used in the analysis.

Reference Scenario

The Reference Scenario assumes that two (Alumina Partners (Alpart) and the Windalco Ewarton) of the three alumina refineries that were closed in 2009 would reopen. It also assumes that the Petrojam Refinery Upgrade will be completed in 2014 and will provide low sulphur diesel and gasoline for the vehicle fleet and petcoke for a 100 MW plant at Hunts Bay. The Reference Scenario also assumes continued use of oil at alumina plants and coal at the new old Harbour power station.

For *S2* and *S3*, the fuels [coal, heavy fuel oil (HFO), diesel oil (diesel), natural gas (NG), gasified coal (Syngas)] that can be used for the following processes are as follows.

- Bayer process boilers and lime kilns (Bayer/Lime kilns), new steam boilers [coal, HFO, NG]
- Slow/Medium speed diesel engines at new power stations [HFO, NG]
- alumina kilns (Al kiln) [HFO, NG, Syngas]
- Gas turbines [Diesel, NG]
- Boilers at existing steam fired electricity generating stations [coal, HFO, NG]

The feasible combinations of processes and fuels lead to the options within *S2* and *S3* and the possible combinations are limited by the following conditions and assumptions.

- Once introduced coal or natural gas is used in all possible processes except as noted below regarding retrofitting
- Alumina kilns may not use coal hence the use of syngas (from gasified coal)

- Existing heavy fuel oil fired boilers and slow speed engines at electricity generating stations would not be retrofitted to burn natural gas (since they are old and due to be retired or mothballed)
- All operating Bayer process boilers would be upgraded/retrofitted to burn either oil up to 2013 or natural gas after 2013
- Any new slow speed engines could use natural gas
- The new alumina plant (*S3* only) would use either natural gas or coal with Syngas in the alumina kiln
- When natural gas is available it would be used in some of the vehicle fleet

Scenario 2 (*S2*):

Scenario 2 assumes a lower population growth rate and higher GDP growth rate than the Reference scenario. It also includes added alumina production capacity. The main option designated as *S2* has coal as the fuel for the Bayer process and lime kilns and a coal fired station at Old Harbour and no natural gas. The main mitigation option in this scenario (designated as *S2 NG*) entails the use of compressed natural gas (CNG) for the Bayer process, lime kilns, electricity generation at the Bogue generating station and for the new Old Harbour generating station (300 MW). Other mitigation measures include Bayer process energy efficiency improvements, the use of more efficient household appliances, use of CNG in some of the vehicle fleet and improved energy efficiency in the Government sector (hospitals, National Water Commission (NWC) and the remainder of the government sector). The various options for scenario 2 are evaluated relative to *S2* and the Reference Scenario.

Scenario 3 (*S3*):

This scenario assumes a lower population growth, a higher GDP growth rate than for *S2* and a more rapid decrease in the number of persons per household. *S3* also includes all of the *S2* initiatives and has additional energy intensity reductions at two of the alumina plants. The mitigation measures are however offset by the proposed addition of a new alumina plant. The possible introduction of additional hydro generation capacity would also contribute to lower emissions across the board. Scenario 3 includes options for coal (*S3*), natural gas (*S3 NG),* syngas in alumina plants (*S3 SYN*) and nuclear power generation along with natural gas (*S3 NGNU*).

Constraints and data gaps

The analysis is constrained by the following:

- Although rail transportation is used (only) in the bauxite sector, (diesel) fuel use for rail transport was not readily disaggregated from other diesel fuel used in the sector
- Fuel use data for domestic marine activities were not always readily available. It is believed that some of the gasoline sold in retail outlets is used for fishing and other domestic marine activities.
- Projections related to hydrofluorocarbon (HFC) emissions are not yet included
- Divestment of government owned sugar factories is under way and no data were available for making projections

Table 2 Fuel and Process Combinations for Scenarios Used in the Mitigation Assessment

Scenario	Bayer/Lime Kilns /New Steam	Engines Existing /New	Al Kilns Existing/ New[#]	Gas Turbines	Existing Steam Plants
Reference Scenario					
Ref	Current use	Current use	Current use	Current use	Current use
Scenario 2 Options					
S2	Coal Jamalco 2013 Alpart 2015 Windalco 2015 JPS Old Hrbr	HFO/HFO	HFO	Diesel oil	HFO
***S2* Oil**	**HFO**	**HFO**	**HFO**	**Diesel oil**	**HFO**
S2 SYN	Coal Jamalco 2013 Alpart 2015 Windalco 2015	HFO	Syngas Retrofit Jamalco 2013 Alpart 2015 Windalco 2015	Diesel oil	HFO
*S2*NG	NG Jamalco 2013 Alpart 2013 Windalco 2015 JPS (Except Hunts Bay)	NG retrofit/ NG	NG retrofit Jamalco 2013 Alpart 2013 Windalco 2015	NG JPS (Except Hunts Bay)	HFO
Scenario 3 Options					
S3	Coal Jamalco 2013 Alpart 2015 Windalco 2015 JPS Old Hrbr	HFO	HFO/Syngas	Diesel oil	HFO
S3 SYN	Coal Jamalco 2013 Alpart 2015 Windalco 2015	HFO	Syngas Retrofit/Syngas Jamalco 2013 Alpart 2015 Windalco 2015	Diesel oil	HFO
S3 NG	NG Jamalco 2013 Alpart 2013 Windalco 2015 JPS (Except Hunts Bay)	NG retrofit/NG	HFO/Syngas	NG	HFO
*S3 NG*NU	Coal Jamalco 2013 Alpart 2015 Windalco 2015 JPS Old Hrbr Nuclear after 2020	NG retrofit/NG	HFO/Syngas	NG	HFO

[#] Note: New alumina kiln in *S3* only

[##] Although the scenario designated as *S2* Oil is possible it is not considered economically viable for the bauxite alumina sector and so was not considered.

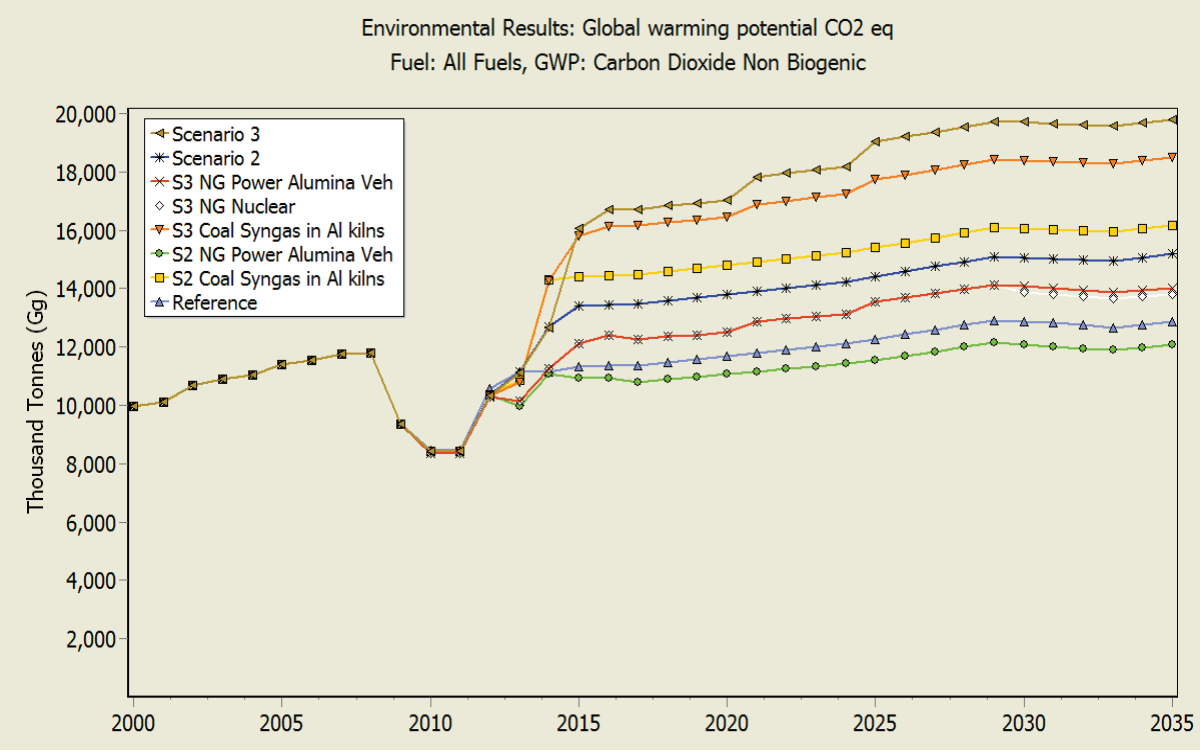
Results

The results of the analysis will focus on presenting the environmental **loadings** or emissions (CO_2 and in some cases SO_2 emissions) and the **final energy demand** broken down by sector and subsector where appropriate. The emissions can be presented either where they occur in the various branches (demand, transformation and non-energy sector effects) or by allocating the emissions in the transformation categories back to the demand branches. Thus when electricity is used we can estimate the amounts of GHG emissions used to produce the electricity. Similarly, emissions from oil refining are allocated back to the demand-side categories where refined oil products are finally consumed (and added to the emissions produced in consuming the refined oil product).

The presentation of the emissions and energy demand include the period 2000 to 2008 so that comparisons can be made with the emissions or energy consumption over this period.

The final environmental loadings of CO_2, for all scenarios are shown in Figure 1. The most striking feature in all scenario projections is the decrease in emissions between 2009 and 2011 due to the closure of three alumina plants in the first quarter of 2009 and the (assumed) reopening of two of those plants in 2011 with full production achieved in the following year. Although scenarios *S2* and *S3* have higher production levels and progressively more aggressive mitigation the effectiveness of the mitigation in *S2* is evident since the CO_2 emissions for *S2* are slightly lower than the Reference scenario even though coal is used in *S2* for power generation and the Bayer process.

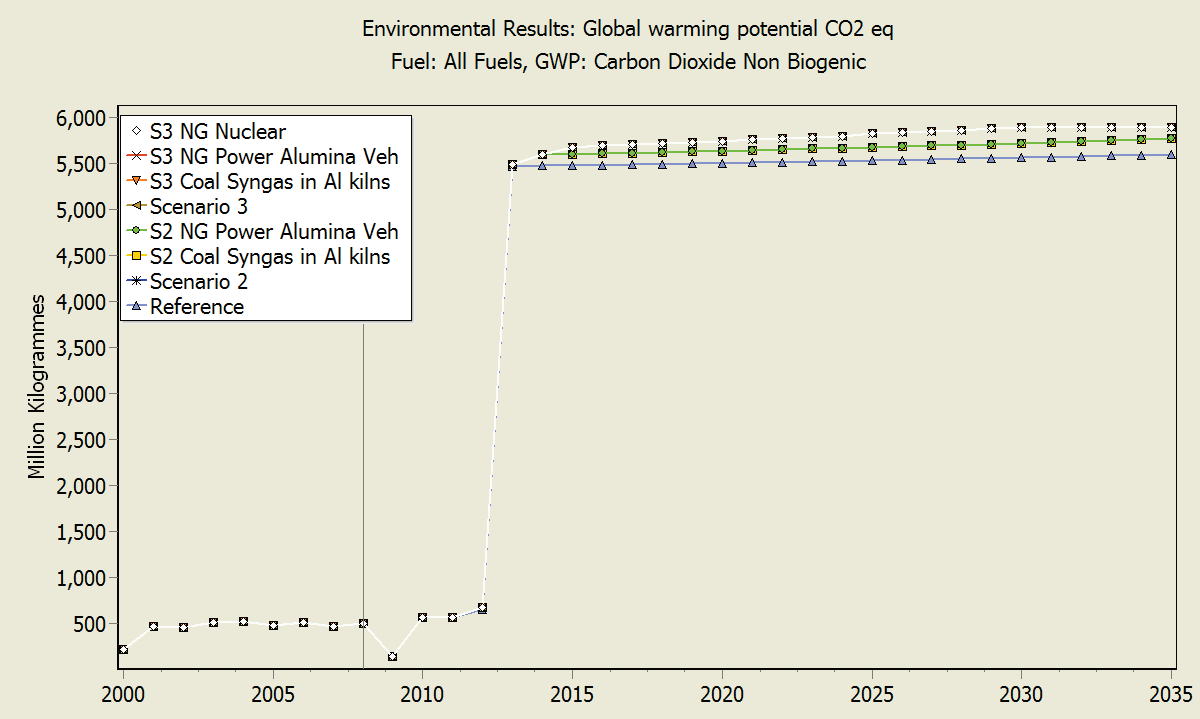
Figure 1-1 Final Environmental Loading for Jamaica, 2009 – 2035: All Scenarios, CO_2



For CH_4 and N_2O the Reference scenario emissions are generally lowest – due to the low production levels while the *S3* emissions are highest because of the use of coal where feasible. The *S3 NG* and *S2 NG* emissions are consistently lower than the corresponding *S2* or *S3* emissions and reflect the lower emission factors when natural gas is used (compared with coal or coal+syngas in alumina kilns).

The non-energy sector emissions are those associated with the chemical transformation of limestone into lime which releases CO_2 or in landfill emissions (releases CH_4 and CO_2) or in the release of CO_2, CH_4 and N_2O from agriculture and forestry sectors. The majority of the non energy sector emissions are from cement manufacture and in the future generation of electricity using petcoke. Use of petcoke for power generation entails using limestone to remove SO_2 which leads to the release of CO_2 from the limestone. Figure 2 illustrates the impact of the use of petcoke on non-energy CO_2 emissions starting in 2013. Beyond 2013 the increases in lime and cement production for *S2* and *S3* scenarios result in greater non-energy CO_2 emissions for *S2* and *S3* relative to the Reference scenario.

Figure 1-2 Final Environmental Loading for Jamaica, 2009 – 2035: Global Warming Potential CO_2: Non-Energy Sector Effects

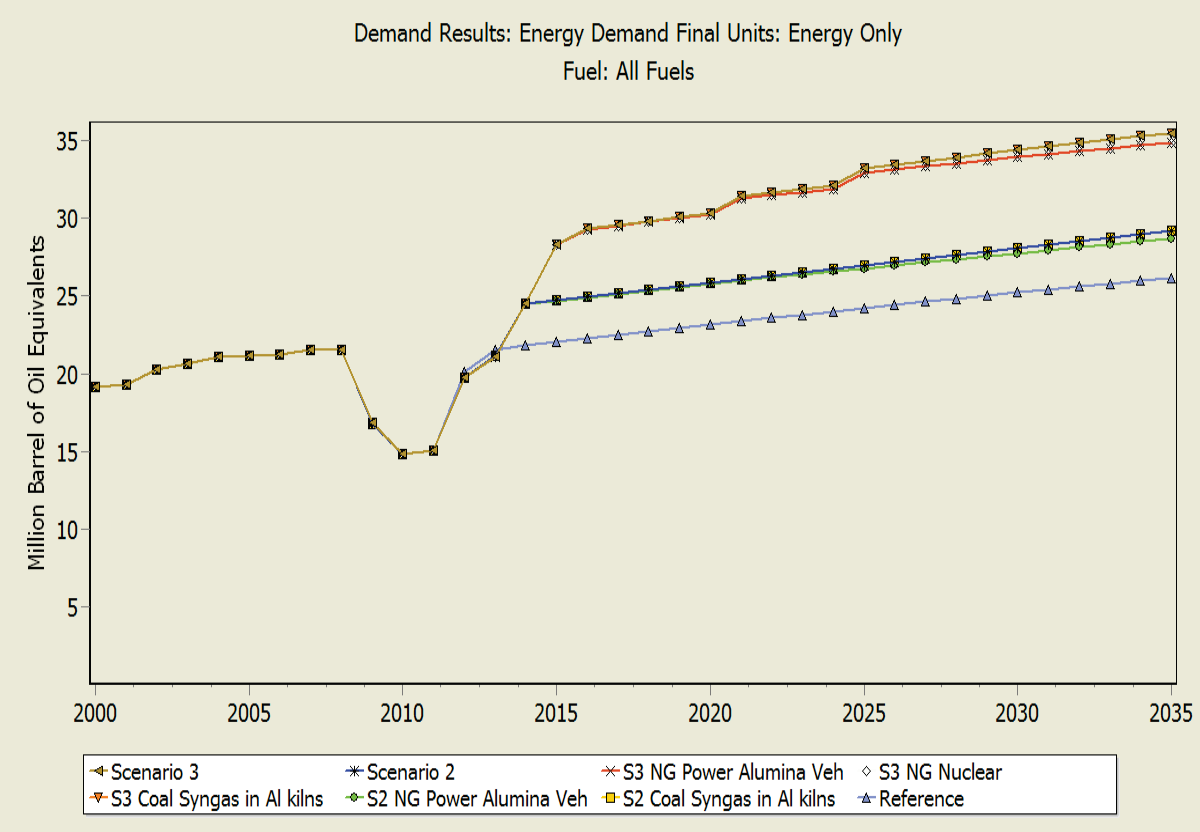


Energy Demand

As with the environmental loadings, the most striking features are the dramatic declines in energy demand in 2009 through 2012 as a consequence of alumina plant closures (see Figure 3). The final energy demand is not very dependent on the choice of fuel in the *S2* and *S3* scenario options and the demand for *S2* options are grouped together lower than the grouping for the *S3* options.

The large increase in energy demand in the *S3* options is due mainly to the new alumina plant which is included only in *S3* options and to lesser extents on population growth and the associated demands for electricity and on the increased cement production.

Figure 1-3 Final Energy Demand Projections for Jamaica, 2009 – 2035: All Scenarios



Transformation

The transformation module includes electricity generation, petroleum refining, coal gasification and charcoal production. No change in the petroleum refining capacity is anticipated although the refinery will be able to vary the output to meet demands. The data for charcoal production are uncertain and it is expected that demand for charcoal will fall as fewer households use charcoal as its use is discouraged.

The changes in total electrical generating capacity in all scenarios to meet the demands are shown in Figure 4 – noting that the added capacity was not optimised.

Gasification outputs will be used to meet the demands for calcining alumina only when coal is used in the Bayer process. The gasification requirements for all scenarios are shown in Figure 5.

Figure 1-4 Electricity Generating Capacities, 2009 – 2035: All Scenarios

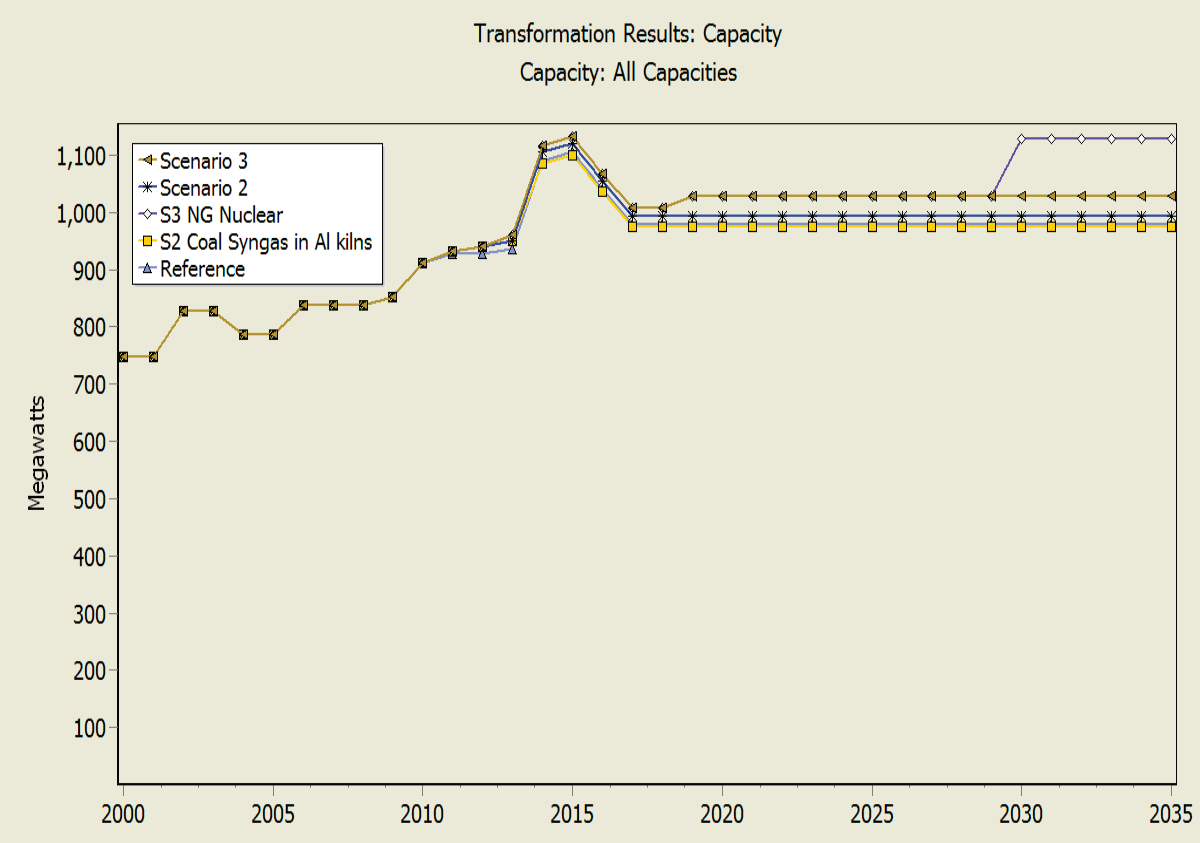
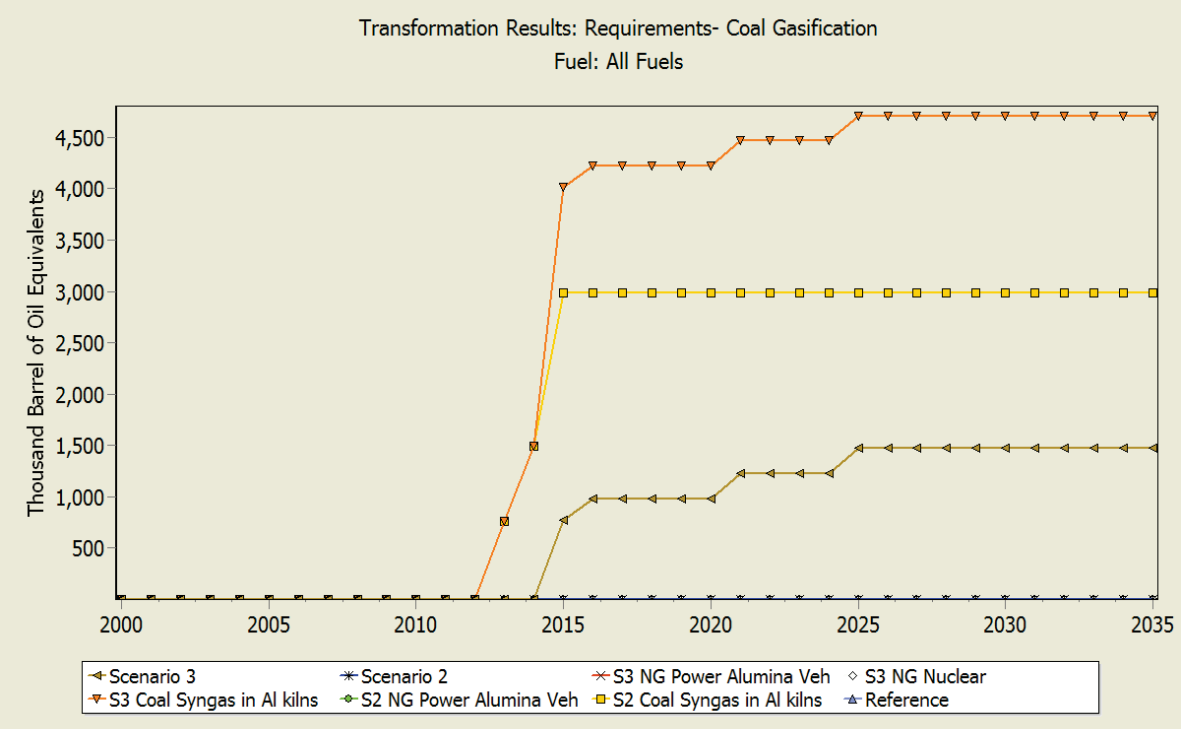


Figure 1-5 Coal Gasification Requirement Projections 2009 – 2035: All Scenarios



HOW MEASURES AFFECT CO_2 EMISSIONS BETWEEN 2000 AND 2035

For all scenarios, the percentage changes in the non-biogenic CO_2 emissions in 2035 relative to the year 2000 for the overall demand, transformation and non energy sector categories provide a measure of the impacts of factors (activity and energy intensity related) that affect emissions.

These percentage changes for each scenario are summarized in Figure 6. Also included in the figure are the percentage changes for branches in these categories. Note that in the case of electricity use and other secondary fuel use in the demand branches, the emissions occurring in the various Transformation modules are allocated back to the demand branches.

Overall Demand

The left-most grouping in Figure 6 shows ΔCO_2, the percentage changes in CO_2 emissions 2035 relative to 2000 for the overall demand in all scenarios. The overall CO_2 emissions in the energy demands for the reference (*Ref*), *S2* and *S3* scenarios increase by 29%, 52% and 98% respectively. This is consistent with the general increase in CO_2 generating (and energy consuming) activities because of population increases, fleet increases and increased bauxite and alumina production. These scenarios all entail additional coal fired electricity generation whose emissions easily outweigh the emission reductions from the much smaller additions of wind and hydro generating stations. In addition *S3* also includes a major expansion in alumina refining capacity.

The major mitigation measure is the introduction of natural gas (scenarios *S2*NG, *S3*NG and *S3 NGNU*) and a nuclear plant in conjunction with natural gas in scenario *S3*NGNU. Because of these measures, the CO_2 emissions in these scenarios are lower than those in the corresponding *S2* and *S3* scenarios.

Cement Kilns

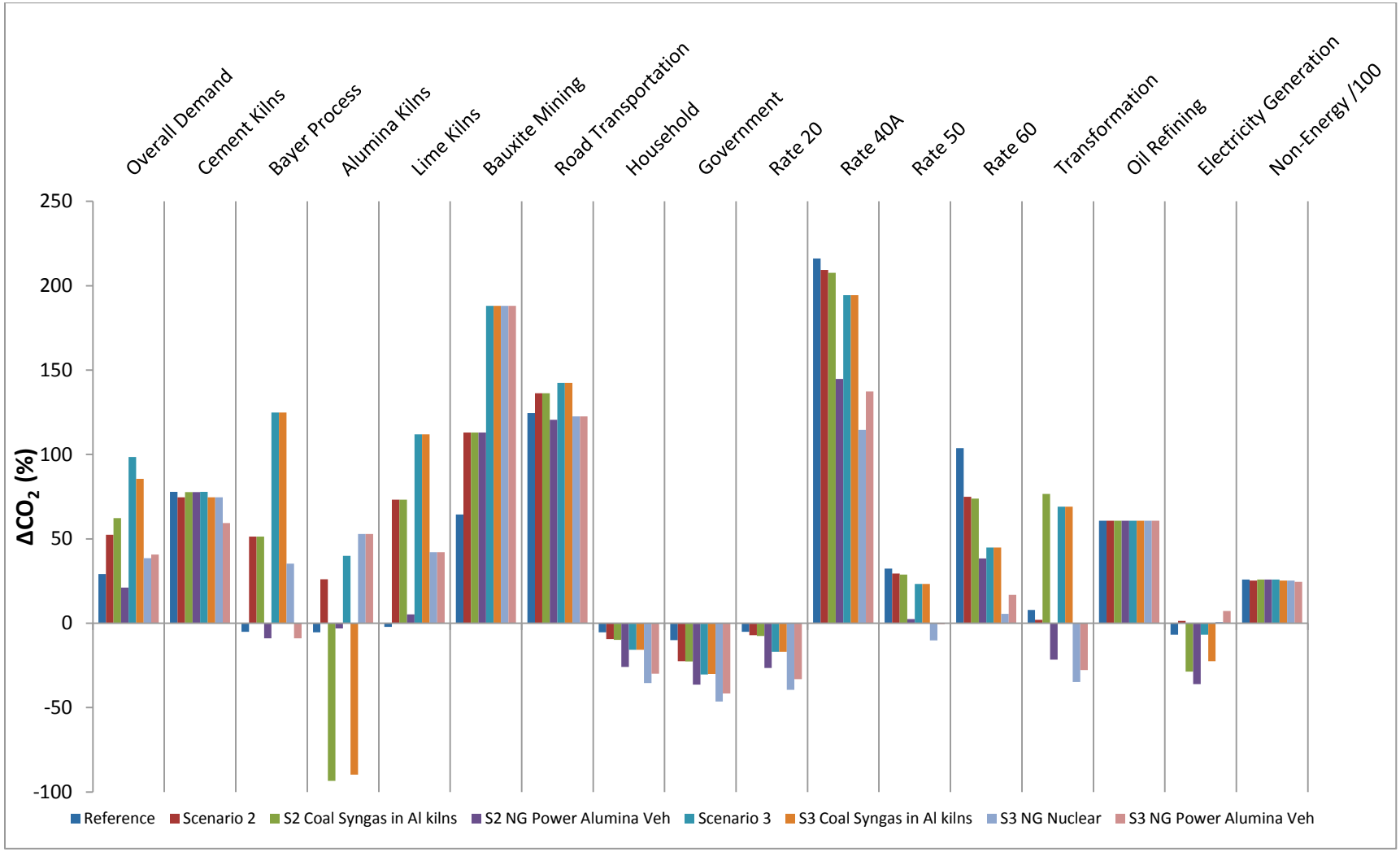
Changes in CO_2 emissions due to cement kilns are driven primarily by increased clinker production. The completion of the new kiln in 2008 resulted in a major improvement in energy efficiency and those changes are therefore present in all scenarios. Note that since the electrical energy use in the cement mills is small (1.8% to 3.5%) relative to the energy used in clinker production a grouping for cement mills is not included in Figure 6.

Bayer process and alumina and lime calcination

The emissions from the Bayer process and alumina and lime calcination that entail using coal (*S2*, *S2* coal+Syngas, *S3* an d*S3* coal syngas) all result in increased emissions relative to the reference scenario and also the *S3* scenarios having higher emissions than the corresponding *S2* ones because of increased alumina production in the *S3* scenarios.

The mitigation measure due to the use of natural gas in scenarios *S2* NG and *S3* NG and *S3* NGNU all dramatically reduce the CO_2 emissions relative to the corresponding scenarios in which coal is used.

Figure 1-6 Summary of Δ CO_2, (Percentage Changes in CO_2 Emissions in 2035 Relative to 2000) for Overall Demand, Transformation and Their Major Categories For Mitigation Assessment Scenarios



Similar patterns occur in the case of lime and alumina kilns but the reduction is more dramatic in alumina kilns since alumina kilns cannot use coal directly (syngas is used).

In the case of bauxite mining, no change in fuel is contemplated in any scenario and hence emissions increase monotonously with production. It should be noted that the vertical axis in Figure 3-46 is a percentage change and does not reflect absolute emissions.

Household Demand

The CO_2 emissions for the household and government demand show reduced emissions in 2035 relative to 2000 for all scenarios. Although there is population increase (and hence an increase in the number of households or JPS customers) the increased demand because of this is more than offset by more energy efficient appliances, mitigation (energy conservation) measures and lower CO_2 emitting electricity generation when natural gas is used. [Remember that the CO_2 emissions for electricity demand are estimated by allocating the emissions to transformation activities.]

Government Demand

The mitigation measures in the hospitals and NWC as well as a government program to reduce electricity consumption by 15% together lead to the overall reduction in CO2 emissions for all scenarios in the Government category.

Rates 20, 40A, 50 and 60 Categories Demands

No significant mitigation measures have been proposed for these rate categories. Estimates for the changes in energy demand are limited by a lack of information on the types of energy end use equipment and/or a knowledge of the distribution of activities (for example based on a knowledge of industrial classification – i.e., JIC Codes - for these customers) on which end use demand estimates could be made. The most notable percentage reduction in CO_2 emission projections is for the street lighting (Rate 60) due to the introductions of energy efficient street lighting (see Figure 3-46).

TRANSFORMATION

The overall changes in CO_2 emissions for transformation processes reflect the introduction of natural gas (lower CO_2 emissions in 2035 relative to 2000 for the scenarios in which natural gas is used for electricity generation).

The CO_2 emissions from oil refining show no variation across scenarios since all assume the refinery upgrade takes place.

The pattern for CO_2 emissions from electricity generation alone also reflects the introduction of natural gas (lower emissions in 2035 than in 2000 for scenarios *S2* NG, *S3*NG and *S3*NG NU).

NON ENERGY SECTOR EMISSIONS

The non energy sector emissions which are ~2500 times higher in 2035 than in 2000, are dominated by the process emissions from the use of petcoke in electricity generation which

is present in all scenarios (Note that the data for the non energy sector emissions are divided by 100).

Mitigation Activities for Implementation

The main and supporting energy sector institutions, policies and legislation and the requirements for implementing mitigation measures provide the context within which mitigation measures will take place. The main gaps that need to be filled and barriers to be overcome are identified so that specific recommendations for implementing some of the mitigation measures can be proposed.

The key institutions include:

- Ministry of Energy and Mining
- Petroleum Corporation of Jamaica
- Jamaica Bauxite Institute
- Electricity Generating Companies
- Office of Utilities Regulation
- Ministry of Transport and Works

Supporting institutions include: Office of the Prime Minister, National Environment and Planning Agency, National Solid Waste Management Authority, Statistical Institute of Jamaica, the Planning Institute of Jamaica, Meteorological Service, Jamaica Bureau of Standards, Forestry Department and the National Focal Point for the Clean Development Mechanism.

The range of policies and legislation that will be necessary to support the mitigation activities include the following.

- Vision 2030 Jamaica: National Development Plan
- Jamaica's National Energy Policy 2009-2030
- Jamaica's Carbon Emissions Trading Policy (draft 2009)
- Regulatory Policy for the Addition of New Generating Capacity to the Public Electricity Supply System
- Policy on Environmental Stewardship of Government Operations (draft)
- National Transport Policy (Draft)

The pieces of legislation that are of relevance to the mitigation assessment are listed below:

- Electricity Survey Act (1956)
- Petroleum Quality Act
- Natural Resources Conservation Authority Act
- Natural Resources Conservation Authority (Air Quality) Regulations (2006)
- Natural Resources Conservation Authority (Permits and Licences) Regulations (1996)

The successful implementation of mitigation measures will *inter alia* depend on:

- the provision of incentives/disincentives for the development and use of innovative technologies that improve/worsen efficiency;

- creation of relevant legislation to support the required investments in efficiency in sectors such as transportation and bauxite;
- a review of previous and existing demand side management programmes for performance, strengths and lessons learned;
- stronger institutional capacities in the energy and environment sectors;
- development of programmes designed to influence market behaviour towards more efficient use in energy across all sectors;
- development of a mechanisms to efficiently share energy related information and for public and private sector entities to collaborate on energy related projects;
- establishment of a system to identify and replace old inefficient electricity equipment and (especially) generating units/plants with more fuel efficient and cost efficient technologies and plants;
- promotion of strategic partnerships between the public and private sectors to finance and develop energy diversification projects; and
- introduction of national vehicle emission standards and regulations to reduce vehicular emissions and promote introduction of cleaner transportation fuels (especially CNG).

Gaps

Various gaps currently exist in the energy sector and the Energy Policy clearly articulates strategies to fill most of these gaps. Some of the critical gaps that affect implementation of mitigation measures are highlighted below.

Carbon Trading

The Draft Carbon Trading Policy includes a proposal to name the designation of the Designated National Authority and to "s*ecure a sustained source of funding to support the provision of DNA related activities and services".* However although the policy recognises that absence of an institution/agency and a CDM governance structure, the nature of the institution or agency that will house the DNA and some of its activities (e.g., whether or not any legislation will be needed; how it would be staffed; a timeline for its establishment and the governance structure surrounding the DNA office) are not clearly articulated.

To date the Wigton Wind Farm is the only project in Jamaica that is engaged in carbon trading and as recognised in the draft policy additional capacity is needed to successfully take advantage of CDM opportunities. Since currently there are several potential projects that could benefit from carbon trading it is essential that the policy be implemented with great urgency.

Coordination Among Energy Sector Stakeholders

The stakeholders involved in the implementation of mitigation measures span the gamut of public as well as private sector agencies and institutions and the general public. Coordination of mitigation activities and communication of vital information to and among

these stakeholders will be vital. Currently there are no formal interagency bodies or other mechanisms that will coordinate mitigation activities that span various agencies or that would facilitate information flow.

Policy and Regulatory Gaps

Some of issues and challenges the energy sector faces include legislation that lack adequate enforcement provisions and clearly articulated policies or protocols that address the pricing of electricity and petroleum products; decision making about retirement or mothballing old inefficient electricity generation plants; tax and pricing structure for road users; how to (better) address electricity system losses; and the development of renewable generation capacity. This has resulted in incremental decisions and has limited the introduction of diverse sources of energy and providing integrated monitoring and enforcement of regulations. There are also no legislative provisions for the net metering, carbon trading (as indicated above) and energy efficiency standards.

Data Collection and Information

In general various pieces of legislation include provisions that require reporting of fuel sales, electricity generation parameters and emissions and for acquisition of production and other "activity data' that are needed for estimating emissions and for planning purposes.

Data on historical electrical energy use and fuel consumption are collected by various entities, including STATIN, PIOJ, JPS, OUR, NEPA, Ministry of Transport and Works, and the Ministry of Energy and Mining.

There are however critical gaps in the collection of information that will allow forecasting of energy and fuel consumption. Recently MEM has been engaged in energy forecasting but it appears that the effort is constrained by the lack of suitable data.

Notwithstanding the collection of historical data, the energy sector is not effectively supported by databases that are accurate and precise to enable analysis, forecasting and overall management of the sector. There also are significant delays in accessing reliable information on various aspects of the energy sector. This has adverse effects on the ability to plan and make decisions on informed judgment.

The annual data compiled by STATIN in the decanal censuses and annual surveys of living conditions (e.g., ESSJ and JSLC reports) provide some of the data required for forecasting purposes based on analysis of historical trends. The JSLC surveys include good data on penetration of household electrical appliances and other amenities. *Similar survey data that would be useful for estimating electricity consumption for non-residential sectors are not available.* A recent survey of residential energy end use was a missed opportunity to obtain energy intensity data for the residential sector.

Enhancement of the survey approach is needed so that energy intensity data can be obtained on a routine basis. Specific examples include the enhancement of the JSLC surveys to include collection of information on the age ranges and numbers in each household of selected high energy consuming appliances (refrigerators, television sets, and air

conditioners). The approaches used in the U.S. RTECs or NRCAN residential energy end use surveys are examples of the approaches that would be suitable.

Since nearly all electrical appliances and equipment are imported, enhancement of the import classification to clearly distinguish between various categories of appliances (based on technology and ranges of energy use) would be useful. Examples are as follows:

- Motor vehicles – to distinguish fuel used (i.e., diesel, gasoline, CNG, hybrid, electricity only etc.)
- Refrigerators (range in SEER value, refrigerant (HC or HFC)
- TVs (based on technology and/or energy intensity)

While various energy sector projects and programmes have been planned, there appears to be a lack of timely implementation of energy sector plans and projects and limited coordination of activities and evaluation of results. Additionally, over the years, while some emphasis has been placed on the promotion of energy conservation in commercial sectors and industries, the successes of pilot projects such as Environmental Audits for Sustainable Tourism (EAST) appear not to have been expanded to embrace the entire tourism sector for example.

Least cost (electricity) expansion plans (LCEPs) that have taken place have been determined by expediency and the lack of financing but it is acknowledged that external factors have in some cases driven the decision making process.

Although there have been several sectoral plans or policies (e.g., tourism, transportation, a (albeit dated) national industrial policy) there was nominal effort directed at forecasting sectoral energy or fuel use. For example there appears to be little if any reliable energy projections (and hence potential savings from energy conservation initiatives) in the tourism sector or among JPS Rate 40 and 50 consumers. The forecasting of electricity consumption among various rate categories was based on macroeconomic data rather than on knowledge of end use equipment.

Information on more immediate or shorter term energy requirements is sometimes included in environmental impact assessments and could also be included in NEPA's permit applications.

Low levels of research in the energy sector can also be identified as a gap, resulting in low levels of adoption and adaptation of new and emerging energy technologies, improvements in energy infrastructure, and appropriate legislation.

The country also lacks a comprehensive and sustained public education programme that would encourage Jamaicans to use energy wisely and to aggressively pursue opportunities for conservation and efficiency. As a result of this, the Jamaican public has a relatively low level of awareness of the importance of energy and its use in their daily lives and the contribution that each can make to the responsible and efficient use of this vital resource. This low level of awareness also could explain the low intensity of use of solar energy for water heating in Jamaican households.

Recommendations

Specific recommendations are provided to improve the enabling environment, build institutional and human resource capacity, encourage adoption of suitable energy conservation/GHG mitigation technologies and fill data gaps. These will facilitate cost effective energy use and implementation of GHG mitigation measures.

In order to improve the enabling environment within which GHG mitigation and other energy sector activities take place it will be necessary to streamline some legislation and/or policies and in some cases enact additional legislation. The specifics are as follows.

- Strengthen the regulations so that there are adequate enforcement provisions and clearly articulated policies or protocols that address the pricing of electricity and petroleum products; decision making about retirement or mothballing inefficient electricity generation plants; how to (better) address electricity system losses; and the development of renewable generation capacity
- Develop and implement a regulatory framework to allow carbon trading to take place. This should include legislation to establish the designated national authority (DNA) and associated entities and specification of the trading modalities for local and international entities (e.g., licensing, certification or regulation of such entities, owning certified emission reductions (CERs) and Verifiable Emissions Reductions (VERs) etc.)
- Establish enabling environment to encourage local and foreign financing of innovative energy projects, especially in renewables. This could entail developing policies and programs that will encourage use of biogas and solar heaters as well as other alternate energy sources such as photovoltaic systems. These could for example entail revolving loans, and/or import duty concessions and incentives for energy efficiency improvements
- Implement incentives that will encourage tertiary level institutions to develop research programmes for the application and implementation of renewable energy projects
- Adapt/adopt or develop energy efficiency standards for consumer and industrial electrical equipment (e.g. by adopt the Energy Star program) and base import duties for such equipment in part on energy efficiency standards.
- Introduce national motor vehicle emission standards and regulations
- Develop regulations and safety standards in anticipation of the introduction of CNG infrastructure and CNG use in industry and in vehicles
- Revise the bases for tax/customs duties so that they are based on vehicle weight class and fuel type (not cc rating)
- The National Environment and Planning Agency (NEPA) in collaboration with MEM and the Petroleum Corporation of Jamaica (PCJ) should include as a requirement in selected permit applications and environmental impact assessments the provision of

projected electrical energy and fuel use and associated technologies and appropriate benchmarking information. In order to focus attention on energy conservation NEPA should rename the EIA as an Environmental and Energy Impact Assessment (EEIA).

- Make use of the energy efficiency fund to increase energy projects such as those related to renewable energy
- Implement the building code

Capacity-building Needs

Capacity building in the energy sector institutions will be required if mitigation measures are to be effectively implemented. The capacity building needs in the public sector centre on institutional arrangements for the collection, compilation, reporting and analysis of energy information and for public education. Implementation of private sector measures requires increased private sector technology awareness and capability and an environment that facilitates and encourages investment for implementation of mitigation measures. Public sector agencies with regulatory or other responsibility for the energy and environment must also be aware of the technologies, be able to assess them and to develop policies that are responsive to private sector and national needs.

The following specific capacity building needs are identified:

Enhance capacity to compile GHG (and other) emission inventories and the capacity to perform energy and GHG emissions forecasting/modelling

- Develop an energy information clearing house
- Train staff to perform functions of the DNA and the supporting institutions (National Carbon Trading Promotional organization)
- Establish the DNA institutions and identify and enact any necessary legislation (e.g., to enable certification or licensing of trading modalities)
- Expand the role of the Energy Efficiency Unit (EEU) within the Petroleum Corporation of Jamaica to provide technical assistance for ECE initiatives in the public and private sectors
- Strengthen regulatory agencies to improve the efficiency of the system and compliance with established benchmarks, procedures and standards
- Develop stronger links with the energy sector and academic institutions to drive the adoption and adaptation of new technologies in the energy sector
- Engage in research towards adoption and adaptation of new and emerging technologies and improvements in energy infrastructure
- Develop and sustain Public Education on energy efficiency and conservation
- Review the sustainable development and energy conservation curriculum needs throughout the (primary, secondary and tertiary levels) in the educational system and enhance the curriculum accordingly

- Take advantage of carbon trading opportunities

Adoption of Clean and Energy Efficient Technologies

- Develop capacity to facilitate greater energy efficiency in the bauxite and alumina industry and the manufacturing sector (Rate 40 and Rate 50 JPS customers). Initiatives such as the recently announced partnership between JPS and NWC could be applied an a sectoral basis (once suitable information is available)
- Implement incentives/disincentives to enable the development and use of innovative technologies to improve energy efficiencies in all sectors and in households
- Research and develop alternative fuels for the transport sector, including the use of biofuels and CNG when it becomes available
- Encourage the use of solar powered water pumping by the NWC
- Mandate that all new hot water installations in all public buildings be solar
- Promote more widespread use of solar water heating in hotels
- Promote the adoption of solar powered cooling/air conditioning especially in the hotel/tourism sector
- Implement a more aggressive demand side management program including the use of energy-efficient appliances, equipment, and building designs, setting and enforcing standards for public sector organizations, and public awareness and educational programmes

Address Data and Information Gaps

- Improve motor vehicle fleet database (ensure correct assignment of fuel type, add off road categories, weight units; clearly distinguish between non-motorised trailers and motorised trailers, add allowance (categories) for hybrid and CNG vehicles. This could be achieved by quality assurance checks during data entry and use of databases with manufacturers' specifications.
- Compile statistics for annual vehicle kilometres travelled (VKMT)1 through periodic surveys or routinely collect and record odometer readings during vehicle inspections for certificates of fitness
- Require fleet management companies to report VKMT and other general vehicle class data
- Code JPS customers (at least the Rate 40 and 50 customers) by JIC and require reporting of energy use statistics by JIC accordingly. This type of information will inform the design of appropriate end use surveys in the commercial/manufacturing sectors and in planning/forecasting demand

[1] A study is currently under way

- Survey industrial and commercial customers for end use equipment
- Conduct periodic surveys for charcoal and wood use
- Conduct proper residential energy use survey in conjunction with data from JPS smart meters
- Compile data on appliance imports or sales for refrigerators
- Assess impact of distributed electricity generation and water storage and if appropriate develop a suitable program to promote its implementation

List of Acronyms

AAJ	Airports Authority of Jamaica
Bbl	Barrel
BSJ	Bureau of Standards Jamaica
bsd	barrels per stream day
CDM	Clean Development Mechanism
CO_2	Carbon dioxide
COP	Conference of Parties
DNA	Designated national authority
DSM	Demand side management
EAST	Environmental Audits for Sustainable Tourism
EDB	Environmental Data Base
EIA	Environmental Impact Assessment
ESSJ	Economic and Social Survey Jamaica
FOEB	Fuel oil equivalent barrel
GDP	Gross domestic product
GEF	Global Environment Facility
Gg	Gigagram (10^9 g or 1000 tonne or 1 kilotonne)
GHG	Greenhouse gas
CNG	Compresses natural gas
GJ	Gigajoule
HDDV	Heavy duty diesel vehicle
HDGV	Heavy duty gasoline vehicle
HFC	hydrofluorocarbon
HFO	Heavy fuel oil
JAMPRO	Jamaica Promotions (now Jamaica Trade and Invest)
JTI	Jamaica Trade and Invest (formerly JAMPRO)
JBI	Jamaica Bauxite Institute
JIC	Jamaica Industrial Classification
JPS	Jamaica Public Service Company Limited
KMR	Kingston Metropolitan Region

LDDT	Light duty diesel truck
LDDV	Light duty diesel vehicle
LDGT	Light duty gasoline vehicle
LDGV	Light duty gasoline vehicle
LEAP	Long-Range Energy Alternatives Planning System
LPG	Liquefied petroleum gas
LTO	Landing and take-off cycle
MC	Motorcycle
MCF	Maximum capacity factor
MEM	Ministry of Energy and Mining
Mg	Megagram (10^6 g or 1 tonne)
MOWH	Ministry of Water and Housing
MWT	Ministry of Transport & Works
MW	Megawatt
MWh	Megawatt hour
NEPA	National Environment and Planning Agency
NIBJ	National Investment Bank of Jamaica
NMIA	Norman Manley International Airport
NRCA	Natural Resources Conservation Authority
NRCAN	National Resources Canada
NWC	National Water Commission
OTEC	Ocean Thermal Energy Conversion
PCJ	Petroleum Corporation of Jamaica
PIOJ	Planning Institute of Jamaica
PV	Photovoltaic
RECS	Residential Energy and Consumer Survey
SIA	Sangster International Airport
SIA	Sugar Industry Authority
SIRI	Sugar Industry Research Institute
SRC	Scientific Research Council
STATIN	Statistical Institute of Jamaica

TA	Transport Authority
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UWI	University of the West Indies
VKMT	Vehicle kilometres travelled

1. INTRODUCTION

1.1 BACKGROUND

The United Nations Framework Convention on Climate Change (UNFCCC) is an international treaty whose stated objective is to stabilise greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the earth's climate system.

Article 4, paragraph 1, and Article 12, paragraph 1, of the convention provide for each Party to report to the Conference of Parties (COP):

- Information on its emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol (greenhouse gas inventories);
- National or, where appropriate, regional programmes containing measures to mitigate, and to facilitate adequate adaptation to climate change (general description of steps taken or envisaged by the Party to implement the Convention);
- Any other information that the Party considers relevant to the achievement of the objective of the Convention.

The treaty, which came into force on March 21, 1994, therefore obliges signatories to submit National Communications that include a greenhouse gas (GHG) mitigation assessment, a national GHG emissions inventory, a report on climate change adaptation and a vulnerability assessment. Jamaica ratified the convention on January 6, 1995 by an act of parliament and the instrument of ratification was deposited at the United Nations in April 1995.

This report contains the greenhouse gas mitigation assessment for Jamaica.

The mitigation assessment provides a national-level analysis of the potential costs and impacts of various technologies and practices that have the capacity to affect greenhouse gas emissions and hence climate change. The assessment provides policy makers with an evaluation of those technologies and practices that can both affect climate change and also contribute to national development objectives, and can identify policies and programs that could enhance their adoption.

This mitigation assessment should be followed by more detailed evaluation of specific policies, programs, or projects designed to encourage implementation of selected technologies and practices.

1.2 OBJECTIVES AND SCOPE

The mitigation assessment study was initiated in March 2009, with the financial assistance of the Global Environment Facility (GEF), through the United Nations Development Program (UNDP). The implementing agency in the Government of Jamaica is the National Meteorological Service. The Terms of Reference for the study are indicated in Appendix 1.

The scope of this assessment covers projections of GHGs for the period 2009 to 2035 and uses historical data for the period 2000 (the base year) to 2008 in order to calibrate where appropriate, the bases for the projections. Three groups of scenarios are developed to project emissions – a Reference Scenario and two other scenarios (Scenario 2 and Scenario 3) characterised primarily by different rates of growth of the gross domestic product (GDP). The Reference Scenario only includes activities and projects that are currently under way and does not include any additional GHG mitigation.

The Reference Scenario includes assumptions that relate to the reopening of three alumina plants that were temporarily closed in 2009: it was assumed that only two of the plants (the Alumina Partners (Alpart) and the Windalco Ewarton plant) would reopen.

The other scenarios describe various possible and plausible energy use and development strategies and activities that are required to satisfy the demand for energy based on population growth and national development goals as set out in *the Vision 2030 Jamaica, National Development Plan*[1]. Various mitigation options (technologies and measures that can affect GHG emissions) are included in these scenarios.

1.3 REPORT STRUCTURE

The report is presented in four sections. After describing background information on characteristics that are most relevant to Jamaica's mitigation analysis (resources, common macroeconomic data), the approach (model description and scenarios) and the constraints in applying the approach in developing the mitigation assessment are described in Section 2. The results of the projections for each scenario are presented in Section 3. Mitigation options, policy implications, capacity building needs and recommendations are presented in Section 4.

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2. APPROACH

2.1 BACKGROUND INFORMATION

Jamaica is an island in the Caribbean Sea, centred on latitude 18º 15"N, 77º 30" W. It is located approximately 145 km south of Cuba or 850 km south of Miami, Florida. The island is approximately 230 km long oriented in an east-west axis and is approximately 80 km at its widest point. Land area is 10,990 sq. km of which about 160 sq. km is water and the coastline is approximately 1,022 km. The climate is tropical and the terrain is characterised by a mountainous region along the island's east west axis and narrow coastal plains. The highest elevation is Blue Mountain Peak which is 2,256 m above sea level.

As measured by the Human Development Index[2] (HDI), Jamaica is considered to be a medium level developing country, with an HDI score of 0.736, ranking 101st out of 177 countries in 2008. The HDI combines measures of life expectancy, literacy, school enrolment and per capita GDP into a single index to measure relative human development among nations.

This index value reflects the fact that Jamaica is characterized by weak economic development as evidenced by low GDP growth rates, high debt load, high unemployment, weak export performance and energy dependence but relatively strong social indicators including a high life expectancy, high primary and secondary enrolment rates, high literacy rates, low birth rates, as well as high access to electricity and piped water (see Table 2-1).

In 2008, Jamaica's GDP per capita was US$5,345 (98th among 210 nations and territories of the world). Notwithstanding this, Jamaica ranked 54th out of 147 countries in the 2008 Environmental Performance Index (EPI), outperforming many developed countries and being among the leaders in the Caribbean with respect to environmental protection and sustainability[3].

As indicated in Table 2-1, between 2000 and 2008 the population rose from 2,597,100 to 2,692,400 with growth rates declining from 0.6% to 0.4%[4]. The population growth rates over the past two decades have been influenced by declines in fertility rates as well as international migration. The population splits between genders in 2008 was 50.7% female, 49.3% male (and in 2007 between urban and rural areas was 53.5% urban 46.5%[5]). Approximately 43.3% of the population resided in the Kingston Metropolitan Region (KMR). Table 2-1 shows that poverty has been declining: the prevalence of poverty declined from just under 20% to just below 10%.

Table 2-1 Select Socio-Economic Indicators

INDICATORS	2000	2005	2006	2007	2008
Real GDP Growth (%)	0.9	1.0	2.7	1.4	-0.6
Debt : GDP Ratio	88.7	119.1	117.5	111.4	
Average Annual Unemployment Rate (%)	15.5	11.2	10.3	9.9	10.6
Average Annual Exchange Rate (J$ = US$1.00)	43.08	62.50	65.88	69.06	72.92
Inflation (%)	6.1	12.6	5.7	16.8	16.8
Population ('000)	2,597,100	2,656,700	2,669,500	2,682,100	2,692,400
Population Growth Rate (%)	0.6	0.5	0.5	0.5	0.4
Life Expectancy at Birth (years)	72.2	73.3	73.3	72.4	
Adult Literacy (% of ages 15 and older)	79.9	79.9	85.5	86.0	
Gross Primary Enrolment ('000)	325.3	326.4	318.7	310	
% Population below Poverty Line	18.9	14.8	14.3	9.9	
Access to Piped Water	66.6	n/a	67.8	70.2	
Access to Electricity			92	92	92

Adapted from Vision 2030 Jamaica National Development Plan
Other sources: Bank of Jamaica: http://www.boj.org.jm/exchange_rates_annual.php
STATIN: http://www.statinja.gov.jm/population.aspx

As indicated above, economic growth over the past ten years has been less than favourable (see Table 2-2 and 2-3). This has been caused in part by external factors such as the September 2001 terrorism attack on the United States (US) and the SARS outbreak in 2003 which adversely affected tourism; unprecedented rises in oil prices in 2007 and 2008 and the global recession starting in 2008. In addition there have been the local effects of hurricanes – Michelle (2001), Ivan (2004), Dennis, Emily, Wilma (2005), Dean (2007) and Gustav (2008)[6]. Over the past decade, the rate of growth of the gross domestic product (GDP) ranged between 3.5% and -0.6%. The average annual exchange rate of the Jamaican dollar with the US dollar rose from 43 in 2000 to 80 in 2008. Oil prices increased by 52% in 2005, 20% in 2006, and 70% in 2008. This is particularly significant since Jamaica depends on imported petroleum to meet 95% of its energy needs.

Towards the end of 2008, there was sharp contraction in global financial markets which among other things led to depreciation of the value of the Jamaican dollar and negatively impacted bauxite, tourism and agriculture and undoubtedly contributed to a lower demand for electricity in 2008 relative to the previous year. Towards the end of 2009 the impacts of the global recession continue to take effect with the closure of three (Alpart, Windalco's Ewarton and Kirkvine Works) of the four alumina plants in 2009.

Vision 2030 Jamaica: National Development Plan

This mitigation assessment takes into account the overarching strategic direction that will guide Jamaica's development to 2030 and which is expected to result in the country achieving developed country status by 2030. This direction is articulated in Vision 2030 Jamaica: National Development Plan, and is based on the comprehensive vision "Jamaica, the place of choice to live, work, raise families, and do business".

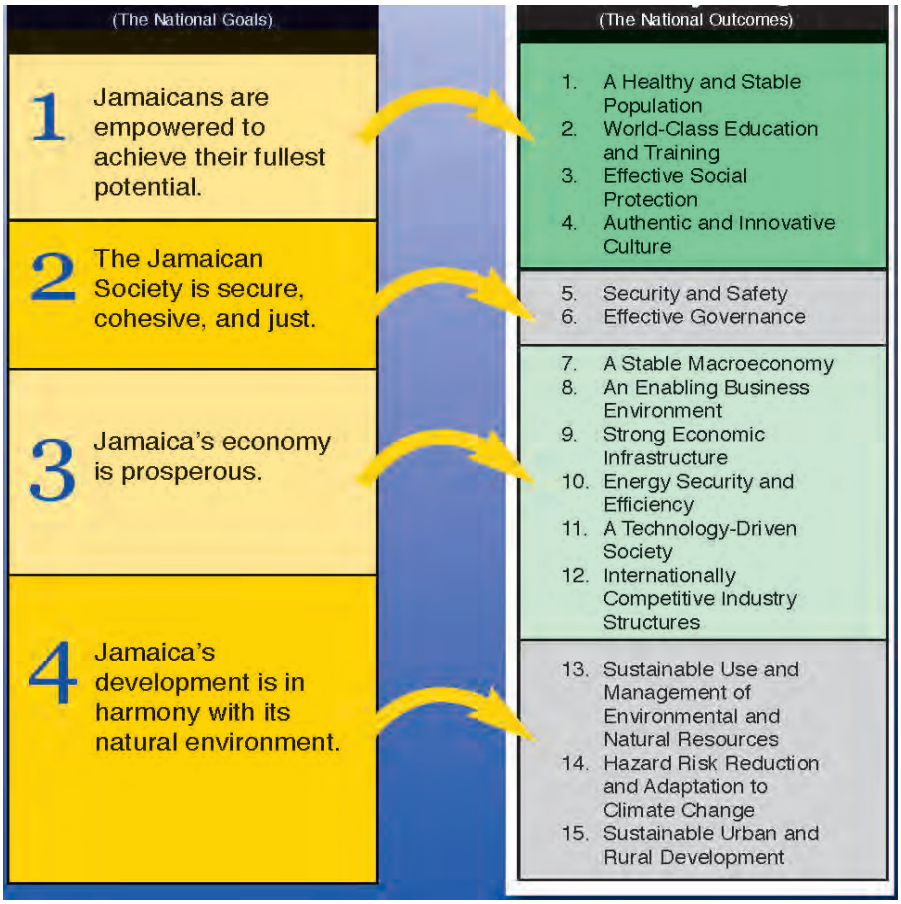


Table 2-2 GROSS VALUE ADDED BY INDUSTRY AT CONSTANT (2003) PRICES, 2004 - 2008 $' Million

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Agriculture, Forestry & Fishing	30,547.5	26,675.9	28,458.4	26,521.4	28,389.8	25,196.5	23,490.6	27,286.1	25,696.1	24,362.1
Mining & Quarrying	17,483.4	17,429.3	17,942.8	18,312.5	19,233.6	19,659.3	20,212.9	20,395.6	19,863.8	19,370.4
Manufacture	47,942.2	47,135.4	46,771.7	45,838.7	45,597.4	46,245.2	44,214.6	43,224.6	43,541.2	42,924.7
Electricity & Water Supply	14,039.8	14,314.7	14,408.7	15,072.6	15,782.4	15,761.8	16,416.4	16,949.3	17,043.8	17,197.7
Construction	35,552.0	35,632.2	35,570.3	35,222.7	37,001.4	40,126.5	43,124.9	42,297.2	44,230.2	41,286.1
Wholesale & Retail Trade, Repairs & Installation of Machinery	85991.9	88,100.9	87,845.8	88,205.7	89,668.2	91,017.2	92,329.5	94,402.5	96,039.7	95,877.8
Hotels & Restaurants	85,991.9	21,911.8	21,632.3	21,685.1	22,686.5	23,664.4	24,733.5	27,230.4	27,320.6	27,929.9
Transport, Storage & Communication	20,814.2	49,015.2	51,375.2	54,553.6	56,747.8	57,546.0	58,068.2	60,651.5	62,664.7	61,250.6
Finance & Insurance Services	45,944.2	44,001.1	46,617.0	49,533.3	52,898.8	54,379.4	54,132.3	55,383.8	57,268.5	57,738.8
Real Estate, Renting & Business Activities	42,250.2	43,754.0	44,133.4	44,383.4	45,359.3	46,233.9	46,871.2	47,679.2	49,190.1	49,800.9
Producers of Government Services	43,825.4	56,679.9	57,454.4	57,941.8	58,055.2	58,144.2	58,294.0	58,579.1	59,365.5	59,322.9
Other Services	56,898.2	28,504.9	28,555.5	29,287.0	30,504.6	31,228.0	32,078.2	33,380.1	34,075.6	34,238.8
Less Financial Intermediation Services Indirectly Measured	28,120.1	23,020.2	24,576.4	25,941.9	25,179.1	25,577.5	25,482.7	25,713.4	27,050.9	26,879.0
TOTAL GROSS VALUE ADDED AT BASIC PRICES	446,214.2	450,135.1	456,189.2	460,616.0	476,745.8	483,624.7	488,483.5	501,746.1	509,248.9	504,421.7

Sources: From Bank of Jamaica Statistical Digest May 2009; Table 46.2 Gross Domestic Product Value Added By Industry At Constant (2003) Prices, 1998-2007. http://statinja.gov.jm/VALUEADDEDBYINDUSTRYATCONSTANT%282003%29PRICES.aspx

Table 2-3 Percent Contribution to Total Goods and Services Production in Basic Values at Constant (2003) Prices, 2000 to 2008

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Agriculture, Forestry and Fishing	6.8	5.9	6.2	5.8	6.0	5.2	4.8	5.4	5.0	4.8
Mining and Quarrying	3.9	3.9	3.9	4.0	4.0	4.1	4.1	4.1	3.9	3.8
Manufacture	10.7	10.5	10.3	10.0	9.6	9.6	9.1	8.6	8.5	8.5
Electricity and Water Supply	3.1	3.2	3.2	3.3	3.3	3.3	3.4	3.4	3.4	3.4
Construction*	8.0	7.9	7.8	7.6	7.8	8.3	8.8	8.4	8.7	8.2
Wholesale & Retail Trade, Repairs & Installation of Machinery	19.3	19.6	19.3	19.1	18.8	18.8	18.9	18.8	18.9	19.0
Hotels & Restaurants	19.3	4.9	4.7	4.7	4.8	4.9	5.1	5.4	5.4	5.5
Transport, Storage and Communication	4.7	10.9	11.3	11.8	11.9	11.9	11.9	12.1	12.3	12.1
Finance & Insurance Services	10.3	9.8	10.2	10.8	11.1	11.2	11.1	11.0	11.2	11.4
Real Estate, Renting & Business Activities	9.5	9.7	9.7	9.6	9.5	9.6	9.6	9.5	9.7	9.9
Producers of Government Services	9.8	12.6	12.6	12.6	12.2	12.0	11.9	11.7	11.7	11.8
Other Services	12.8	6.3	6.3	6.4	6.4	6.5	6.6	6.7	6.7	6.8
Less Financial Intermediation Services Indirectly Measured (FISIM)	6.3	5.1	5.4	5.6	5.3	5.3	5.2	5.1	5.3	5.3
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
GDP at 2003 Prices (J$ Billion)	**446.2**	**450.1**	**456.2**	**460.6**	**476.7**	**483.6**	**488.5**	**501.7**	**509.2**	**504.4**

Sources: From Bank of Jamaica Statistical Digest May 2009; Table 46.1 Percentage Contribution Of Gross Domestic Product Value Added By Industry At Constant (2003) Prices, 1998-2007; Data for 2008 derived from STATIN: Gross Value Added By Industry At Constant(2003) Prices, 2004 - 2008 $' Million.

http://statinja.gov.jm/VALUEADDEDBYINDUSTRYATCONSTANT%282003%29PRICES.aspx

The Plan articulates 4 national goals and is based on the achievement of these goals. It identifies 15 national outcomes and over 50 national strategies to achieve them. The national strategies will be implemented through sector level programmes, plans and activities for each of the social, governance, economic and environmental sectors of the country. Vision 2030 Jamaica will be supported by seven three year medium term socioeconomic policy framework (MTF) documents. The MTF 2009-2012 is the first such document which focuses on seven priority outcomes, one of which is energy efficiency and conservation.

It is recognised that the 25 year period selected for this mitigation assessment (2009 to 2035) extends by 5 years the period in the *Vision 2030 Jamaica: National Development Plan*. The mitigation assessment focuses on energy related emissions but non-energy sector activities (agriculture, forestry, waste and non-energy emissions) are also included.

National planning activities are supported by recent and ongoing development of policies or plans in energy, transportation and forestry.

National Energy Policy 2009-2030

The government is developing a *National Energy Policy 2009-2030*[2] that will lead toward developing:

> *A modern, efficient, diversified and environmentally sustainable energy sector providing affordable and accessible energy supplies with long-term energy security and supported by informed public behaviour on energy issues and an appropriate policy, regulatory and institutional framework*[3].

The achievement of this vision for the sector will be realized by translating the policy into strategies and specific areas of action such as diversification of the country's existing fuel sources, development of renewable sources of energy, biofuels and waste-to-energy programmes, to name a few. These strategies and actions will be administered through the corporate and operational plans in a range of organizations, starting with the Ministry of Energy and Mining (MEM) and its agencies, and also including other Ministries, agencies and departments such as the ministries with responsibilities for transport and agriculture as well as the ministry with the responsibility for the environment.

The policy places priority attention on seven key areas:

1. Security of Energy Supply through diversification of fuels as well as development of renewable energy sources.
2. Modernizing the country's energy infrastructure
3. Development of renewable energy sources such as solar and hydro
4. Energy conservation and efficiency
5. Development of a comprehensive governance/regulatory framework

[2] This Policy was promulgated as a white paper in December 2009.

[3] Vision articulated in the National Energy Policy

6. Enabling government ministries, departments and agencies to be model/leader for the rest of society in terms of energy management
7. Eco-efficiency in industries

By focusing on these priority areas, the National Energy Policy will ensure that the country minimizes the effects of volatile and rising crude oil prices, takes advantage of renewable resources and promotes conservation in use of energy resources amongst all sectors of the society.

The framework for the implementation of the National Energy Policy is presented below.

Figure 2-1 Implementation Framework for Jamaica's National Energy Policy

National Transport Policy (Draft)

The National Transport Policy[7], drafted in 2007, is guided by the vision to create a "Sustainable competitive safe accessible and environmentally friendly transport network providing world class air, land, rail and marine facilities contributing to a vibrant import, export and trans-shipment trade for Jamaica and the world."

The policy includes actions aimed at promoting energy conservation and environmental protection.

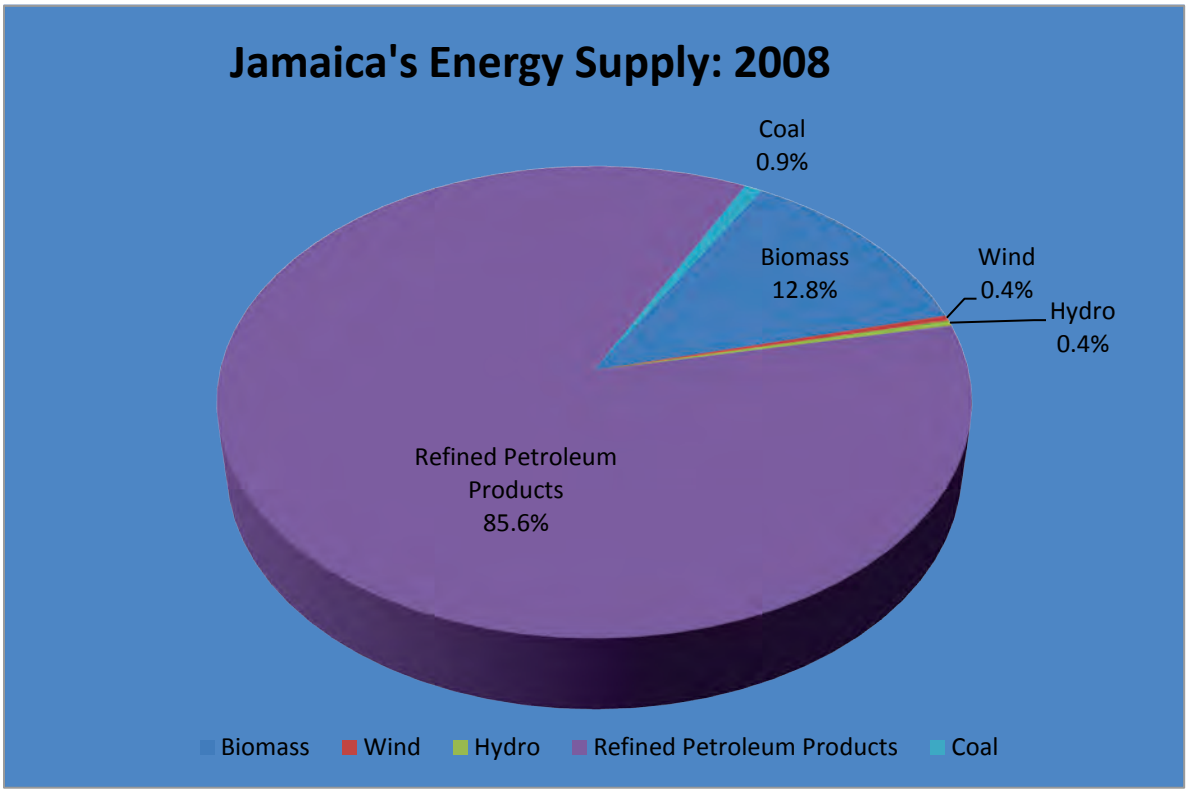
Forestry Department Strategic Forest Management Plan: 2009 – 2013

The Forestry Department has developed the *Forestry Department Strategic Forest Management Plan: 2009 – 2013*, to enable the Department to fulfil its mission to manage, protect and conserve the country's forest resources[8]. The Forest Management Plan specifically refers to the mandate to maintaining and measuring the role of forests as carbon sinks as part of Jamaica's commitments under the UN Framework Convention on Climate Change.

2.2 JAMAICA'S ENERGY SECTOR PROFILE

Jamaica has no known primary petroleum or coal reserves and imports all of its petroleum and coal requirements. Domestic energy needs are met by burning petroleum products and coal and from burning renewable fuels biomass (bagasse, fuel wood and charcoal) and from using other renewable (solar, wind and hydro) resources. Figure 2-1 illustrates that approximately 86% of the energy mix is imported petroleum the remainder coming from renewables and coal. The data for Figure 2-1 exclude fuel supplied for international bunkers. Electricity is generated primarily by oil-fired steam, engine driven and gas turbine units. Smaller amounts of electricity are generated by hydroelectric and wind power. Use of solar energy is negligible and is limited to a few solar water heaters and solar crop dryers.

Figure 2-2 Jamaica's Energy Supply: 2008



The Petrojam refinery, which has a nameplate capacity of 35,000 barrels per stream day (bsd), provides some of the refined petroleum products and the remainder is imported. The Petrojam refinery is a state-owned enterprise and the electric utility – the Jamaica Public

Service Company Limited (JPS) – is 80.1% privately owned and the remainder government owned. JPS is the sole distributor of electricity to the public and it generates the majority of the electricity sold to the public. The remainder is purchased from independent privately owned power producers (IPPs). A small amount of electricity is generated by industrial, commercial or residential operators for their own use. The petroleum products market is open and the refinery along with multinational petroleum marketing companies import refined petroleum products. Heavy fuel oil needed by the bauxite alumina industry is imported directly by the industry.

The energy consumption by end use activity between 2000 and 2008 is shown in Figure 2-2 which shows the sectors that use energy and also includes the fuels supplied to international bunkers. The latter are not counted as part of Jamaica's energy consumption since consumption of these fuels occurs outside Jamaica's borders.

The bauxite and alumina industry has the largest percentage end use which was 37.4% in 2008 (see Figure 2-3) followed by electricity generation (25%), transportation (20.4%) and then the sugar industry (12.2%). The majority of the fuel used in the sugar industry is bagasse with much smaller amounts of heavy fuel oil and wood and while the other sectors use petroleum products nearly exclusively. The exceptions are coal in the cement industry and small amounts of wood used at one lime kiln. In making the sectoral assignments from the data provided by MEM it was assumed that all gasoline consumption was for transportation. Small quantities of gasoline are used for domestic marine vessels but it was not feasible to allocate fuel consumption for domestic marine purposes. Initially all of the turbo and aviation gasoline was attributed to international bunkers but were adjusted downwards by the estimates of fuel used for landings and take offs and internal flights. Details of the methodology for estimating fuel use and emissions from domestic flights were provided in the national GHG emission inventory[9]. Estimates of charcoal use (included in the "Other" sector are subject to considerable uncertainty since the production and distribution of charcoal is in the informal economy.

2.3 METHODOLOGY FOR THE MITIGATION ASSESSMENT

The mitigation analysis used the Long-Range Energy Alternatives Planning System (LEAP) model[10] and examined the demand, transformation, resources and non-energy sector emissions and effects. LEAP is a scenario-based energy-environment modelling tool based on comprehensive accounting of how energy is consumed, converted and produced in a given region or economy under a range of alternative assumptions. Scenarios are self-consistent story-lines of how a future energy system might evolve over time in a particular socio-economic setting and under a particular set of policy options defined for example by specific projects and measures. Scenarios in LEAP can be compared to assess their energy requirements, environmental impacts and social costs and benefits.

Figure 2-3 Jamaica's Energy End Use and International Bunkers: 2000 to 2008

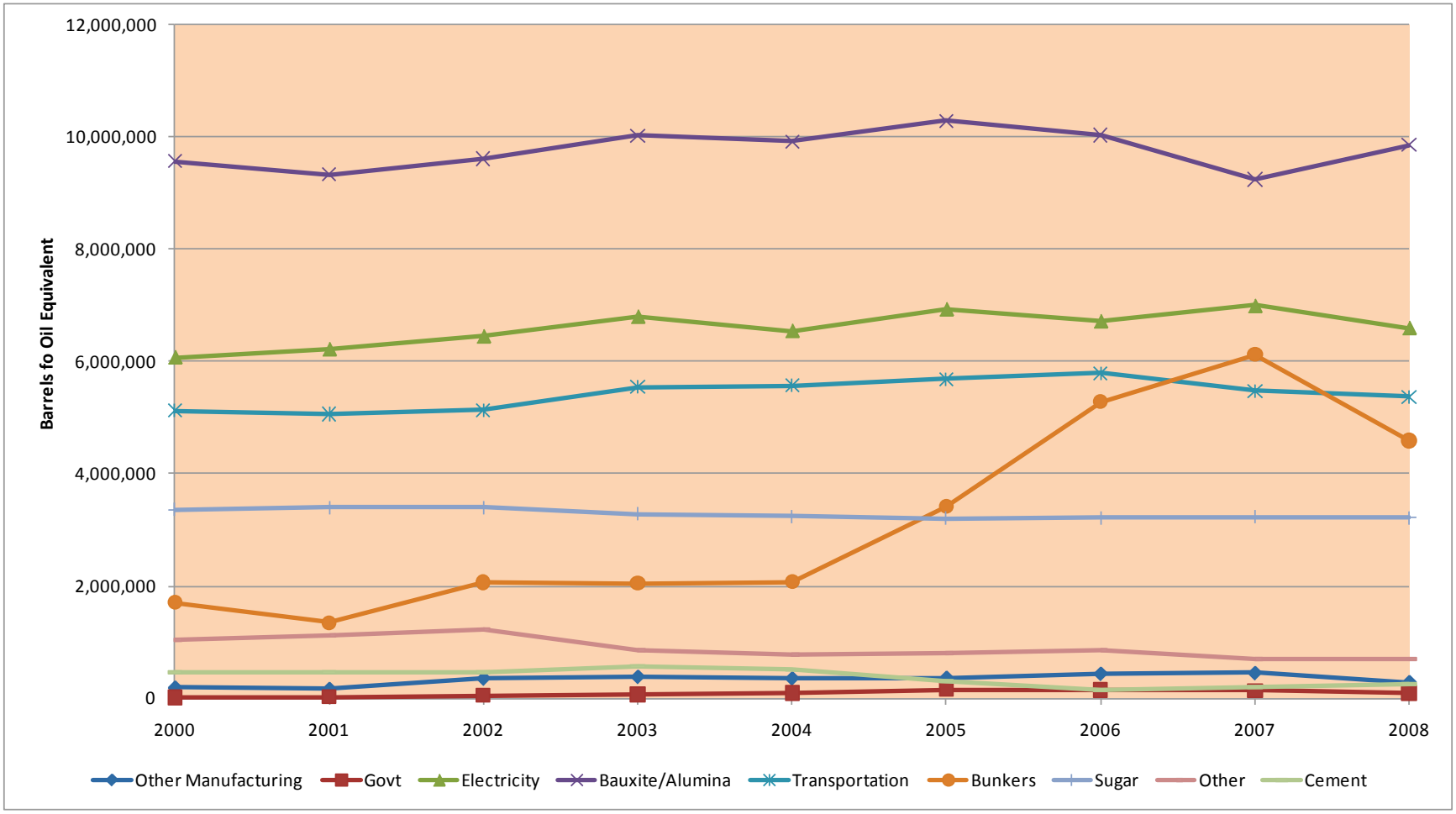
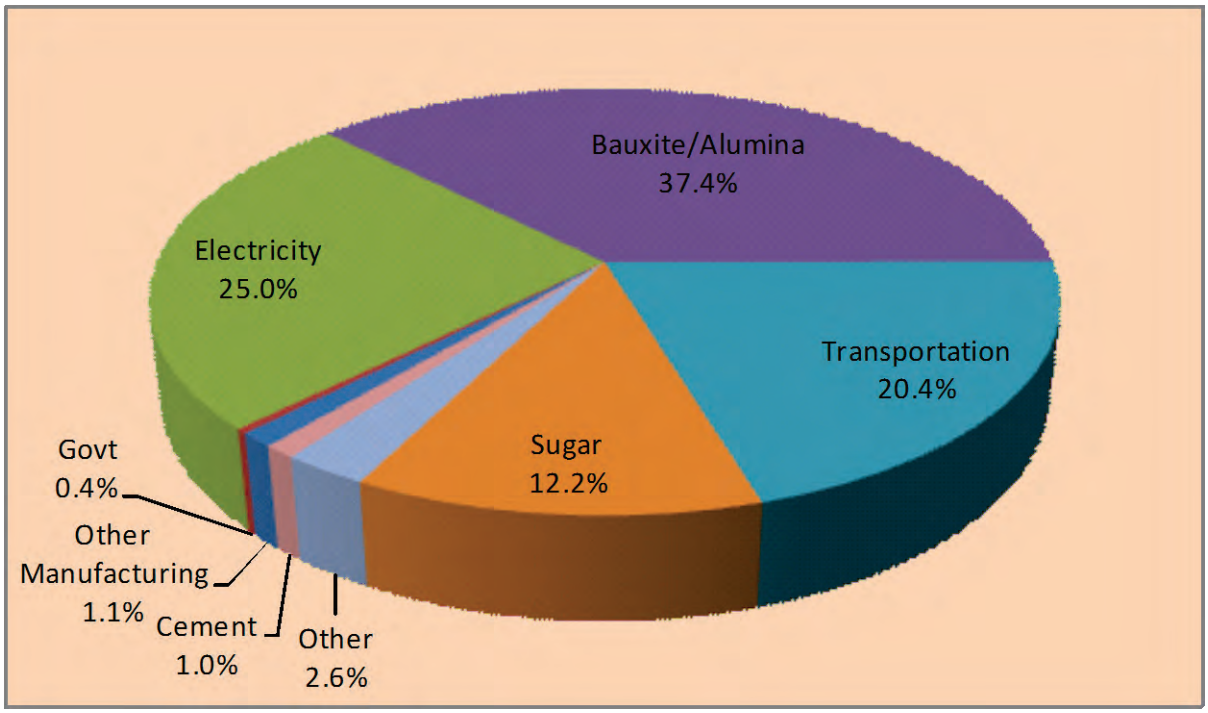


Figure 2-4 Percentage End Use of Jamaica's Energy in 2008

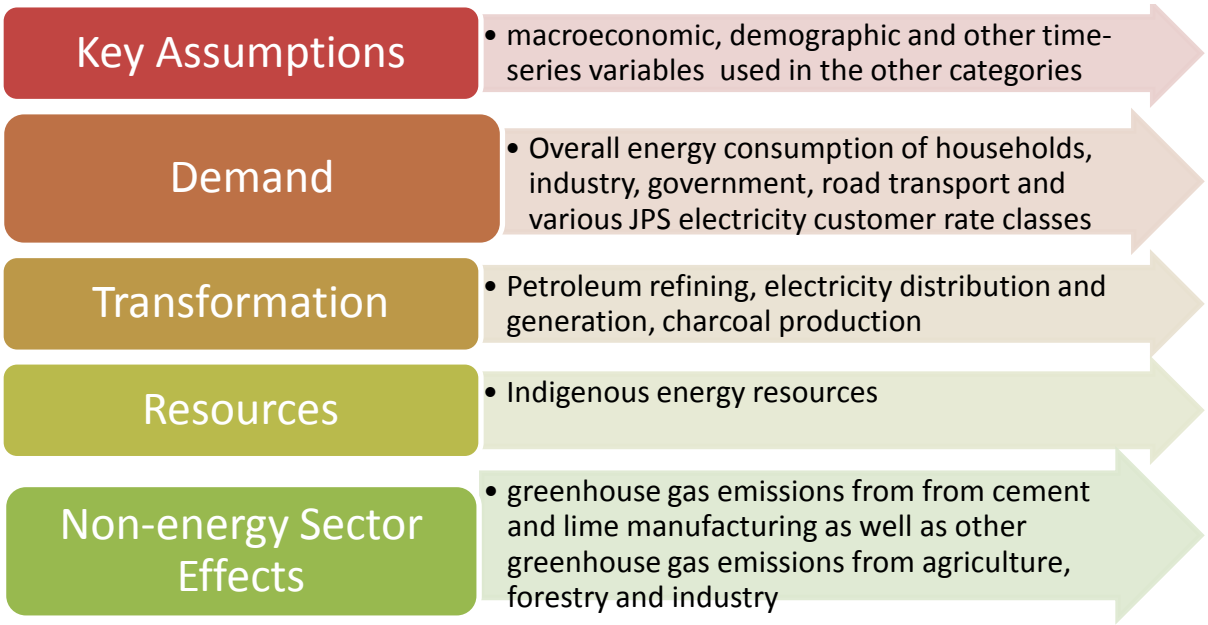


Sources: Ministry of Energy and Mining; Cement Company; Jamaica Bauxite Institute, Sugar Industry Research Institute. Preference was given to primary data sources when these data were available.

The base year used in this analysis is 2000 - the same year used for compilation of the national GHG emission inventory and is the year preferred by UNFCCC for reporting national communications. The first projection year for all scenarios was 2009 and the last 2035. Historical data between 2000 and 2008 were used in the so called Current Account (LEAP model terminology). Projections for the years 2009 to 2035 were made for three groups of scenarios: the Reference Scenario and two others called Scenario 2 and Scenario 3.

The input data for the LEAP model are grouped into five categories called modules (see Figure 2-4).

Figure 2-5 Modules in the LEAP Model



The subcategories or branches in each of these modules were determined by the level of detailed data that were available. The subcategories in the model are shown in Table 2-4. The information sources for the data used in the five categories are described below.

2.3.1 Information Sources

2.3.1.1 Key Assumptions

This module contains macroeconomic (GDP and GDP growth rate), demographic (population, population growth rate, household size) and other time-series variables (for example, emission factors for the on road fleet) that are used in the other modules.

Historical and projected gross domestic product (GDP) data were obtained from the Planning Institute of Jamaica (PIOJ) and Bank of Jamaica publications (see footnotes in Tables 2-2 and 2-3). The population and number of households data were obtained or derived from information published by STATIN and in annual Economic and Social Survey Jamaica (ESSJ) reports or Bank of Jamaica Reports. Emission factors for pollutants emitted by various vehicle classes were obtained from outputs of a transportation model (MOBILE6).

Table 2-4 Subcategories in the Five Modules in the LEAP Model Input Data

Key Assumptions	**Demand**	**Transformation**	**Natural Resources**	**Non-Energy Sector Effects**
Population	Household	Transmission &	Primary	Landfill emissions
Household Size	Refrigeration	Distribution	Wind	Agriculture
GDP in J2003$	Lighting	Oil Refining	Hydro	Animals
Population growth rate	Cooking	Electricity Generation	Wood	Soils
Household size	Fans	Charcoal making	Bagasse	Rice Production
GDP Growth Rate	Stereo	Coal gasification	Municipal Waste	Forestry
Transportation Emission	Air conditioners		Peat	Industry
factors (for 11 pollutants	Computer equipment		Secondary	Lime kilns
in 8 vehicle classes)	Washing machines		Output fuels	Cement
	Clothes ironing			Pet Coke limestone
	Television			
	All other			
	Industry			
	Cement (Clinker, cement mills)			
	Bauxite mining[#]			
	Bayer Process			
	Alumina Kilns			
	Lime kilns			
	Sugar			
	Sugar (Private)			
	Sugar (SCJ)			
	Government			
	Hospitals, NWC			
	Other Government			
	Municipal (Rate 60)			
	Rate 20, Rate 40A[##], Rate 50			
	Road Transport (8 vehicle classes)			
	Commercial charcoal			

Bauxite mining includes rail transportation ## Rate 40A defined to avoid double counting – see text.

2.3.1.2 Demand

The demand module requires activity and energy intensity data such that the product of the two gives the energy consumption. The demand module was broken down into various "branches" namely, household, industry, government, road transport and various electricity customer rate classes used by JPS. These branches were selected because fuel and electricity end use and other activity data are available for them and/or subcategories within them. The methodologies applied for the various demand branches are described below. Additional details for future activity and energy intensity information are provided in the following section on scenarios.

Households

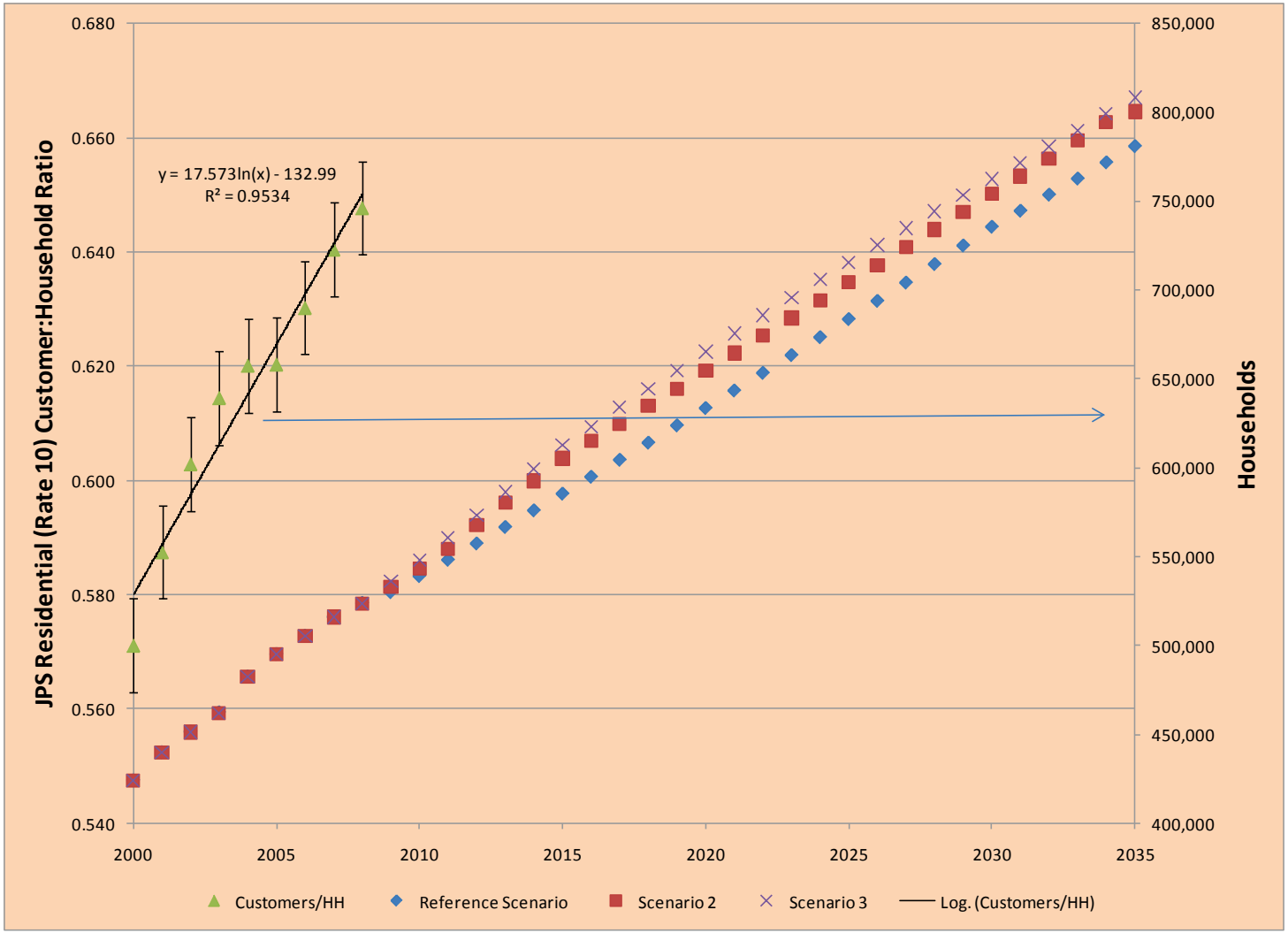
The 2001 census[11] and Jamaica Survey of Living Conditions (JSLC) 2007[12] provided detailed household (residential) data for the numbers of households that have or use various types of household amenities or appliances. These amenities or appliances are used as the sub-branches indicated in Table 2-3. Appliances with small penetration (low percentages of households that have them) and either low annual energy use or little prospect for increased penetration were grouped into the sub-branch "All other". These activity data – i.e., the numbers of households that are represented in the sub-branches and in some cases energy use (fuel consumption or electricity use). Additional household data were also obtained form a recent survey of residential energy end use[13].

Since the available residential (JPS Rate 10) electricity consumption data are for customers (not households), it was assumed that the percentages of households with the various amenities and appliances were the same as the percentages of customers with them. The best fit relationship between the ratio of customers to households that held between 2000 and 2008 was assumed to apply out to 2035 but with manual adjustments for 2009 and 2010. Figure 2-5 shows the estimated values for the customer:household ratio for the three scenarios and the number of households between 2000 and 2008. Load shape information was taken into account in modelling the household electricity use.

Energy intensity data for residential (household) appliances (i.e., average annual electricity consumption for various appliances) used in Jamaica are not available and so U.S. or Canadian energy intensity data were used as a starting point. These data were adjusted to match electricity consumption over the current account period (between 2000 and 2008). Energy intensity (and activity – i.e., percentage of households with CFLs) data for lighting were based on the data available from the distribution of compact fluorescent bulbs[14]. Data for the average annual household fuel consumption used for cooking and lighting were obtained from data provided by MEM.

Future energy intensity data used in scenarios *S2* and *S3* were based on existing and proposed voluntary energy standards for the appliances used in the U.S. and/or Canadian Energy Star programs but with later implementation or penetration for Jamaica. Import data for various appliances and the typical and maximum lifetimes of appliances together with policy initiatives were taken into consideration in estimating the penetration of energy efficient appliances in scenarios *S2* and *S3*.

Figure 2-6 Households and JPS_Customer:Household Ratios for Scenarios



Industry

Sectoral fuel use information is compiled by the Ministry of Energy and Mining (MEM) and is available for the bauxite and alumina sector, cement, sugar and "Other Manufacturing". MEM provided these sectoral fuel consumption data for 2000 to 2008. More detailed energy end use and production data were obtained from the Jamaica Bauxite Institute (JBI), Caribbean Cement Company Limited (CCCL), and the Sugar Research Institute (SIRI). Although initiatives are under way to privatise sugar estates and factories owned by the government (Sugar Company of Jamaica), no data were available for projected production for the sugar industry. Future production was assumed to remain at the 2008 levels. Energy intensity assumptions for industry are described in the Scenarios.

Transportation

Estimates of fuel consumption and hence GHG emissions from the road transport sector require data for the annual distance travelled (vehicle kilometres travelled or VKMT) and the emissions per kilometre for the on road fleet which is broken down into various vehicle classes. The former are the activity data and the latter the energy intensity (sometimes called emission factors).

Data for the entire fleet were obtained from Inland Revenue and data for subsets of the fleet were obtained from the Transport Authority, Jamaica Urban Transit Company (JUTC) and Montego Bay Metro (MBM). The vehicle emission rates were estimated for various vehicle classes (based on vehicle weight and fuel) using an US EPA model (MOBILE6[15]). This model uses detailed fleet information (including the age (model year), weight, fuel type, emission control technology) to estimate emission rates (in g/mile or g/km) for tailpipe, evaporative and road emissions for each of up to 26 vehicle weight/fuel classes. The MOBILE 6 emission rates for the 26 vehicle classes were consolidated into rates for 8 vehicle classes which were then used in the LEAP model together with estimated projections for the vehicle fleet. Future fleet data were estimated based on assumed levels of vehicle imports using historical import data as a guide.

Emissions from aircraft and marine vessels were based on data compiled in the recent GHG emissions inventory for Jamaica[16]. Aircraft emissions are those that occur during landing and takeoff (LTO) and during flights that originate and end entirely within Jamaica. LTO emissions for 2000 to 2005 were estimated in the GHG emissions inventory[4] and projected emissions were based on the growth in air and marine traffic. The Airport Authority of Jamaica (AAJ) provided some air transport related data.

Similarly marine emissions are those that occur when vessels ply in Jamaican waters. Fuel delivered for international flights (aviation bunkers) and international shipping (marine bunkers) are not included in emissions estimates. Limited fuel use data were available for domestic marine travel and this sub-branch was not included separately. The fuel consumption for domestic marine travel is small and would be included in other branches.

Government

Since data for fuel and electricity consumption by government agencies are available, the Government branch was included. Electricity consumption and fuel use data were obtained from the MEM and from National Water Commission (NWC) annual reports. The government sector was broken down into NWC, Hospitals and "Other Government" since for the first two branches especially, extensive audit data are available and mitigation proposals for hospitals (fuel end electricity conservation) and NWC are planned. The hospital audits[17] included several groupings of energy conservation measures which were grouped together to define mitigation measures that were assigned in Scenarios 2 and 3.

Other Electricity Branches

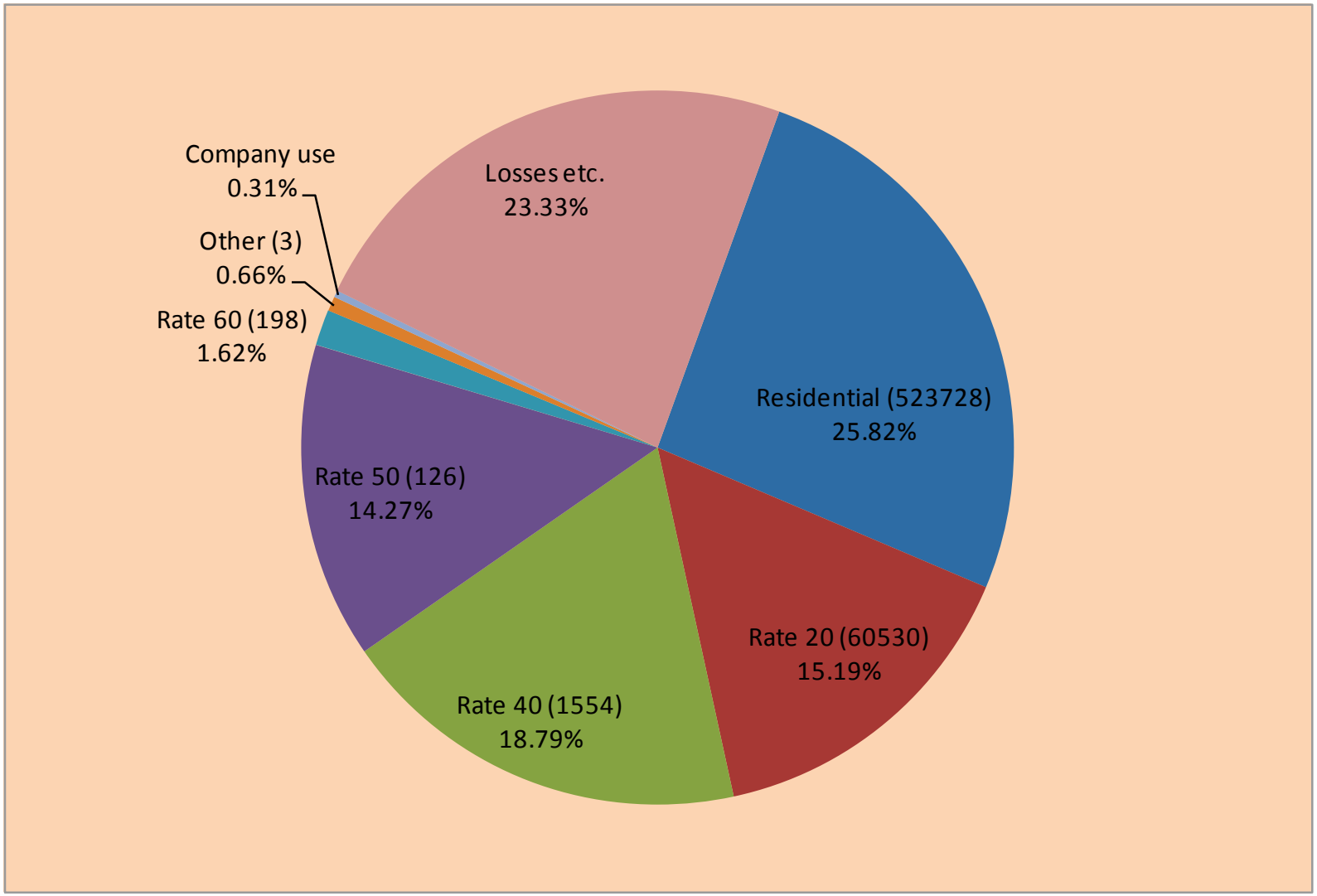
Electricity consumption information is available for the rate classes used by JPS (Rates 20, 40 and 50 and 60 and "Other") and so these rate classes were used as sub-branches in the mitigation assessment. Care was taken to avoid double counting where separate electricity consumption data were available (e.g., cement, petroleum refining, NWC, government). This was achieved by defining an arbitrary Rate 40A sub-branch to make the necessary adjustments. The recent JPS Rate Application[18] and ESSJ publications provided data on the numbers of customers in each rate class, the load shape and the annual electricity use for all rate classes. Week day/week end load shape information for all rate classes available in the JPS Rate application was used in modelling the electricity demand.

The disposal of electricity in 2008 (percentages of total GWh for various rate classes, losses and company use) is shown in Figure 2-6. The numbers in parentheses after the rate classes are the numbers of customers in the rate class. The Rate 40 and Rate 50 customers accounted for 33.3% of the total electricity disposal with only 1680 customers: this is compared to the residential rate class (Rate 10) which accounted for 25.8% of the electricity disposal. Unfortunately information on the types of equipment (or other information such as a Jamaica industrial classification code) used by the Rate 40 and Rate 50 customers which could allow similar analysis to that for the residential customers as described above, is not available. Information and data on recently completed and planned energy conservation measures for one Rate 50 customer (UWI) was provided and it illustrated the potential for energy conservation (mitigation). However, the UWI may not be representative of the average Rate 50 customer and hence we applied less aggressive mitigation measures for the Rate 40A and 50 sub-branches.

2.3.1.3 Transformation

The transformation module comprises petroleum refining, electricity distribution and generation, charcoal production and coal gasification branches. Electricity transmission and generation data were obtained primarily from the publicly available March 2009 JPS 2009 to 2014 Tariff Rate Application that was available on the OUR web site and from historical JPS reports provided by OUR. Petrojam provided data for the Refinery and charcoal data were derived from ESSJ and MEM reports. Coal gasification this was included since syngas from gasified coal is an option for use in alumina kilns. Additional details on the transformation are provided in the scenario section.

Figure 2-7 Disposal of Electricity in 2008[#]



Numbers in parentheses are the number of customers

2.3.1.4 Resources

Indigenous energy resources are limited to hydropower, solar, wind, biomass (bagasse, fuel wood, charcoal) and peat since there are no known petroleum or coal resources.

Hydropower

There are currently (2008) 23.1 megawatts (MW) of installed hydropower at 8 locations and additional hydropower generation capacity is planned.

Biomass

Bagasse, which is a fibre residue from sugar cane milling, is the largest indigenous renewable energy resource. Current use in boilers at sugar factories is not optimal due to irregular or insufficient cane supply and inefficient boiler equipment at the majority of sugar factories. Additional utilisation of biomass is planned.

Firewood and Charcoal

Charcoal and fuel wood are used primarily in the residential sector as fuel for cooking. There is also commercial use of charcoal for cooking especially in roadside establishments. Fuel wood (bamboo and acacia, leucaenea) has been used at one sugar factory and also at one lime kiln. Except for fuel wood use in the sugar industry, the estimates of fuel wood and charcoal use are subject to large uncertainties.

Biogas

Generation of biogas from agricultural and farming operations has been limited. There are currently (2000) about 120 biogas generators based on agricultural wastes (e.g., pig or chicken farm wastes) or domestic sewage. The energy supplied by each of these systems is about 37 GJ/y based on gas production of 4.5 m^3/day (65% methane). Many of the residential owners of biogas use the system for all of their energy (cooking, refrigeration and lighting) needs. The overall potential for biogas production in Jamaica has been estimated at 20,000,000 m^3/y (equivalent to 75,000 bbl oil). The potential for further exploitation of biogas is attractive especially in remote/low population density areas where costs for electricity transmission lines are not cost effective.

Peat

There are limited amounts of peat located near the Negril and Black River areas. Estimates of deposits are approximately 20 million metric tonnes – but exploitation of peat resources has been ruled out primarily because of the adverse environmental impacts since the deposits are located in areas that are ecologically sensitive and are dependent on tourism.

Wind

There are currently (2008) a 20 MW facility at Wigton and a 0.225 MW wind turbine at Munro College. Additional wind farms are planned but additional wind mapping is to be undertaken to help determine the additional potential for wind energy [total wind energy potential is estimated at 45 to 70 MW][19].

Solar

Given Jamaica's tropical location and good solar insolation, solar energy potential for a wide range of applications is excellent. Currently there is limited use of solar crop drying or water heating but additional solar water heating systems are planned for hospitals. Expanded use of solar water heating for example in hotels would reduce the need for energy derived from fossil fuel combustion. We are not aware of any consideration in Jamaica of solar technologies such as for solar cooling or power generation.

Other Alternate Energy Sources

Currently there are very limited applications in Jamaica of photovoltaic (PV) systems but additional PV systems are contemplated. The siting of a demonstration Ocean Thermal Energy Conversion (OTEC) plant to produce electricity (e.g., a 15 MW plant) in Jamaica has been under investigation for some time but the prospects do not warrant including OTEC as a source of electricity in any scenario. A waste to energy project is contemplated.

2.3.1.5 Non-Energy Sector Effects

The non-energy sector effects included were CO_2 emissions from cement and lime manufacture and from the proposed electricity generation using Petroleum coke. Other GHG emissions from agriculture, forestry and industry were based on projections from the 2000 to 2005 emission inventory except in cases where data from specific projects were available. These included rice farming, reduction ion deforestation rates, and replacement of HFC refrigerants by hydrocarbon refrigerants.

2.3.2 Scenarios

Three scenarios are developed to project emissions – a Reference Scenario (Ref) and two other scenarios - Scenario 2 (*S2*) and Scenario 3 (*S3*) - characterised primarily by different rates of growth for population and the gross domestic product (GDP). The Reference Scenario is linked to the Vision 2030 GDP and population growth targets and does not include any initiatives to mitigate GHG emissions. *S2* and *S3* assumed progressively higher GDP growth rates but lower population growth rates. Both of the scenarios *S2* and *S3* have mitigation options.

The Reference Scenario assumes that two (Alumina Partners (Alpart) and the Windalco Ewarton) of the three alumina refineries that were closed in 2009 would reopen and that there would be continued use of oil at alumina plants. It also assumes that the Petrojam Refinery Upgrade will be completed in 2014 and will provide low sulphur diesel and gasoline for the vehicle fleet and petcoke for a 100 MW plant at Hunts Bay. The Reference Scenario also assumes the use of coal at the new old Harbour power station.

For scenarios 2 and 3, there are choices for fuels [coal, heavy fuel oil (HFO), diesel oil, natural gas (NG), gasified coal (Syngas)] that can be used for the various processes. Also included in Scenario 3 is an option for the use of nuclear power as noted in the Energy Policy.

The fuel choices for various demand and transformation processes are indicated in Table 2-5.

Table 2-5 Fuel Choices for Various Demand and Transformation Processes

Process	HFO	Diesel	Coal	Natural Gas	Syngas	Nuclear
Bayer process boilers and lime kilns (Bayer/Lime kilns), new steam boilers	√		√	√		√[#]
Slow/Medium speed diesel engines	√			√		
Alumina kilns	√			√	√	
Gas turbines		√		√		
Boilers at existing steam fired electricity generating stations	√					

[#] Considered only as an option in Scenario 3 – see text

The feasible combinations of processes and fuels lead to the options within Scenarios 2 and 3 (see Table 2-6) since the possible combinations are limited by the following conditions and assumptions.

- Once introduced coal or natural gas is used in all possible processes except as noted below.
- Alumina kilns may not use coal (hence the use of syngas from gasified coal). Syngas at Alpart and Windalco would be in 2015 and 2013 at Jamalco
- Existing heavy fuel oil fired boilers and slow speed engines at electricity generating stations would be retrofitted to burn natural gas
- Bayer process boilers would burn oil up to 2013 and be upgraded/retrofitted to use natural gas or coal after 2013 (Coal or gas at Windalco in 2015; cola t Alpart in 2015)
- Existing and new medium/slow speed engines retrofitted could use natural gas
- The new alumina plant (Scenario 3 only) would use either natural gas or coal with gasified coal in the alumina kiln
- Included are coal or natural gas fired power generation at some alumina plants and/or at the cement company
- The addition of a nuclear power (in the event that nuclear power generation becomes economically and otherwise (e.g., human resource, logistics etc.) feasible is included as an option that entails the use of natural gas for other purposes (although it could be combined with other fuels used elsewhere)
- When natural gas is available it would be used in some of the vehicle fleet

Highlights of the process and fuel combinations considered are indicated in Table 2-6. Note that although a scenario (designated as *S2* Oil in Table 2-6) that would entail continued exclusive use of oil (similar to the reference scenario) is possible, it would not sufficiently diversify the fuel supply and also would not be economically viable for the bauxite & alumina and power generation sectors. Because of these factors the scenario option *S2* Oil was not included in the mitigation assessment.

Table 2-6 Process and Fuel Combinations for Potential Scenario Options

Scenario	Bayer/Lime Kilns /New Steam	Slow Speed Engine Existing /New	Al Kilns Existing / New[#]	Gas Turbines	Existing Steam Plants
Reference Scenario					
Ref	Current use	Current use	Current use	Current use	Current use
Scenario 2 Options					
S2	Coal Jamalco 2013 Alpart 2015 Windalco 2015 JPS Old Hrbr	HFO/HFO	HFO	Diesel oil	HFO
***S2* Oil**	**HFO**	**HFO**	**HFO**	**Diesel oil**	**HFO**
S2 SYN	Coal Jamalco 2013 Alpart 2015 Windalco 2015	HFO	Syngas Retrofit Jamalco 2013 Alpart 2015 Windalco 2015	Diesel oil	HFO
*S2*NG	NG Jamalco 2013 Alpart 2013 Windalco 2015 JPS (Except Hunts Bay)	NG retrofit/ NG	NG retrofit Jamalco 2013 Alpart 2013 Windalco 2015	NG JPS (Except Hunts Bay)	HFO
Scenario 3 Options					
S3	Coal Jamalco 2013 Alpart 2015 Windalco 2015 JPS Old Hrbr	HFO	HFO/Syngas	Diesel oil	HFO
S3 SYN	Coal Jamalco 2013 Alpart 2015 Windalco 2015	HFO	Syngas Retrofit/Syngas Jamalco 2013 Alpart 2015 Windalco 2015	Diesel oil	HFO
S3 NG	NG Jamalco 2013 Alpart 2013 Windalco 2015 JPS (Except Hunts Bay)	NG retrofit/NG	HFO/Syngas	NG	HFO
*S3 NG*NU	Coal Jamalco 2013 Alpart 2015 Windalco 2015 JPS Old Hrbr Nuclear after 2020	NG retrofit/NG	HFO/Syngas	NG	HFO

[#] Note: New alumina kiln on *S3* only

Highlights of the main scenario groupings

Reference Scenario (Ref):

Only one option was considered – namely the continued use of fuels in all existing processes. This scenario also assumes completion of the Petrojam Refinery upgrade in 2014 and that low sulphur gasoline and diesel will be available for the on road vehicle fleet.

Scenario 2 (*S2*):

Scenario 2 assumes a lower population growth rate and higher GDP growth rate than the Reference scenario. It also includes added alumina production capacity. The main option designated as *S2* has coal as the fuel for the Bayer processes, lime kilns and a new coal fired station at Old Harbour and no natural gas. The main mitigation option in this scenario (designated as *S2 NG*) entails the use of natural gas (NG) for the Bayer process, lime kilns, electricity generation at the Bogue generating station and for the new Old Harbour generating station (300 MW). Exiting slow or medium speed diesel engines currently using heavy fuel oil would be retrofitted to use natural gas. Other mitigation measures include Bayer process energy efficiency improvements, the use of more efficient household appliances, use of CNG in some of the vehicle fleet and improved energy efficiency in the Government sector (hospitals, NWC and the remainder of the government sector).

Scenario 3 (*S3*):

This scenario assumes a lower population growth and a higher GDP growth rate than for *S2* and a more rapid decrease in the number of persons per household. *S3* includes all of the *S2* initiatives and has additional energy intensity reductions at two of the alumina plants. The mitigation measures however, are offset by the increase energy requirements and emissions from the proposed addition of a new alumina plant. The introduction of additional hydro generation capacity would also contribute to lower emissions across the board. An option entailing nuclear power along with natural gas is included. Under this option the nuclear power would be added instead of power stations at bauxite alumina plants or the cement company.

Constraints and data gaps

The analysis is constrained by the following:

- Although rail transportation is used only in the bauxite sector, information on fuel used for rail transport was not readily disaggregated from other diesel fuel used in the sector. The diesel fuel used for rail was included in that used for mining,
- Fuel use data for domestic marine activities were not always readily available. It is believed that some of the gasoline sold in retail outlets is used for fishing and other domestic marine activities.
- Projections related to HFC emissions are not yet included

- Divestment of government owned sugar factories is under way and no data were available for making projections
- Cost data for mitigation options and for some processes were not always available and hence costs were not modelled.

At the outset of the project the data requirements for the mitigation assessment were presented to the key providers of energy related data and information at the "Energy Database Development and Modelling Symposium" hosted by MEM (May 6-7, 2009). The presentation facilitated the data gathering process.

A preliminary draft report was circulated to stakeholders and feedback on draft scenarios was solicited during a second workshop (October 21, 2009) attended by participants from almost all sectors (see Appendix 3).

The main features of the "activity" aspects of scenarios are highlighted below and followed by the mitigation aspects for the measures and activities.

Key Activity-Related Features of Scenarios

Key Parameters: For the Reference Scenario, the GDP growth rates and population projections are the same as those included in Vision 2030 Jamaica. The GDP growth rate for the Reference Scenario was assumed to increase to 4% by 2015 and remain constant at 4% up to 2035. For Scenarios 2 and 3, GDP growth is assumed to be the same as the Reference scenario up to 2015 and thereafter increases to 4.5% and 5% in 2035 respectively for the *S2* and *S3* scenarios.

Population growth rates are based on the achievement of targets set in the Population Sector Plan under Vision 2030 Jamaica (0.25% and 0% for Scenarios 2 and 3 respectively). Household size was assumed to decline from 3.33 in 2008 to 3.2 in 2015 then to 3.15 in 2035 (Scenario 2) or to 3.2 in 2015 then to 3.10 in 2035 (Scenario 3). [The number of households (as determined by population growth and household size) largely determined household demand.]

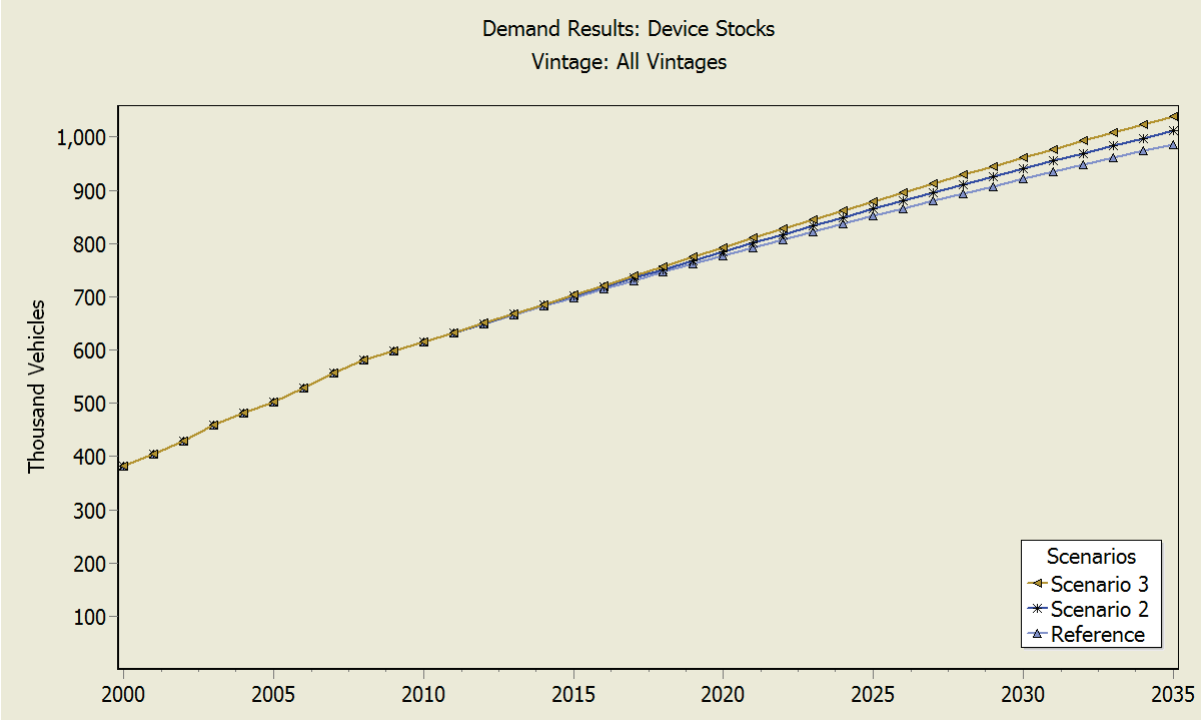
Demand Branches: Growth rates in electricity consumption between 2009 and to 2014 were estimated in the JPS rate application and these were used in all scenarios. After 2014, increasingly optimistic growth rates were used in the various sub-branches that corresponded to JPS rate classes.

For the bauxite and alumina sector, it was assumed that two (Alpart and Windalco Ewarton) of the three plants closed in 2009 would reopen in 2012 in all scenarios. The introduction of natural gas was assumed only to occur in Scenario 2 together with capacity expansions at Ewarton and Jamalco). Scenario 3 would see the introduction of a new alumina plant in 2015. Bauxite mining, kiln drying and lime production were linked to alumina production. Energy use for bauxite mining included rail transportation since data were not always reliably disaggregated to delineate fuel used for rail transportation (which is used only in the bauxite alumina sector) from fuel used for other bauxite and limestone mining activities. Cement

production was assumed to increase as percentages of the GDP growth rate (30% for Reference, 35% for *S2* and 45% for *S3*).

Activity data for the on-road sub-branch in the transport branch (vehicle fleet) were based on assumptions for the growth and age distribution of the fleet. Various approaches were considered in making estimates of the growth in the vehicle fleet. Between 2000 and 2008 the percentage of households owning vehicles increased from 15.0% to 20.3% in 2006 and then decreased somewhat to 19.3% in 2007. The number of motor cars in 2000, 2005 and 2008 were respectively 270,005, 355,091 and 408,264 – an average annual increase of 6.3% between 2000 and 2005 and 5% between 2005 and 2008. These trends illustrate how challenging it is to estimate the future growth in the vehicle fleet especially when compounded by the volatility in the prices of gasoline and vehicles as a result of devaluation of the Jamaican dollar and the global increase in fuel prices as well as likely changes in consumer preferences (e.g., switch from SUVs to smaller, more fuel efficient vehicles). In the absence of more definitive projections it was assumed that the fleet would continue to grow based on the trends between 2000 and 2008. The annual vehicle sales for each vehicle weight class were assumed to be in the same proportion as the weight class distribution for the fleet in 2008. The resulting stock changes (total fleet size) taking into account the age distribution of the fleet over time are illustrated in Figure 2-8.

Figure 2-8 Growth in Vehicle Stocks for Scenarios



Numbers in parentheses are the number s of customers

Transformation Module: The branches are transmission and distribution (of electricity), petroleum refining, electricity generation, Coal gasification and charcoal making.

Historical data on losses in electricity distribution and JPS' projections between 2009 an 2014 for reduction in these losses were used in all scenarios.

In all scenarios, the upgrading of the Petrojam Refinery was assumed. The "own use" energy and the slate of products after the upgrade were provided by Petrojam.

Electricity generation projections were based on characteristics of individual thermal and wind units and on collective hydro generating stations. Additions and retirements of generating capacity were based on the addition of individual units. Projections between 2009 and 2014 in all scenarios were based on the changes indicated in the recent JPS rate application.

After 2014 the reference scenario assumed coal and Pet Coke as the fuels used for added capacity together with wind stations to meet the goals in the Energy Policy. CNG as a fuel was assumed in Scenarios 2 and 3 and a nuclear option was included in Scenario 3. Details are indicated in Table 2-4.

Coal gasification and charcoal conversion data were obtained from the literature[20].

Historical charcoal production data are notoriously subject to considerable uncertainty. The historical charcoal consumption data between 2000 and 2005 were adjusted downwards based on estimates of residential charcoal use derived from the percentage of households using charcoal for cooking and estimates of the energy required for cooking and an arbitrary estimate of the amount of charcoal used in commercial activities. These estimates were equivalent to wood removal rates about 30% higher than that used in the GHG inventory. This corresponds to 0.13% of disturbed forest versus 0.1% of disturbed forest in the GHG inventory. It must be stressed that these estimates are also subject to uncertainty and point to the need for better estimates for charcoal production and consumption.

Details of the various assumptions and mitigation measures for these scenarios are given in Table 2-6 (Key Assumptions, Demand and Non-Energy Sector Effects modules) and Table 2-7 (Transformation and Resources modules). These tables reflect feedback obtained during the second workshop. Most if not all of the mitigation activities and projects for the addition of generation capacity were based on a detailed list of energy related policies, measures and projects compiled by the Ministry of Energy and Mining. This list is provided in Appendix 2.

Table 2-7 Scenarios for the Demand and Non-Energy Sector Effects

Category	Reference (REF)	Scenario 2 (*S2*)	Scenario 3 (*S3*)
Key Parameters			
Population	Growth at 0.47% declining to 0.25% in 2030	Growth at 0.38% declining to 0.25% in 2030.	Growth at 0.38% declining to 0.0% in 2030
Household size	Constant at 3.33	From 3.33 in 2008 to 3.2 in 2015 then to 3.15 in 2035	From 3.33 in 2008 to 3.2 in 2015 then to 3.10 in 2035
Number of Households	Population/household size	Population/household size	Population/household size
GDP 2003J$	Use data from PIOJ for 2009, 2010, 2012, 2015 and 2030	Same GDP growth to 2020 as Reference: Growth increasing by 1% between 2020 and 2030 (i.e., from 3 to 4% and constant after (2031 to 2035)	Same GDP growth to 2020 as Reference: Growth increasing by 2% between 2020 and 2030 (i.e., from 3 to 5% and constant after (2031 to 2035)
GDP Growth rate	0% in 2009, 1% in 2010; to 3% in 2012 until 2015; to 4% in 2030	0% in 2009, 1% in 2010; to 3% in 2012; to 4% in 2015; to 4.5% in 2035	0% in 2009, 1% in 2010; to 3% in 2012; to 4% in 2015; to 5.0% in 2035
Demand			
Households	Number of households based on population and household size (above)	Number of households based on population and household size (above)	Number of households based on population and household size (above)
Residential (Rate 10) Customers	Appliance penetration for Rate 10 customers assumed the same as household penetration from JSLC	Appliance penetration for Rate 10 customers assumed the same as household penetration from JSLC	Appliance penetration for Rate 10 customers assumed the same as household penetration from JSLC

Category	Reference (REF)	Scenario 2 (*S2*)	Scenario 3 (*S3*)
Residential (Rate 10) Customers	Rate 10 customers increase from 523,728 in 2008 to 780,951 in 2035. Customer/Household ratio increases from 0.648 in 2008 to 0.860 in 2035	Rate 10 customers increase from 523,728 in 2008 to 800,850 in 2035. Customer/Household ratio increases from 0.648 in 2008 to 0.860 in 2035	Rate 10 customers increase from 523,728 in 2008 to 808,290 in 2035. Customer/Household ratio increases from 0.648 in 2008 to 0.8825 in 2035
Refrigeration	Penetration (saturation) increases from 2008 level (77.4%) to 92% in 2030; No energy efficient refrigerators. Note – imports account for ~0.5% of stock of refrigerators.	Penetration (saturation) increases from 2008 level (77.4%) to 92.5% in 2035 Energy efficient fridges' penetration increases from 0 to 5% in 2015; 8.5% in 2020; 12% in 2025; 19% in 2035. Energy efficiency improves by 15% in 2025 for existing and energy efficient fridges.	Penetration (saturation) increases from 2008 level (77.8%) to 95% in 2035. Energy efficient fridges increase from 0 to 9.5% in 2015; 16.5% in 2020; 21.5% in 2025; 31.5% in 2035. Energy efficiency improves by 15% in 2025 for existing and energy efficient fridges.
Lighting	Keep current mix of technologies (incandescent (17.7%), CFLs from 74% in 2008 to 80% in 2015 based in existing programs. No LED; Kerosene decreases from 6.1% in 2008 to 1% in 2035	CFLs from 74.13 to 90% in 2015 and incandescent to decrease from 17.87 to 10% by 2015; LED from 0 to 2% in 2015 and 5% in 2035; Kerosene decrease from 6.3 to 3% in 2015;	Add CFLs to 95% saturation by 2015 (from 74.13 to 95%) and incandescent to decrease from 17.87 to 5% in 2015 and 0% by 2035; LED increases from 0 to 5% in 2015 and to 10% in 2035; Kerosene decrease from 6.3 to 1% in 2015;
Cooking	LPG from 89.3% in 2008 to 95% in 2030; Electric stoves from (2.5% to 10% in 2030; charcoal and firewood flat	LPG from 89.3% in 2008 to 95% in 2020; Electric stoves from (2.5% to 10% in 2020; charcoal and firewood flat	LPG from 89.3% in 2008 to 95% in 2020; Electric stoves from (2.5% to 10% in 2020; charcoal and firewood flat

Category	Reference (REF)	Scenario 2 (*S2*)	Scenario 3 (*S3*)
Fans	Assume current penetration rates (68.1%) remains flat	Assume current penetration rate (68.1%) increases to 80% in 2015. Energy efficiency improves by 15% in 2025	Assume current penetration rates (68.1%) goes to 90% in 2015 Energy efficiency improves by 15% in 2020
Stereo	Assume 2008 penetration rates and energy efficiency	Penetration rates from 35.8% to 50% in 2020; Energy efficiency improves by 5% in 2020	Penetration rates from 35.8% in 2008 to 60% in 2020; Energy efficiency improves by 10% in 2020
Air Conditioners	Keep current penetration rate (2.9%) and assume no efficient or HC-based ACs	Total penetration rate Existing from 2.9% to 10% in 2020; 5% in 2035; Efficient ACs 0% to 10% in 2020; 20% in 2035; HC from 0 to 5% in 2020 and to 20% in 2035. Energy efficiency improves by 15% in 2025 for existing; by 25% in 2035 for efficient ACs and by 16% in 2035 for HC ACs	Penetration rates for existing from 2.9% to 10% in 2015,12% in 2020,10% in 2025, and 0 in 2035; Efficient ACs 0% to 15% in 2020; 20% in 2035 and 25% in 2030; HC from 0 to 10% in 2020 and to 25% in 2035 Energy efficiency for existing ACs improves by 15% in 2025, for HC ACs by 16% in 2035 and by 25% for efficient ACs by 2035
Computer equipment	Assume current (2008) penetration rate (15.5%) remain the same	Penetration rates from 15.4% to 30% in 2020 and 60% in 2035; Energy efficiency improves by 15% in 2025	Penetration rates from 15.4% to 15% in 2020 and 80% in 2035; Energy efficiency improves by 15% in 2020 and further 10% by 2035

Category	Reference (REF)	Scenario 2 (*S2*)	Scenario 3 (*S3*)
Washing Machine	Penetration rate for existing machines increases from 29.74% to 35% in 2020 and 50% in 2035 (no energy efficient machines)	Penetration rate for existing machines decreases from 29.74% to 22% in 2020 and 20% in 2035; Energy efficient machines penetrate to 3% by 2015; 8% by 2020 and to 30% in 2035 Energy efficiency for existing machines improves by 15% by 2020 and for efficient machines by 50% by 2020	Penetration for existing machines from 29.74% to 27% in 2020 and 15% in 2035; Energy efficient machines to 3% in 2015; 13% by 2020 and 52% by 2035 Energy efficiency for existing machines improves by 20% by 2020 and for efficient machines by 50% by 2020
TV	Penetration rate increases from 89.5% to 95% by 2015; Energy efficiency – no change Note: Insufficient data on types (LED, plasma etc.) of TVs – so assumed overall group.	Penetration rate increases to 95% by 2015; Energy efficiency improves by 4% by 2012 and by 33% in 2025 (relative to 2008 values)	Penetration rate increases to 95% by 2015; Energy efficiency improves by 4% by 2012 and 44% in 2025 (relative to 2008 values)
Clothes iron	Saturation from 92% in 2008 to 95% by 2035. No change in energy efficiency	Saturation to 95% by 2035. Energy efficiency improves by 15% in 2020	Saturation to 95% by 2030. Energy efficiency improves by 20% in 2020
All other	Assume current penetration rates remain the same Energy efficiency – no change	Assume current penetration rates remain the same. Energy efficiency improves by 10% in 2025	Assume current penetration rates remain the same. Energy efficiency improves by 15% in 2025
Industry			

Category	Reference (REF)	Scenario 2 (*S2*)	Scenario 3 (*S3*)
Cement Clinker	2009 value from CCCL; 2010 at 0.9 Million tonne or 900 ktonne and thereafter growing at 30% of GDP growth (including assumed export market (increasing from 132 ktonne in 2011 to 181 ktonne in 2035)) [1.181 Million tonne in 2035] Note: kilns at capacities after 2035 Kilns 4 reopened 2011 and Kiln 3 permanently closed.	2009 value from CCCL; 2010 at 900 Mt and thereafter growing at 35% of GDP growth rate (including assumed export market (115 ktonne 2009-2020; 110 ktonne to 2021; 100 ktonne to 2025; decreasing to 60 ktonne 2035)) [1.280 Million tonne in 2035]; Note: kilns at capacities in 2035 Kilns 4 reopened (2011) and Kiln 3 permanently closed.	2009 value from CCCL; 2010 at 900 Mt (17%) and thereafter growing at 45% of the GDP growth (including assumed export market (120 ktonne to 2012; 100 ktonne in 2013 decreasing to 20 ktonne in 2025 then 0 ktonne in 2032)) [1.3 Million tonne in 2031 through 2035]; Note: kilns at capacities in 2031) Kilns 4 reopened (2011) with improved efficiency. Kiln 3 permanently closed.
Cement Mills	Based on clinker production	Based on clinker production	Based on clinker production
Bauxite Mining	Bauxite linked to alumina production based on existing average ratios of bauxite to alumina at each alumina plant	Bauxite linked to alumina production based on existing average ratios of bauxite to alumina at each alumina plant	Bauxite linked to alumina production based on existing average ratios of bauxite to alumina at each alumina plant

Category	Reference (REF)	Scenario 2 (*S2*)	Scenario 3 (*S3*)
Bayer Process	Alpart reopens in 2012 at same capacity (1.625 million tonne alumina) as in 2008 (ramping from 75% in 2012 to 95% capacity in 2013; No Jamalco JU3 expansion but 5% capacity increase (from 1.425 Mt to 1.5 million tonne alumina in 2010 (Note: assumed production at 95% capacities). Windalco Kirkvine closed; Windalco Ewarton opens at 75% (original - i.e. when closed in 2009) capacity in 2012, 90% in 2013 and 95% in 2014 and thereafter. St Ann Bauxite – 4.2 million tonne bauxite in 2010 then up to 4.452 million tonne thereafter. HFO used in all plants.	Alpart reopens in 2012 at same capacity as in 2008 (ramping from 75% in 2012 to 95% capacity in 2013; Jamalco expansion 1.425 to 2.8 million tonne alumina in 2014. Windalco Kirkvine closed; Windalco Ewarton expanded to capacity equal to previous Kirkvine and Ewarton capacities in 2013 (ramping from 75% in 2013 to 95% in 2014) [0.975 to 1.235 million tonne alumina]. St Ann Bauxite – 4.2 million tonne in 2010 then up to 4.452 million tonne thereafter. Coal or CNG at Jamalco in 2013 and at Alpart and Ewarton in 2015.	Alpart reopens in 2012 at same capacity (ramping from 75% in 2012 to 95% capacity in 2013; Jamalco expansion 1.425 to 2.8 million tonne alumina) in 2014. Windalco Kirkvine reopened in 2015 at 500 t/y; Windalco Ewarton expanded to capacity equal to previous Kirkvine and Ewarton capacities in 2013 (ramping from 75% in 2013 to 95% in 2014) [Total Windalco from 0.975 in 2012, 1.17 in 2013, 1.235 in 2014, 1.71 million tonne in 2015; New Alumina plant added in 2015 (2.0 Million tonne alumina up to 2.5 Million tonne in 2020 and 3.0 Mt in 2025 – using coal). All alumina and associated lime plants use CNG except alumina kiln at New plant which uses CNG l or gasified coal. St Ann Bauxite – 4.2 million tonne in 2010 then up to 4.452 million tonne thereafter. Coal or CNG at Jamalco in 2013 and at Alpart and Ewarton in 2015 and New Plant in 2015.

Category	Reference (REF)	Scenario 2 (*S2*)	Scenario 3 (*S3*)
Alumina Kilns	See above for production levels. Not boilers for Bayer process and HFO in all alumina kilns.	Alpart reopens in 2012 at 80% of previous capacity and going to 100% capacity in 2013 (4,128 Mt to 5,156 Mt bauxite) using LNG; Jamalco JU3 expansion 1,710 Mt to 2,000 Mt alumina (4,419 Mt to 6,978 Mt bauxite) in 2014 with LNG and coal options. Windalco Kirkvine closed; Windalco Ewarton expanded to capacity equal to previous Kirkvine and Ewarton capacities in 2013 (ramping from 80% in 2013 to 100% in 2014). Coal or CNG at Jamalco in 2013 and at Alpart and Ewarton in 2015. CNG or Syngas in kilns	Alpart reopens in 2012 at 80% of previous capacity and going to 100% capacity in 2013 (4,128 to 5,156 Mt bauxite); Jamalco JU3 expansion 1,710 Mt to 2,000 Mt alumina (4,419 Mt to 6,978 Mt bauxite) in 2014. Windalco Kirkvine closed; Windalco Ewarton expanded to capacity equal to previous Kirkvine and Ewarton capacities in 2013 (ramping from 80% in 2013 to 100% in 2014. One new Alumina plant at 1,500 Mt alumina/y in 2015 at 75% then at 95% in 2016. CNG or Syngas in kilns.
Lime Kilns	Lime linked to bauxite and alumina production based on existing average ratios of bauxite to lime at each plant. HFO in lime kilns.	Lime linked to bauxite and alumina production based on existing average ratios of bauxite to lime at each plant. Coal or CNG in lime kilns.	Lime linked to bauxite and alumina production based on existing average ratios of bauxite to lime at each plant Assume energy efficiency for new lime plants at 5GJ/tonne lime. Coal or CNG in lime kilns.

Category	Reference (REF)	Scenario 2 (*S2*)	Scenario 3 (*S3*)
Energy intensity bauxite/Alumina	Mining: Used available historical data for Alpart, St Ann Bauxite and Windalco and then used average of these for Jamalco Boiler (Bayer) Used historical data (to 2007) Alumina Kilns Used historical data (to 2007) Lime kilns: Used available historical data for Alpart, Windalco. Assumed same for Rugby	Mining: Historical data for Alpart, St Ann, Windalco; Used average of these for Jamalco - continue value for 2007 out to 2035 Boiler (Bayer): Used historical data (to 2007) Continue values for 2007 out to 2035 (Note no mitigation or improvement in energy/tonne alumina Alumina Kilns: Used historical data (to 2007) Continue value for 2007 out to 2035 Lime kilns: Used historical data for Alpart, Windalco. Assume same for Rugby. Continue value for 2007 out to 2035. New lime kiln for Windalco and new plant at 5 GJ/tonne	Mining: Historical data for Alpart, St Ann, Windalco; Used average of these for Jamalco - continue value for 2007 out to 2035 Boiler (Bayer): Used historical data (to 2007) Continue values for 2007 out to 2035 (Need better values for upgraded Alpart and Windalco plants to reflect improvement in energy/tonne alumina Alumina Kilns: Used historical data (to 2007) Continue value for 2007 out to 2035 Lime kilns: Used historical data for Alpart, Windalco. Assume same for Rugby. Continue value for 2007 out to 2035. New lime kiln for Windalco and new plant at 5 GJ/tonne
Sugar SCJ	No data – assumed 2008 production levels continue	No data – assumed 2008 production levels continue	No data – assumed 2008 production levels continue
Sugar Private	No data – assumed 2008 production levels continue	No data – assumed 2008 production levels continue	No data – assumed 2008 production levels continue
Other Manufacturing	BOE growth at 1%/year.	BOE growth at 1.2%/year.	BOE growth at 1.5%/year.

Category	Reference (REF)	Scenario 2 (*S2*)	Scenario 3 (*S3*)
Municipal Rate 60	2.4% growth to 2014 and 3% after	2.4% growth to 2014 and 3% after	2.4% growth to 2014 and 3% after Introduction of LED street lighting to 5% in 2015 and 50% in 2035
Rate 20	-1.18%, -1.18%, -0.44%, 0.56%, 1.14% and 1.12% growth rates between 2008 and 2013 and 1% after	Same as Reference to 2013 and 1.5% after	Same as Reference to 2013 and 2.0% after Energy efficiency improves by 20% in 2035
Rate 40A#	-0.99%, -0.99%, 2.88%, 4.76% and 4.53% between 2008 and 2013 and 2% after No change in energy efficiency	Same as Reference to 2013 and 2.5% after Energy efficiency improves by 10% between 2009 and 2035	Same as Reference to 2013 and 3.0% after Energy efficiency improves by 20% between 2009 and 2035
Rate 50	Growth rates: 2008,-3.15%; 2010, -2.92%; 2011, 0.42%; 2012, 3.05%; 2013, 2.83%; 2014 and after, 2.0%	Same as Reference to 2013 and 2014 and after, 2.5%	Same as Reference to 2013 and 2014 and after, 3.0%
Rate 50 Other	-1.7% growth to 2014 and 0.25% after	-1.7% growth to 2014 and 0.5% after	-1.7% growth to 2014 and 1.0% after
Rate 50 UWI		Need additional UWI Data Assume further 150 MWh reduction from AC and 50 MWh from other initiatives 2009 to 2013	Need additional UWI Data Assume further 350 MWh reduction from AC and 75 MWh from other initiatives 2009 to 2013
Government	No change	10.4% reduction in overall energy by 2014. Flat after.	15.9% reduction in overall energy by 2014.
NWC	Note - no mitigation initiatives	NWC Phase 1. Assumed 5% /year for 2009-2011 for a total of 15% reduction]	NWC Phase 2 [Assumed 10% /year in 2012-2013 for a total of an additional 20% reduction]

Category	Reference (REF)	Scenario 2 (*S2*)	Scenario 3 (*S3*)
Hospitals	Note - no mitigation initiatives. Assumed average electricity over 2000 to 2008 for future years.	Hospital AC (Packages 5,15,20,22) [11.8%] 2011+5y Hospital Lighting (Packages 9,20) [.54%] 2011+2y Hospital Other (Packages 1,2) [3.96%] 2012 +3y Hospital Refrigeration (Packages 6,16) [5%] 2013 +5y Hospital fuels (Packages 28-30) 1.22% reduction Total Reduction in electricity [14.83%]	Hospital AC (Packages 18, 19, 21); [2.29%]2016 +5 Hospital Lighting (Packages 7, 8, 11); [3.79%] 2013 +4 Hospital Other (Packages 3,4,12,13,14); [5.66%]2015 +4 Hospital Refrigeration (Packages 17); [0.41%] 2018 +3 Total reduction in electricity use [12.15%]
Other Govt (includes all government except NWC and Hospitals)	Note - no mitigation initiatives	3% reduction/year for 2010 to 2014 (inclusive) in electricity [equivalent to 14.2% reduction by 2014]	Additional 5% reduction in electricity use by 2014
Transportation			
Growth in fleet	1% to 2012,0.5%to2020,0.1% to 2035	1.5% to 2012,1.0% to2020,0.1% to 2035	2.0% to 2012, 1.5% to 2020, 0.1% to 2035
E10 market penetration	100% by 2010	100% by 2010	100% by 2010
E20, E25, E30 or E85 introduction	No initiatives	No initiatives	No initiatives
Low Sulphur gasoline & diesel	2014	2014	2014
Biodiesel introduction	None	To be determined	To be determined

Category	Reference (REF)	Scenario 2 (*S2*)	Scenario 3 (*S3*)
Impact of cross country highways (Highway 2000, North Coast Highway)	Kingston Bushy Park and Montego Bay /Port Antonio completed; Spanish Town Ocho Rios in 2012; Sandy Bay Four Paths Four Paths WIlliamsfield (2020)	As for Reference	As for Reference
JUTC & MBM	None	10% of JUTC and MBM fleet by 2020 and 20% by y2035	15% of JUTC and MBM fleet by 2020 and 30% by 2035
CNG taxi & passenger cars	None	0.1% of LDGV by 2020 and 0.2% by 2035	0.2% of LDGV by 2020 and 0.4% by 2035
CNG	None	5% of fleet by 2020	10% of fleet by 2020
Other transport – buses HDGV	None	0.3% by 2020; 0.6% by 2035 (1000 and 2000 vehicles)	0.6% by 2020; 1.2% by 2035 (2000 and 4000 vehicles)
Other buses and HDDV	None	1% by 2020; 2% by 2035 (200 and 400 vehicles)	2% by 2020; 4% by 2035 (400 and 800 vehicles)
Growth in air traffic	Assume 5% growth in LTOs	Assume 7% growth in LTOs	Assume 9% growth in LTOs
Agriculture			
Increase in sheep population	No new initiatives	Herd needed to replace 80% of imports by 2015 has negligible impact on CH_4 emissions	Herd needed to replace 80% of imports by 2015 has negligible impact on CH_4 emissions
Increase in other animal population	No new initiatives	Negligible impact on CH_4 emissions (for local pork, beef production)	Negligible impact on CH_4 emissions (for local pork, beef production)
Rice	No new initiatives beyond current	25,000 ha by 2011 Increasing by population growth rate	25,000 ha by 2011 Increasing by population growth rate
Biogas generation initiatives	No new initiatives	Need additional data	Need additional data

Category	Reference (REF)	Scenario 2 (*S2*)	Scenario 3 (*S3*)
Non-Energy Sector Effects			
Landfill Emissions	Population growth projections	Population growth projections (less EFW waste)	Population growth projections (less EFW waste)
Forestry			
Program to reduce deforestation rate to zero by 2013	No new initiatives	Program to reduce deforestation rate to zero by 2013	Program to reduce deforestation rate to zero by 2013
Program to plant trees (reforestation)	No new initiatives	No measurable effect so excluded	No measurable effect so excluded
Percentage increase in sustainable forest harvesting (target to be determined)	No new initiatives	No measurable effect so excluded	No measurable effect so excluded
Industry			
Cement	Based on clinker production	Based on clinker production	Based on clinker production
Lime	Based on lime production	Based on lime production	Based on lime production
Coke	Based on Pet Coke project	Based on Pet Coke project	Based on Pet Coke project
Biogas generation initiatives	Based on existing number of biogas units remaining the same	Need data available	Need data available

[#] JPS Rate 40 adjusted to avoid double counting of Petrojam and CCCL electricity use and also to include the JPS Other class with 3 customers – and renamed as Rate 40A

Table 2-8 Scenarios for Transformation and Energy Resources

Transformation Category	**Size**	**Reference (REF)**	**Scenario 2 (*S2*)**	**Scenario 3 (*S3*)**
Transmission & Distribution				
Electricity Distribution		Losses reduced from 23.8% to 16.3% in 2014	Losses reduced from 23.8% to 16.3% in 2014	Losses reduced from 23.8% to 16.3% in 2014
Oil Refining		Upgrade in 2014 Any product shortfall met by imports; Petcoke, VGO and sulphur by products	Upgrade in 2014 Any product shortfall met by imports; Petcoke, VGO and sulphur by products	Upgrade in 2014 Any product shortfall met by imports; Petcoke, VGO and sulphur by products
Electricity Generation				
Bogue Gas Turbines	179.3 MW	Continue		
Bogue GT6 & GT8		Add 4 MW to each - engine installations 2010		
Bogue CGCT	40 MW	Continue		
Bogue CGCT inlet adjustment	10 MW	2009		
Bogue GT6 & GT8	8 MW	2015		
Convert Bogue to CNG	120MW		**2013**	
Hunts Bay Gas Turbines	32.5 MW	Continue		
Hunts Bay B6	68.5 MW	Retire in 2017	**Retire** in 2017	
Rockfort JPS enhancement	36 MW	Add 4 MW in 2010		
Jamaica Broilers	16 MW	Retired in 2004		
Rockfort JPS	36 MW	Continue		
Upgrade Rockfort Unit # 2	2MW	2009		

Transformation Category	**Size**	**Reference (REF)**	**Scenario 2 (*S2*)**	**Scenario 3 (*S3*)**
JEP	90	Continue		
JPPC	60 MW	Continue		
IPP (JEP Marcus Garvey)	60 MW	2010		
Jamalco	12.1 MW	Continue	**Retire** in 2014	
Old Harbour1-4	223 MW	Retire OH1 in 2015 (-30 MW) Retire OH3 and OH4 in 2018 Retire OH2 in 2017 (-60 MW)		
Hydro	21.59 MW	Continue		
Restore Constant Spring Hydro	0 MW	Restore to 0.8 MW 2009		
Maggotty hydro	6.4 MW	2013		
New hydro A	15.3 MW	None of these new hydro	**2011** Spanish R (2.5 MW) 2012 Great R (8.0 MW) 2013 Martha Brae (4.8 MW)	
New hydro B	24.6 MW	None of these new hydro		**2015** Laughlands (2.0 MW) 2017 Yallahs (2.6 MW) 2019 Back Rio Grande (20 MW)
Wigton	20 MW	Continue		
Munro	0.36 MW	Continue		
Wigton Wind Farm	*18 MW*	*2011*		

Transformation Category	**Size**	**Reference (REF)**	**Scenario 2 (*S2*)**	**Scenario 3 (*S3*)**
Expansion				
Pet Coke	*120 MW*	*2014*	*2014*	*2014*
Old Harbour Phase 1 Coal LNG	150 MW	2013	 2015 2015	
Old Harbour Phase 2 Coal LNG	150 MW	2013	 2015 2015	 2015 2015
Waste to Energy	65 MW		2014	
Munro wind JPS	3.0 MW	2010		
Munro School	20 MW			2018
Windalco expansion 60 MW			2015	2015
Coal or Nuclear 100 MW	100 MW 100 MW			2025 2030
New Petcoke at Cement or Bauxite plant	100 MW			2020 100 MW 2025 200 MW (total)

Mitigation Aspects of Scenarios

It must be reiterated that the Reference Scenario does not include any mitigation measures beyond those that are currently in place. However, as indicated above the upgrading of the Petrojam refinery and the reopening of two of the three alumina plants were included in the Reference scenario. These activities imply certain mitigation measures as follows:

- The refinery upgrade will entail provision of low sulphur diesel and gasoline which will affect the emission rates for vehicles.
- The reopening of the Alpart plant is assumed to entail improvement in the energy efficiency of the Bayer process. (Additional improvements in energy efficiency of the Bayer process at all alumina plants are indicated in Scenarios 2 and 3.)
- The construction of a new kiln and cement mills at the cement company resulted in significant energy intensity improvements. In all scenarios it was assumed that kiln 4 which was closed in 2008 would reopen with improved energy efficiency in 2011. Because of this further energy intensity improvements for the cement industry are negligible.

Scenario 2 (*S2*): The main mitigation feature of this scenario (option *S2 NG*) is the introduction of compressed natural gas for alumina production (instead of oil in the reference scenario) and for electricity generation at the Bogue generating station (instead of diesel), the new Old Harbour plants (300 MW) (instead of coal) and in existing and new medium/slow speed diesel engines used to generate electricity. Other mitigation measures include Bayer process improvements in the alumina sector, use of more efficient household appliances (lighting, refrigerators). Although the mitigation measures in the Government sector (hospitals, NWC projects and general energy conservation in the remainder of the government sector) are small relative to the total demand, the reductions have been demonstrated to be cost effective. The same is true of lighting and air conditioning initiatives at UWI.

Scenario 3 (*S3*): This scenario is in part driven by a lower population growth (and hence household electricity demand. *S3* also includes all of the *S2* and *S2 NG* initiatives and has additional energy intensity reductions at two of the alumina plants. The mitigation measures are offset by the proposed addition of a new alumina plant though. The possible introduction of additional hydro generation capacity would also contribute to lower emissions across the board.

3. RESULTS

3.1 SCOPE OF RESULTS PRESENTED

The results of the analysis will focus on presenting the **environmental loadings** (GHG and in some cases SO_2 emissions) and the **energy demand** broken down by sector and subsector where appropriate.

LEAP allows presentation of the emissions either a) where they occur in the various branches (demand, transformation and non-energy sector effects) or b) by allocating the emissions in the transformation categories back to the demand branches. Alternative b gives the so called final energy demand (or final environmental loadings) by assuming for example that the electricity use in the demand category is allocated to fuels in proportion to the average mix of transformation (supply side) processes used in electricity generation in each year. Similarly, emissions from oil refining or coal gasification emissions are allocated back to the demand-side categories where oil products or syngas are finally consumed.

The non-energy sector emissions are those associated with the chemical transformation of limestone into lime (which releases CO_2) or in landfill emissions (releases CH_4 and CO_2) or in the release of CO_2, CH_4 and N_2O from agriculture and forestry sectors.

The presentation of the **environmental loadings** for all three scenario projections includes the current account period (2000 to 2008) so that comparisons can be made with the GHG emissions inventory and/or energy consumption over this period.

3.1.1 Constraints and Data Gaps

The analysis is constrained by the following:

- Although rail transportation is used (only) in the bauxite sector, information on (diesel) fuel used for rail transport was not readily disaggregated from other diesel fuel used in the sector. Rail is used to transport bauxite from some mines to plants, for transporting products (alumina and hydrate) from plants to shipping ports and for transporting materials from the ports to plants. The diesel fuel used for rail was included in that used for mining and all diesel fuel use in the bauxite and alumina sector was assumed to be for bauxite mining.
- Fuel used for domestic marine activities was not always readily available. It is believed that some of the gasoline sold in retail outlets is used for fishing and other domestic marine activities.
- Projections related to HFC emissions are not included
- Limited data was available to make projections for the sugar industry

3.2 ENERGY BALANCE

LEAP's outputs include annual energy balances and those for 2000 and 2008 are shown in Figure 3-1 and 3-2.

3.3 OVERVIEW OF PROJECTIONS

3.3.1 Environmental Loadings

The final environmental loadings of CO_2, N_2O and CH_4 for all scenarios are shown in Figures 3-3 to 3-5.

The most striking feature in all scenario projections is the decrease in emissions between 2009 and 2011. This of course is due to the closure of three alumina plants in the first quarter of 2009 and the (assumed) reopening of two of those plants in 2011 with full production achieved in the following year.

For CH_4 and N_2O the Reference scenario emissions are generally lowest – due to the low production levels relative to the other scenarios. The *S3* emissions are also highest because of the use of coal where feasible and the emission factors for coal are higher than for oil or natural gas. In the case of CO_2, the pattern is similar except that the use of natural gas in *S2 NG* results in CO_2 emissions that are slightly lower than the Reference scenario.

The *S3 NG* and *S2 NG* emissions are consistently lower than the corresponding *S3* or *S3* emissions and reflect the lower emission factors when natural gas is used (compared with coal or coal+syngas in alumina kilns).

The combined Energy and Non-Energy CO_2 emissions are shown in Figure 3-6 while the Non Energy CO_2 emissions alone are shown in Figure 3-7. The latter figure illustrates the impact of the use of petcoke starting in 2013. Use of petcoke for power generation entails using limestone to remove SO_2 and that process will release additional CO_2 from the limestone.

The most dramatic effect of the use of natural gas is seen in the SO_2 emissions for the various scenarios (see Figures 3-8 for SO_2 emissions from Demand sources and Figure 3-9 for SO_2 emissions from all Transformation sources – that is oil refining, electricity generation, charcoal making and coal gasification). The *S2 NG*, *S3 NG* and *S3 NGU* emissions are considerably lower than the corresponding *S2* or *S2* Coal/Syngas and *S3* and *S3* Coal/Syngas emissions.

Figure 3-1 Energy Balance for Jamaica: 2000

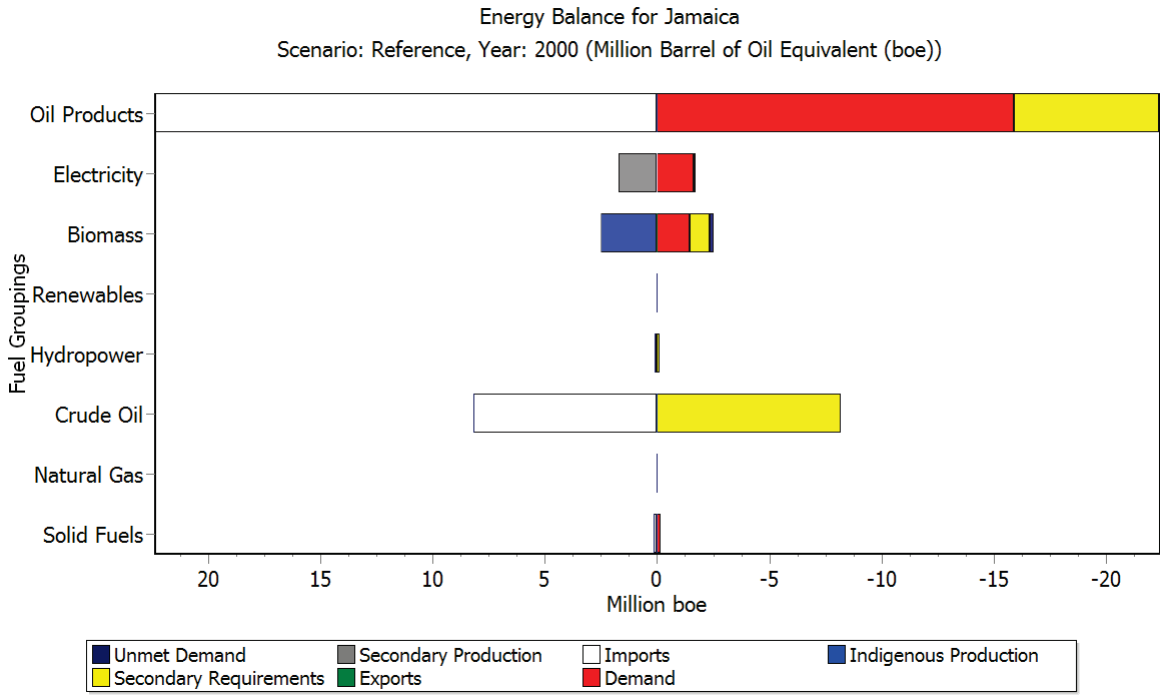


Figure 3-2 Energy Balance for Jamaica: 2008

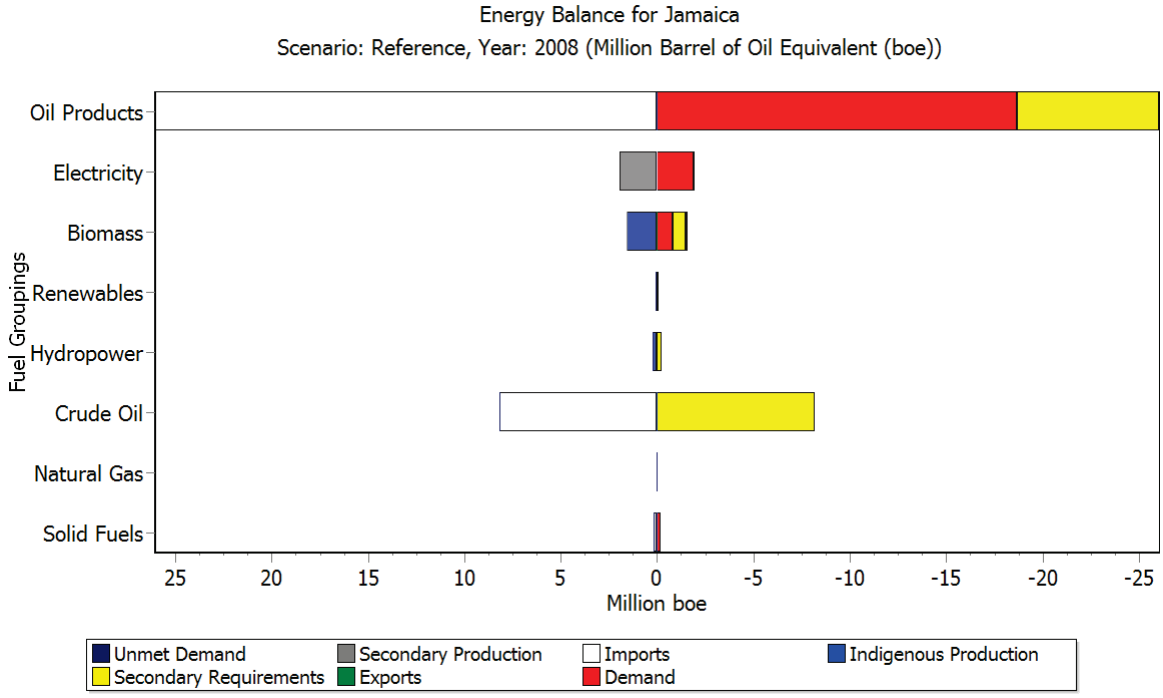


Figure 3-3 Final Environmental Loading for Jamaica, 2009 – 2035: All Scenarios, CO_2

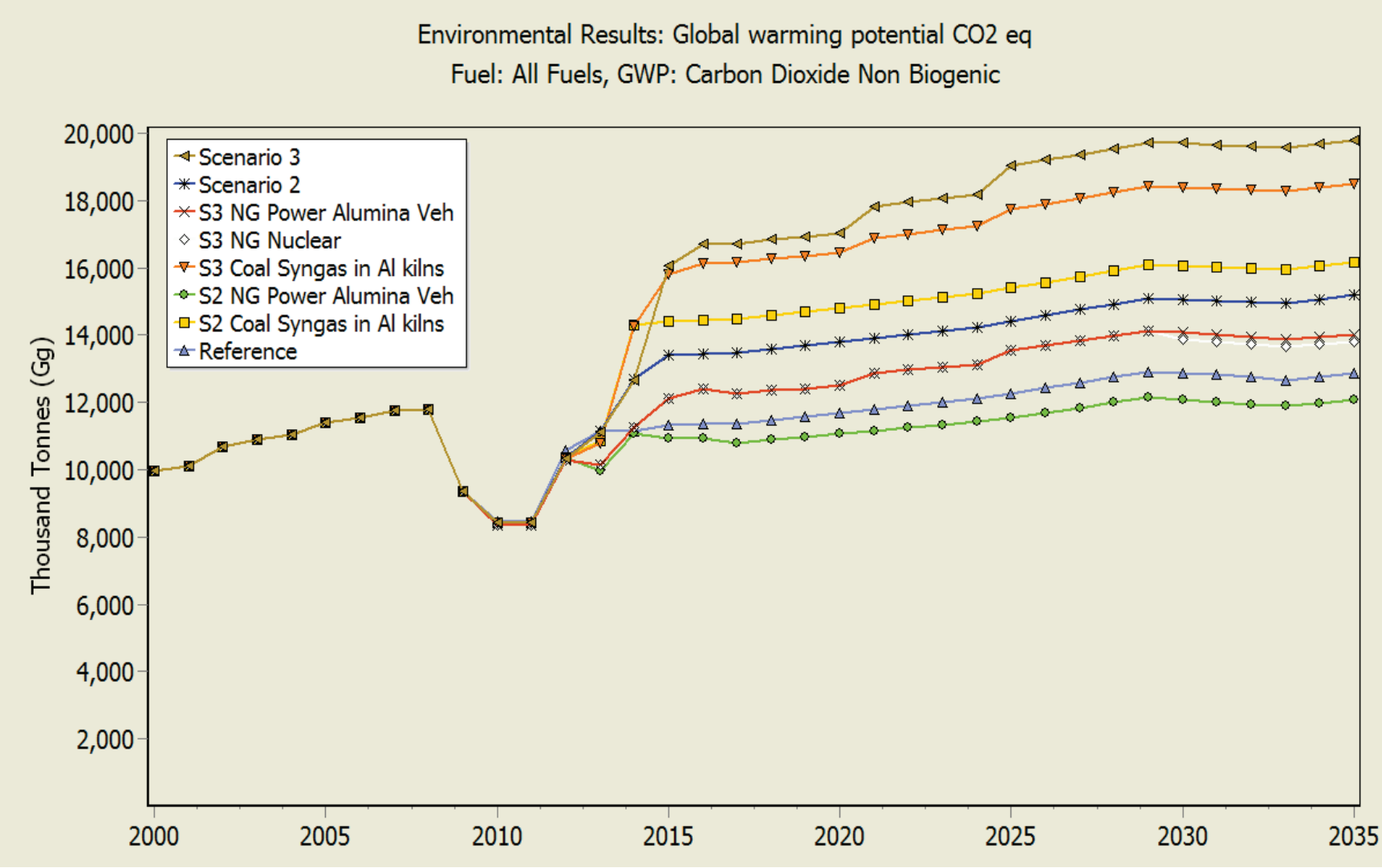


Figure 3-4 Final Environmental Loading for Jamaica, 2009 – 2035: All Scenarios, N_2O

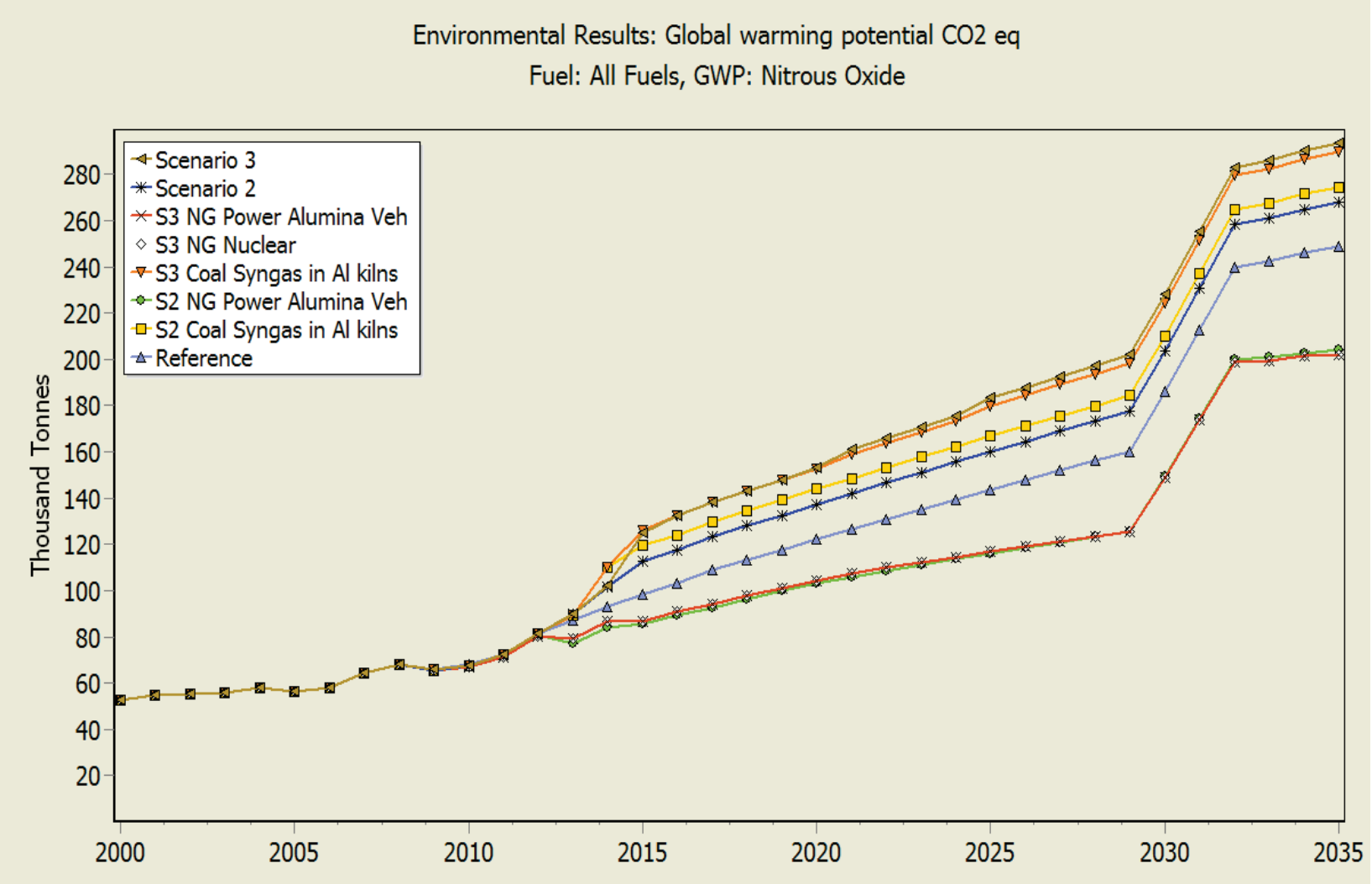


Figure 3-5 Final Environmental Loading for Jamaica, 2009 – 2035: All Scenarios, CH_4

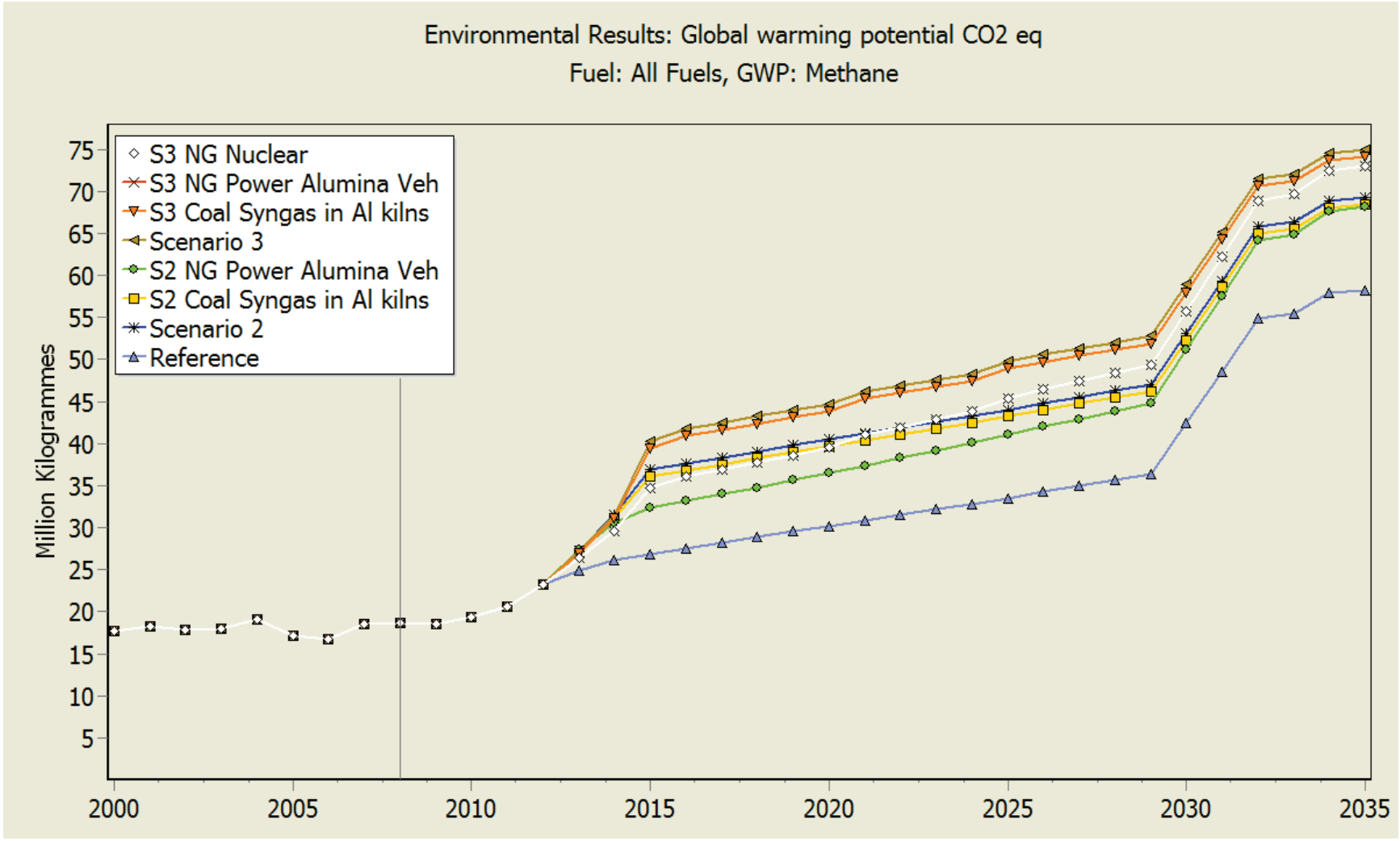


Figure 3-6 Final Environmental Loading for Jamaica, 2009 – 2035: Global Warming Potential CO_2 (Biogenic and Non-Biogenic)

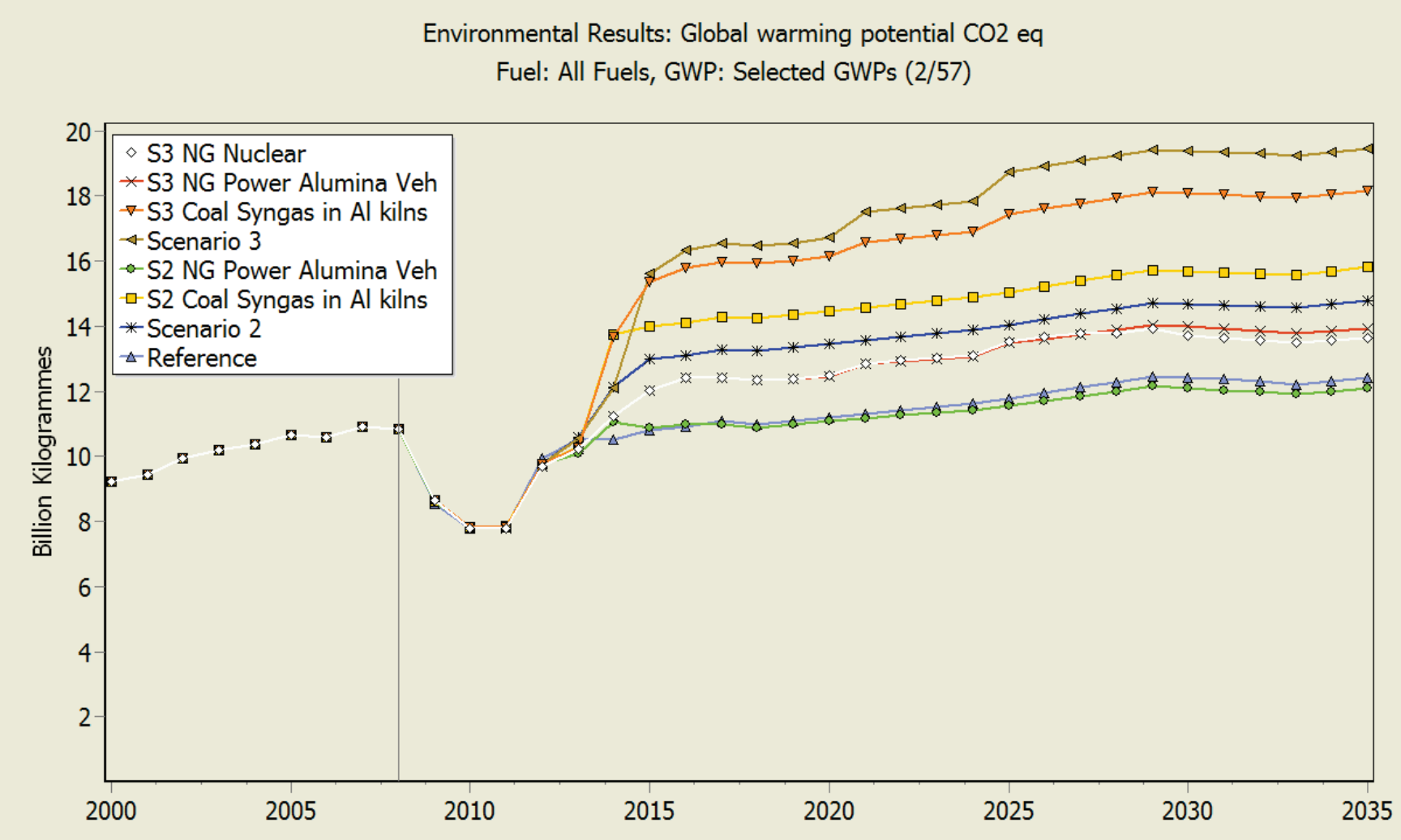


Figure 3-7 Final Environmental Loading for Jamaica, 2009 – 2035: Global Warming Potential CO_2: Non-Energy Sector Effects

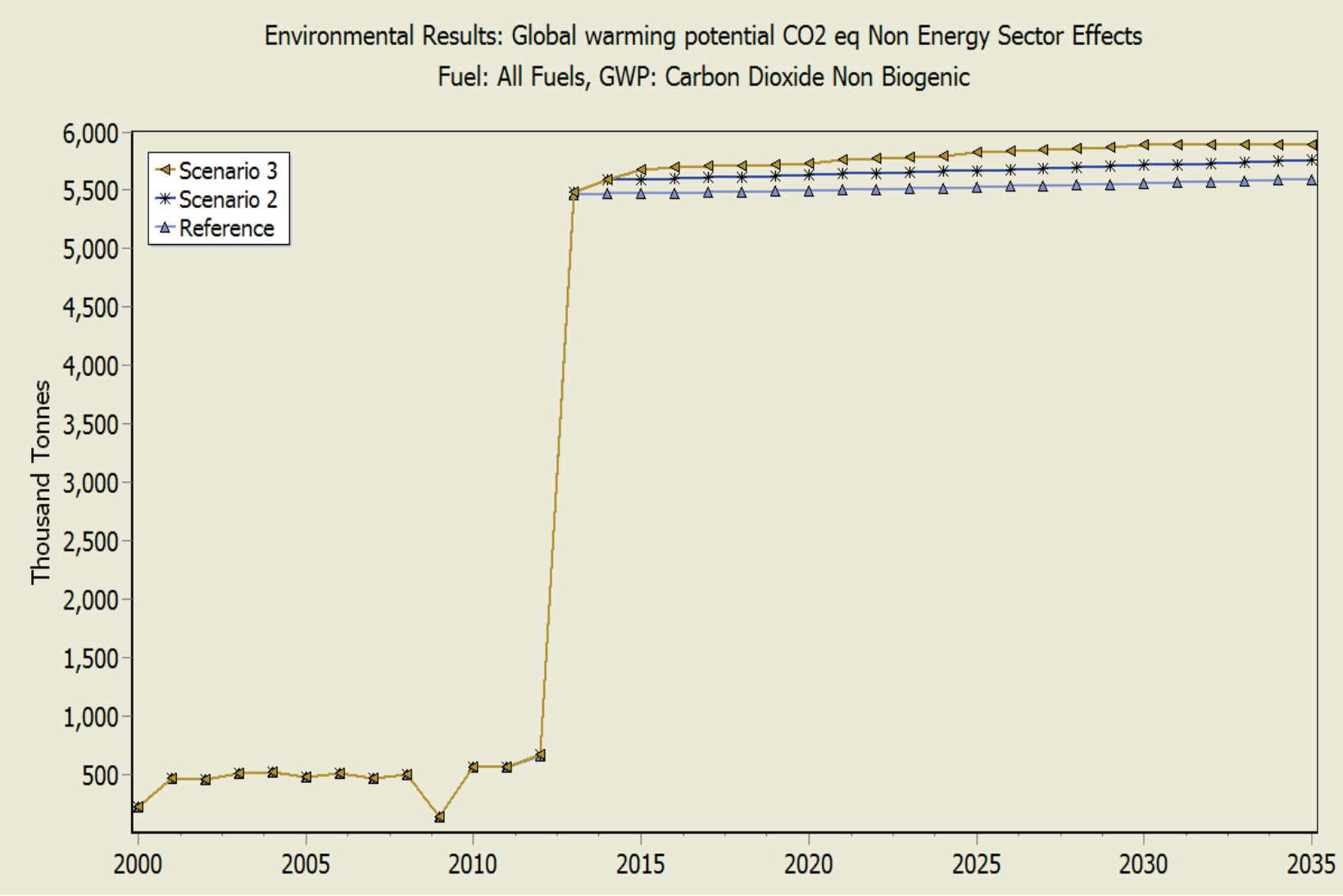


Figure 3-8 Final Environmental Loading for Jamaica, 2009 – 2035: SO_2 From Demand Branch Sources

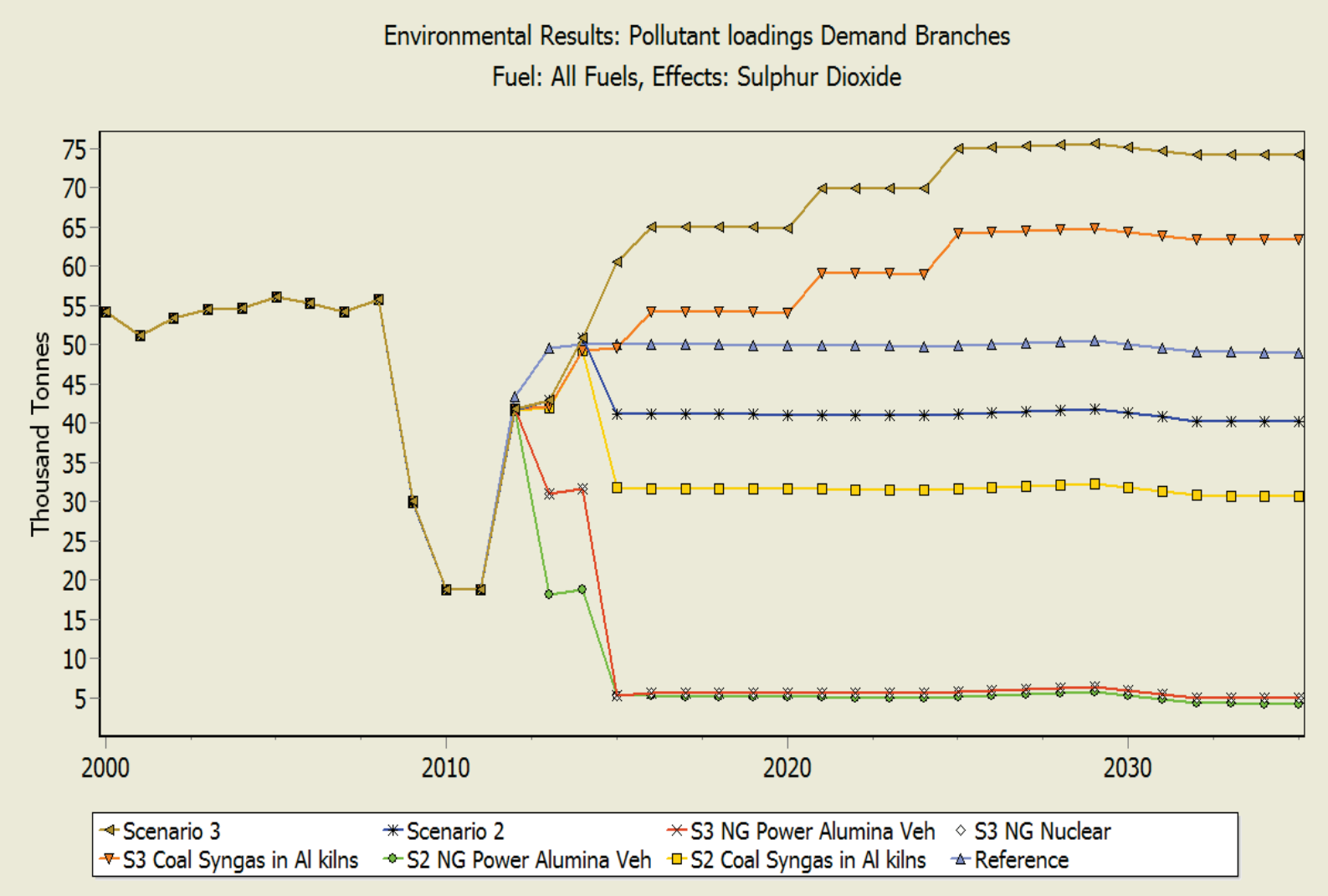
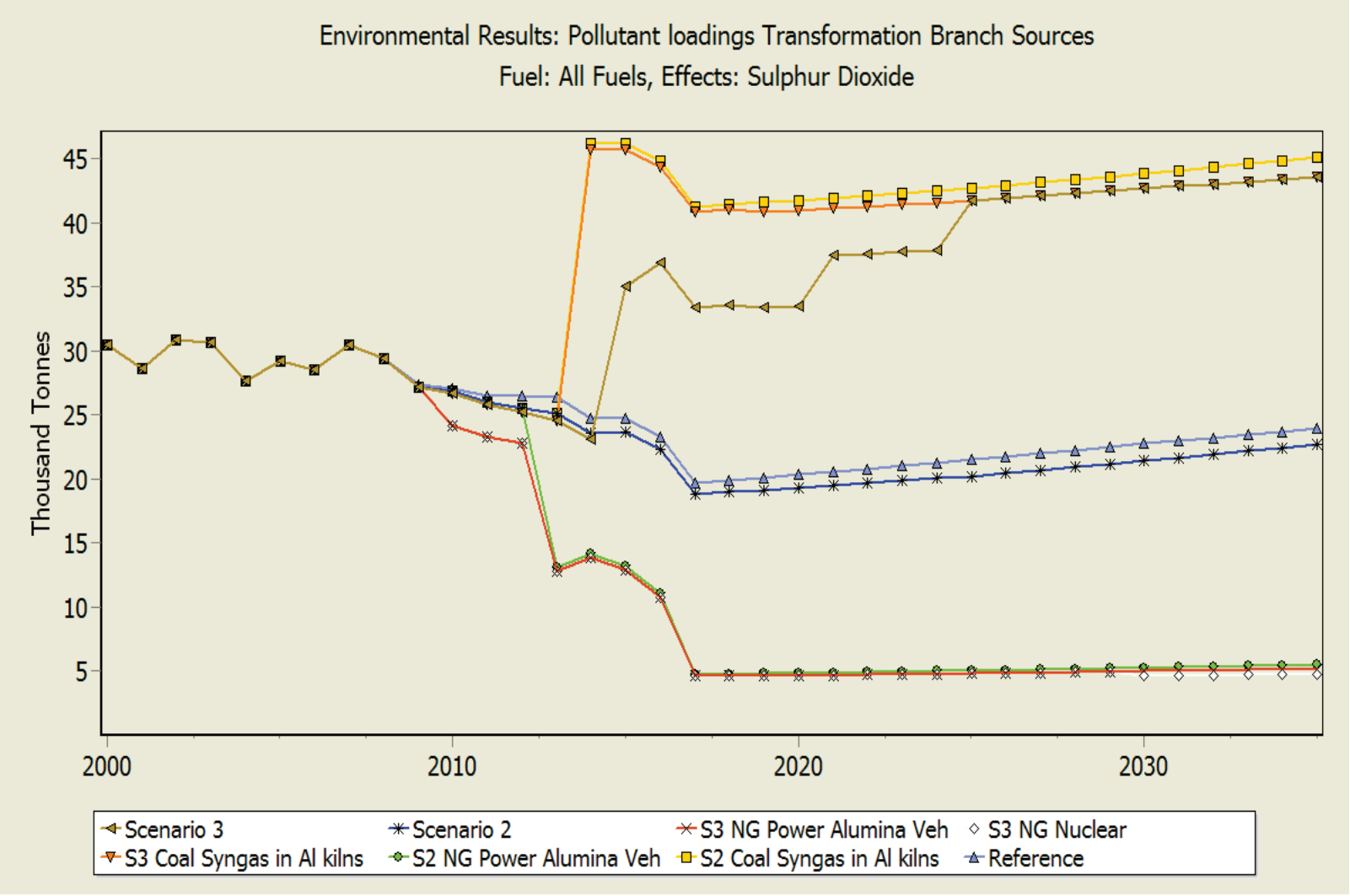


Figure 3-9 Final Environmental Loading for Jamaica, 2009 – 2035: SO_2 From Transformation Branch Sources



3.3.2 Overview of Final Energy Demand Projections

The final energy demand for all scenarios is shown in Figure 3-10. As with the environmental loadings, the most striking features are the dramatic declines in energy demand in 2009 through 2012 as a consequence of alumina plant closures.

The final energy demand is not very dependent on the choice of fuel in the *S2* and *S3* scenario options and the demand for *S2* options are grouped together lower than the grouping for the *S3* options. The large increase in energy demand in the *S3* options is due mainly to the new alumina plant which is included only in *S3* options and to lesser extents on lower population growth (but this is mediated by lower persons/household) and the associated demands for electricity and on the increase in cement production.

3.3.3 Overview of Transformation Projections

The transformation module includes electricity generation, petroleum refining, coal gasification and charcoal production. No change in the petroleum refining capacity after the refinery upgrade is anticipated although the refinery will be able to vary the output to meet demands. The data for charcoal production are uncertain and it is expected that demand for charcoal will fall as fewer households use charcoal and its use is discouraged.

The changes in total electrical generating capacity in all scenarios to meet the demands are shown in Figure 3-11 – noting that the added capacity was not optimised.

Gasification outputs will be used only to meet the demands for calcining alumina only when coal is used in the Bayer process. The gasification requirements for all scenarios (*S2 SYN* and *S3 SYN*) are shown in Figure 3-12.

3.4 DETAILED ANALYSIS OF ENVIRONMENTAL LOADINGS AND ENERGY DEMANDS

The environmental loadings and energy demands for selected demand, transformation and non-energy branches are described to illustrate the impacts of various projects and mitigation measures. The environmental loadings refer to where they occur (since the transformation loadings will be presented separately) and will focus on CO_2 since nearly all mitigation measures are directed at energy conservation or fuel substitution which directly affect CO_2 emissions and their impact on other pollutants (except for SO_2) are less dramatic. The branches selected for illustration will be based on including only those where there are significant mitigation measures in scenarios *S2* and *S3*: hence cement and sugar manufacturing and the "Other Manufacturing" branches which have no significant mitigation measures are not included. In the case of the sugar industry the exclusion is based not on the need or opportunity for mitigation measures but rather on the lack of information. Significant mitigation measures have already been implemented by the cement industry and are already included in the Reference scenario and hence there are nominal cement industry related changes in *S2* and *S3* scenarios that can be attributed to mitigation.

The energy demands are driven mainly by activity levels and the differences between the scenarios will be illustrated.

Figure 3-10 Final Energy Demand Projections for Jamaica, 2009 – 2035: All Scenarios

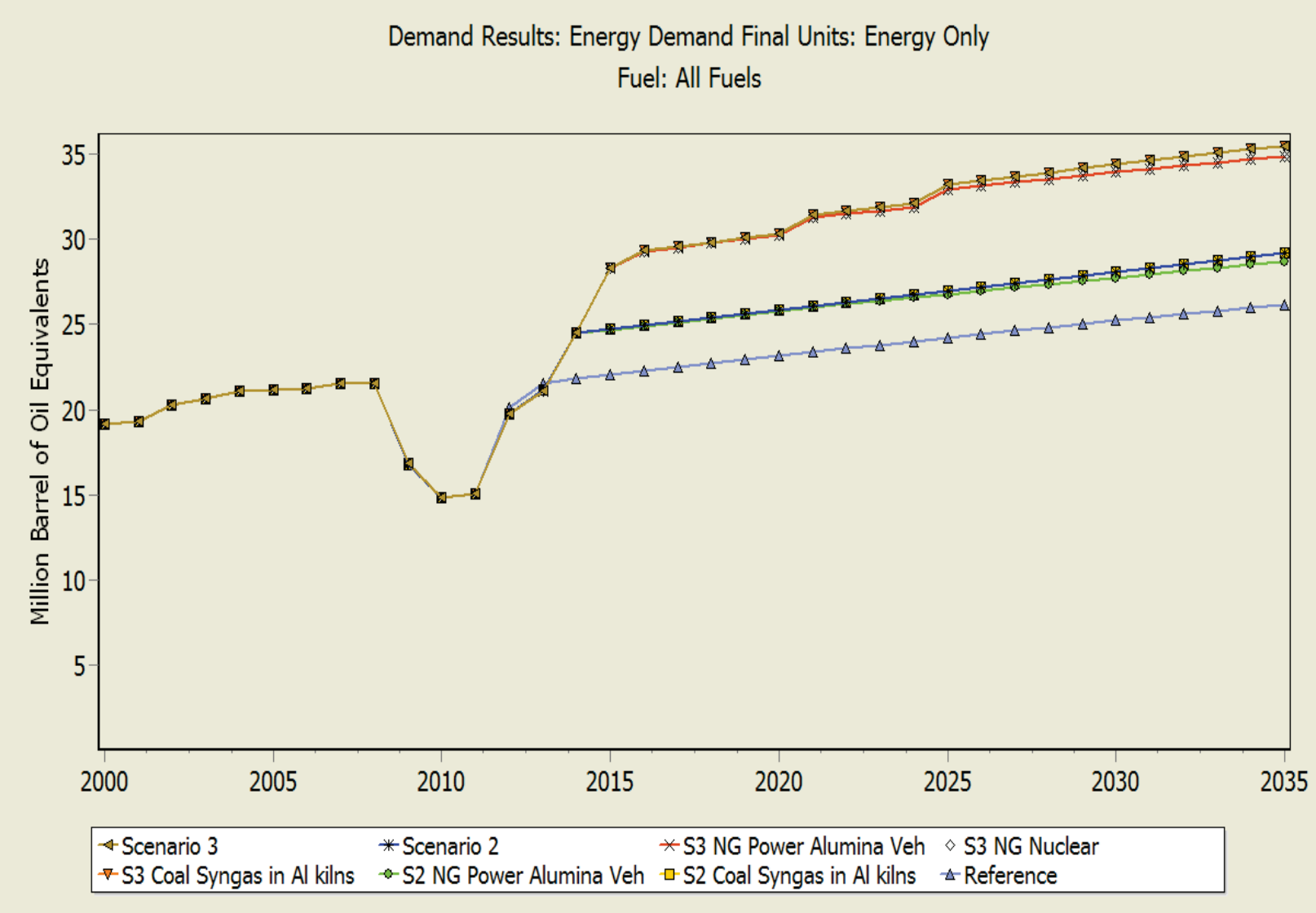


Figure 3-11 Electricity Generating Capacities, 2009 – 2035: All Scenarios

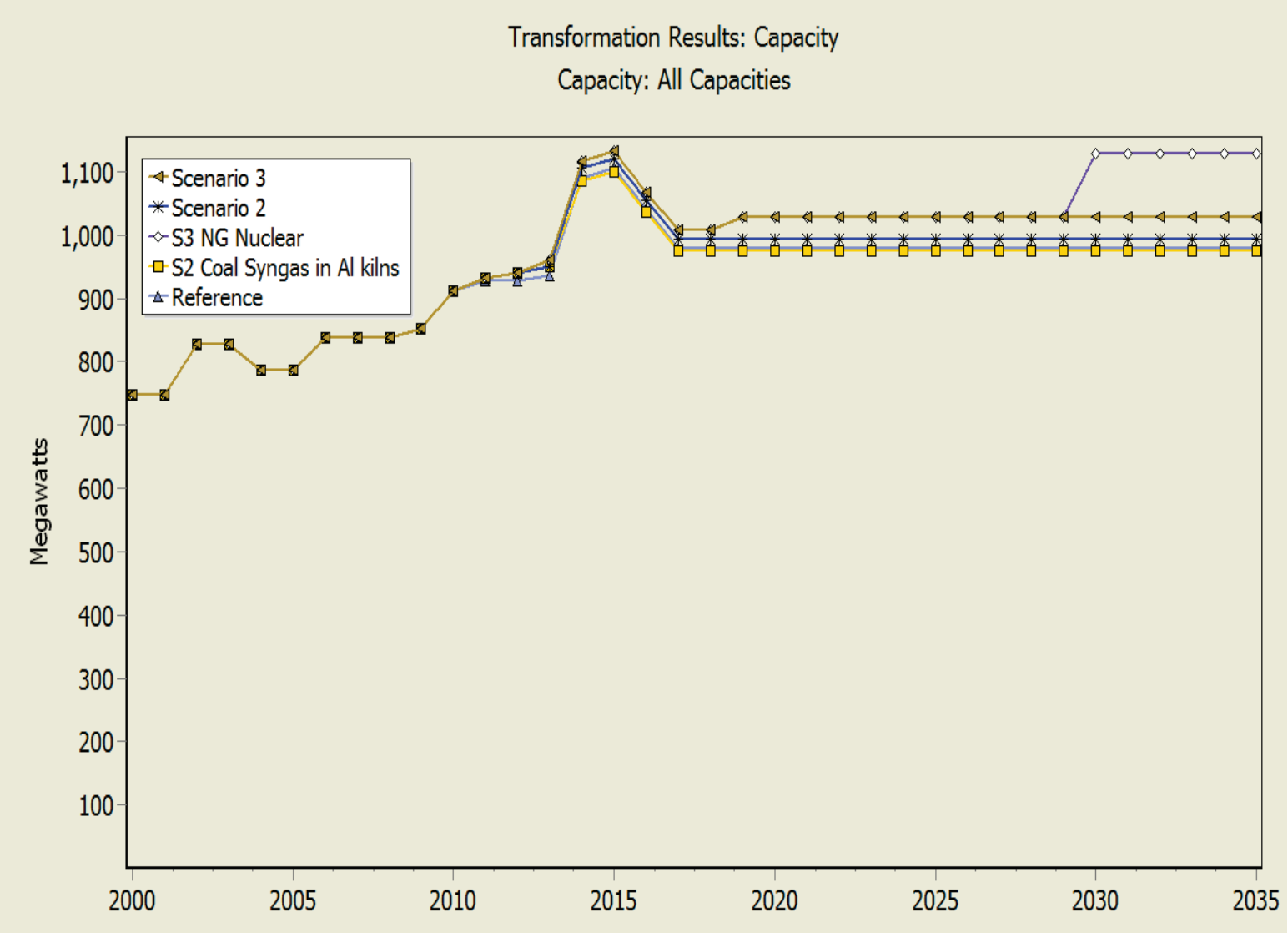
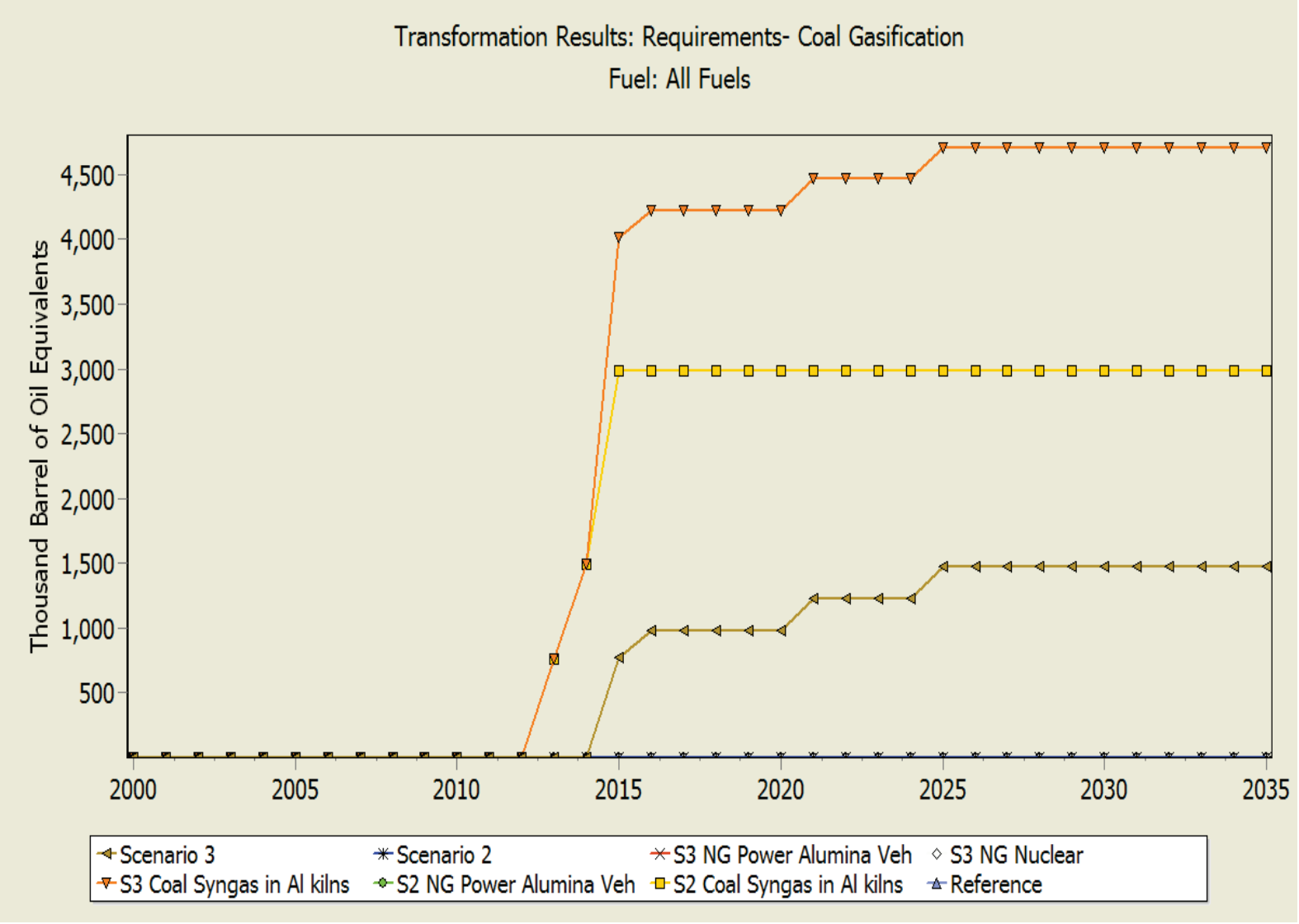


Figure 3-12 Coal Gasification Requirement Projections for Jamaica, 2009 – 2035: All Scenarios



3.4.1 Detailed Analysis of Selected Environmental Loadings

3.4.1.1 Industrial Branches

The industrial sectors considered were:

- Bayer processing
- Alumina kilns
- Bauxite mining
- Lime kilns

The CO_2 emissions for all scenarios for these activities are shown in Figures 3-13 to 3-16. In all cases the emissions are dictated by the alumina production levels but the impacts of using natural gas are evident in *S2 NG* and *S3 NG* relative to *S2* and *S3* (which respectively have the same alumina production levels but use coal). Since there are no fuel choices for bauxite mining the CO_2 emissions are determined only by the alumina production levels (which are directly related to the amount of bauxite mined).

3.4.1.2 Transport

The transport sector comprises emissions from mobile sources namely rail, marine, aircraft and on-road and off-road traffic.

3.4.1.2.1 Rail

Jamaica's rail traffic is limited to freight movement by the bauxite and alumina industry. Bauxite is shipped by rail to some alumina plants from some transfer points near bauxite mines; alumina is shipped from the alumina refineries to ports and fuel, caustic and other materials are shipped from the port to the refineries. Data for fuel use for rail activities has not been consistently compiled and hence the estimates for rail have been aggregated with diesel fuel use for the Bayer process.

3.4.1.2.2 Marine

Although fuel deliveries to international bunkers and commercial intra-island shipping are compiled, the fuel consumption by domestic marine activity such as fishing, recreational boating are likely included in retail sales and some commercial customers. The current data collection does not distinguish between fuel consumption for agriculture, forestry and fishing activities and hence projections for marine activities are not included.

3.4.1.2.3 Aircraft

Aircraft emissions in the 2000 to 2005 inventory were based on detailed analysis of landing and take-off (LTO) emissions at the international and domestic aerodromes and cruising emissions during intra-island flights. The LTO emissions were based on modelling using the US Federal Aviation Administration (FAA) Emissions Dispersion Modeling System (EDMS) model and cruising emissions were based on emission factors available in EDMS and US EPA AP42[21]. Projections of aircraft emissions were based on projections of air traffic movements at the two international airports that are contained in the Master Plans (to 2022) for the airports (see Figure 3-17).

Figure 3-13 Bayer Process CO_2 Emissions for Jamaica, 2009 – 2035: All Scenarios

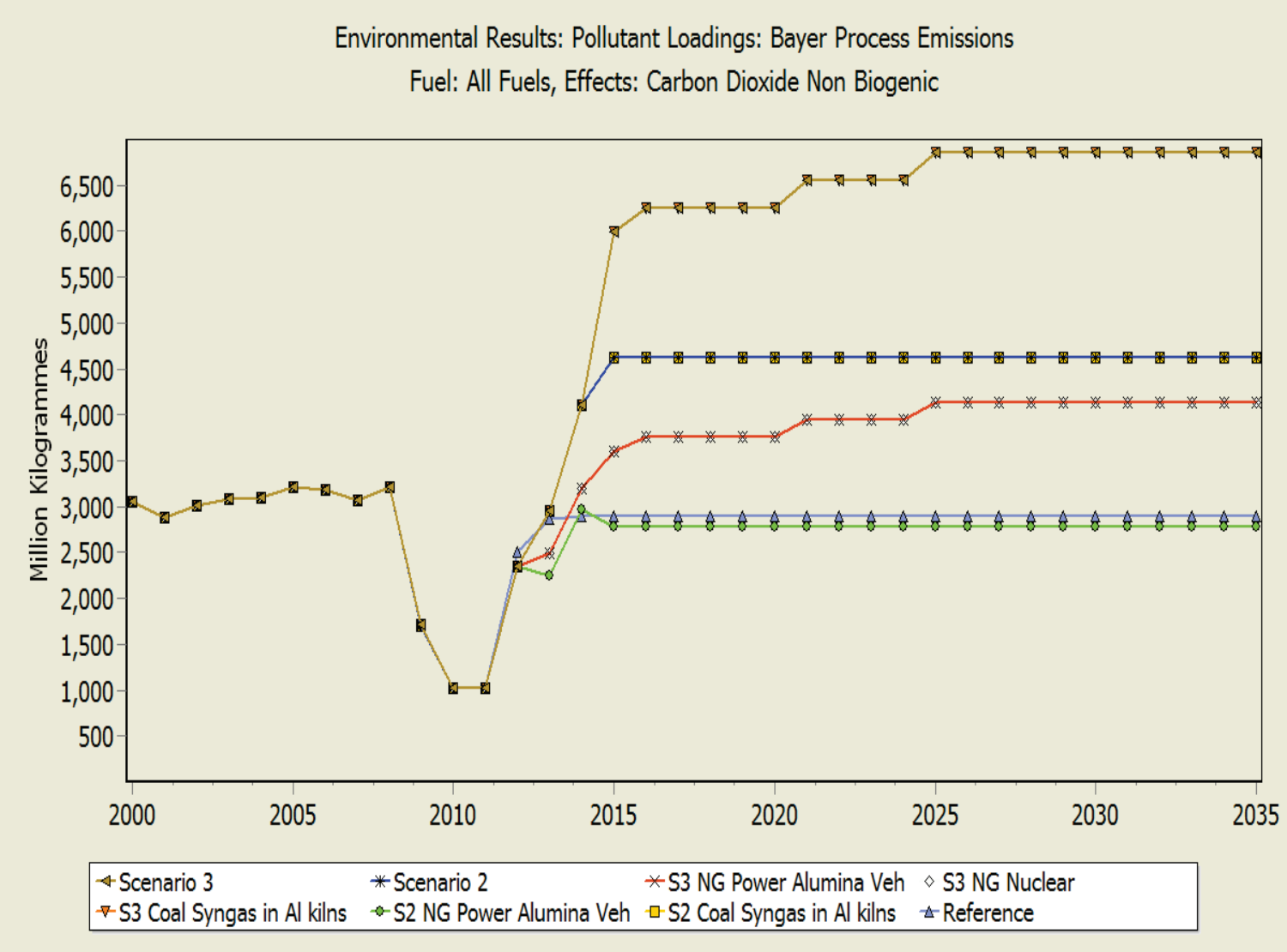


Figure 3-14 Alumina Kiln CO_2 Emissions for Jamaica, 2009 – 2035: All Scenarios

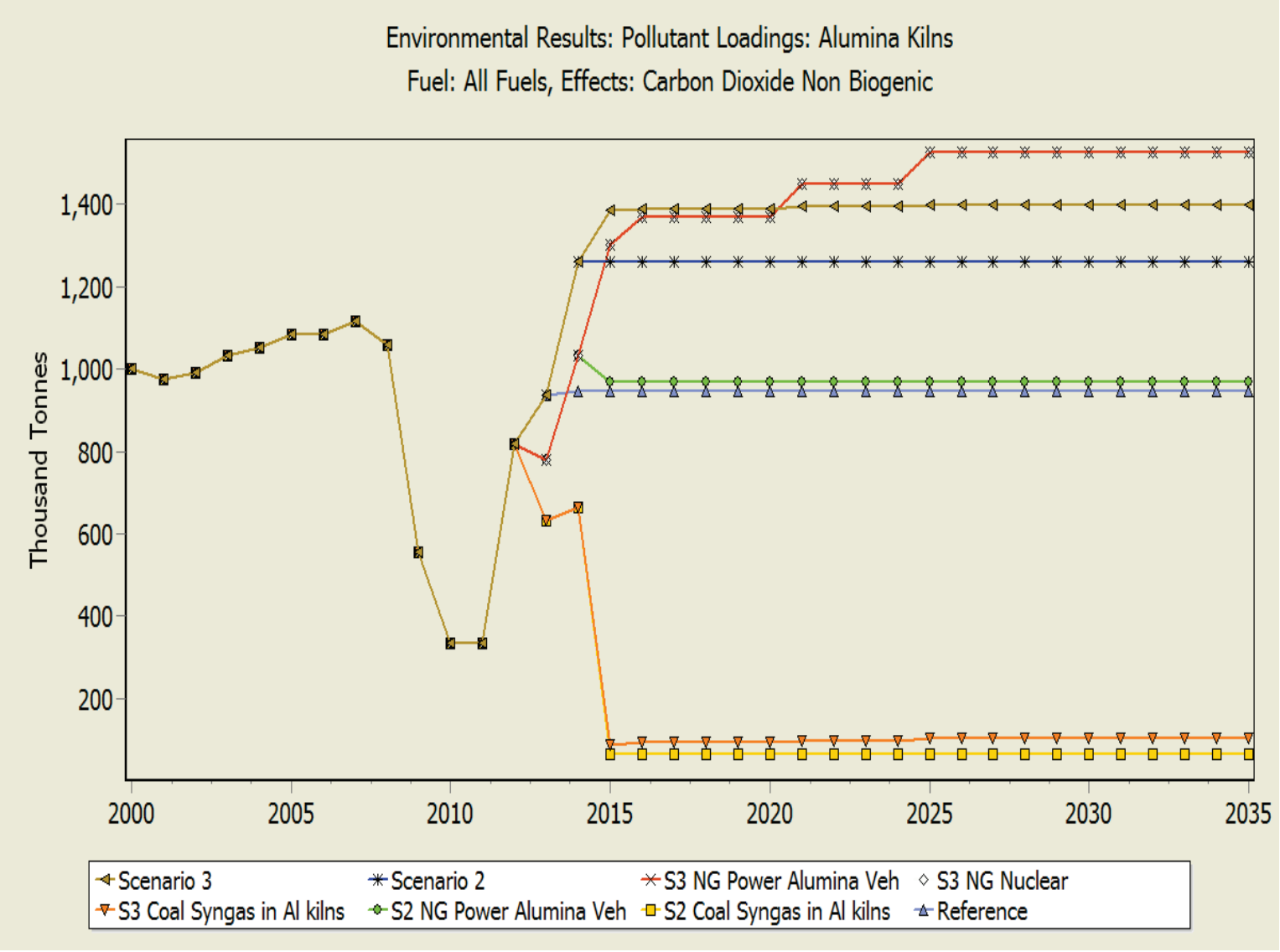


Figure 3-15 Lime Kiln CO_2 Emissions for Jamaica, 2009 – 2035: All Scenarios

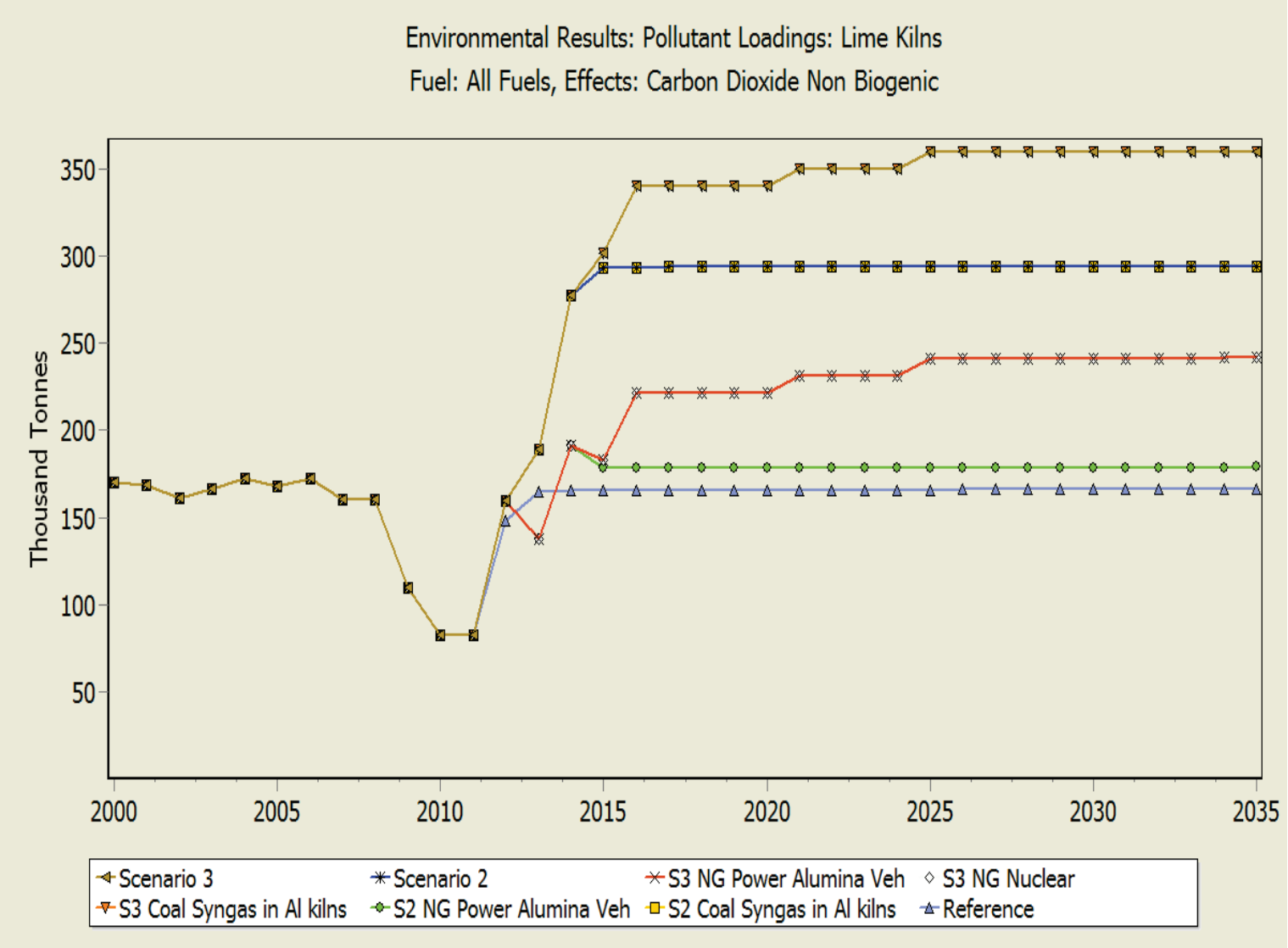


Figure 3-16 Bauxite Mining CO_2 Emissions for Jamaica, 2009 – 2035: All Scenarios

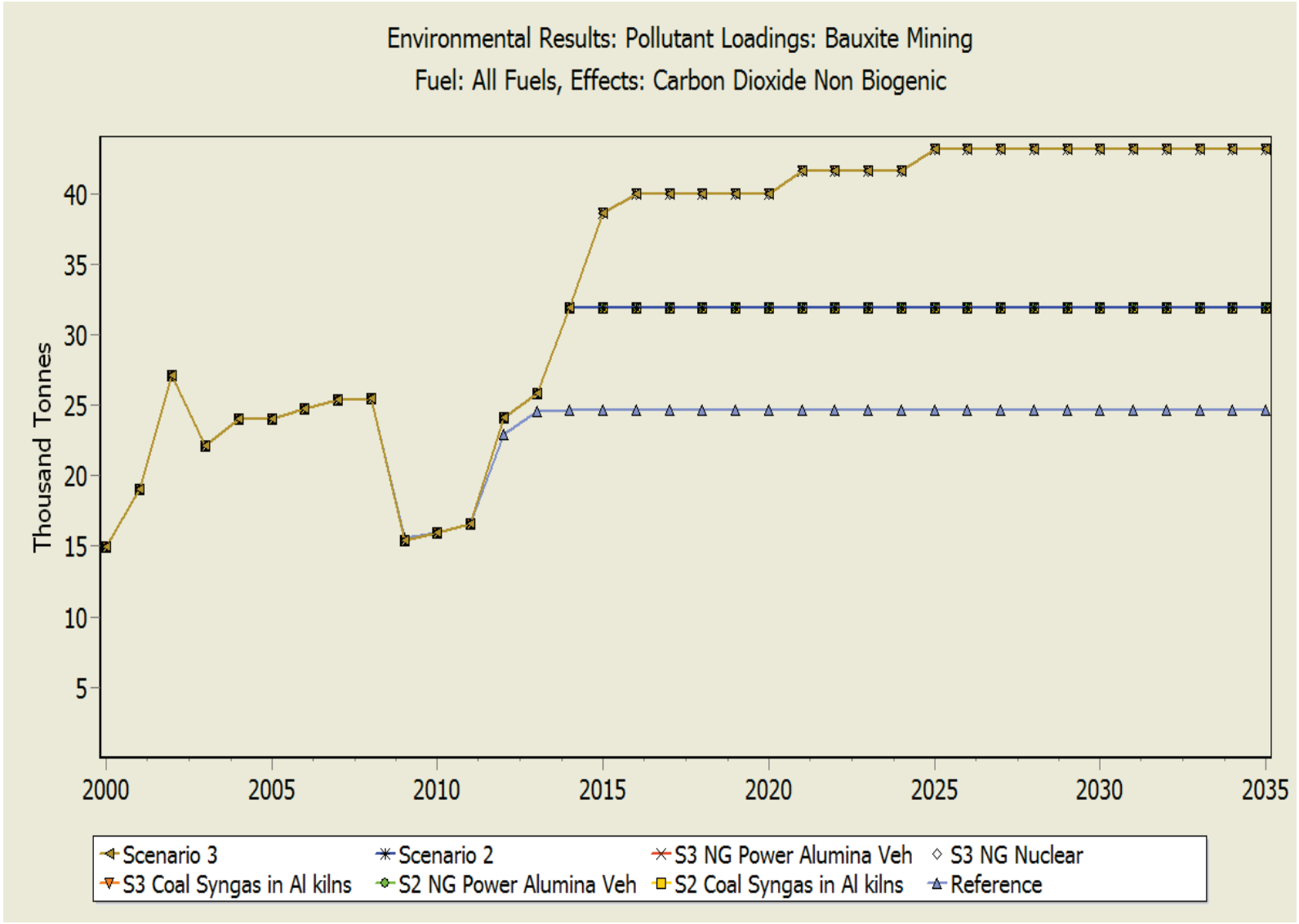
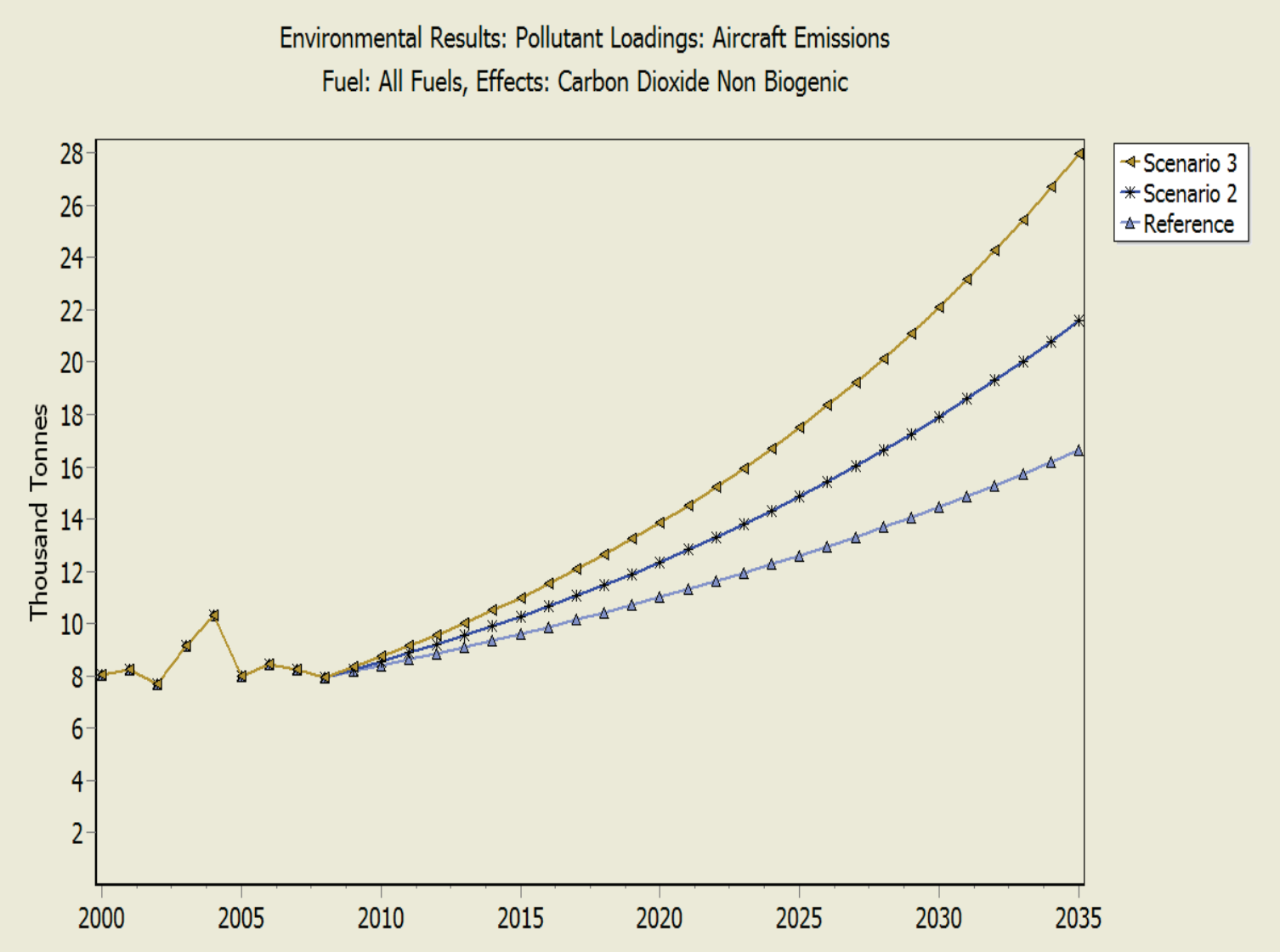


Figure 3-17 Domestic Aircraft CO_2 Emissions for Jamaica, 2009 – 2035: All Scenarios



3.4.1.2.4 On-Road and Off-Road Traffic

Fuel consumption (gasoline, diesel and lubricants) by the on-road fleet accounted for about 23% of Jamaica's energy consumption in 2008 and it is therefore critical to obtain reliable estimates of projected fuel consumption and GHG emissions for the mitigation scenarios.

The energy consumption and GHG emissions of on road vehicles are determined (inter alia) by the vehicle weight, age (model year) and fuel type. Data for the entire fleet of licensed vehicles were obtained in order to determine the numbers of vehicles by weight class and age. In order to assign all vehicles to appropriate weight classes and fuel type the raw fleet data had to be edited to:

- eliminate duplicates (based on chassis numbers)
- add missing vehicle weights (to allow allocation into vehicle weight classes)
- correct incorrect units in weights (e.g., use of pounds instead of kg for some vehicles)
- correct fuel assignments
- assign some urban buses to the appropriate vehicle class
- reallocate some vehicles in the tractor and trailer categories

It should be noted that some of the vehicles designated as motor tractors and trailers include vehicles such as forklifts (some of which use LPG fuel), cranes and other off-road equipment. The editing was based on various information sources such as manufacturers' vehicle specifications and vehicle identification number (VIN) codes, information from Jamaica Urban Transit Company (JUTC) and Transport Authority (TA). The fleet data for 2000, 2005 and 2008 (after editing indicated above) are shown in Table 3-1. The editing is not considered perfect but rather sufficient to provide more reliable data than originally received.

Estimates of fuel consumption (mileage) and emissions (emission factors) were determined using a US EPA emissions model MOBILE6 for various combinations of vehicle classes and fuels (e.g., g/vehicle–km for each vehicle class). The estimates together with the number of vehicles and the annual vehicle kilometres travelled (VKMT) in each weight class by fuel allowed calculation of total fuel use.

Estimates for annual VKMT were based on limited surveys conducted by STATIN/PIOJ[22] and the Ministry of Transport & Works (MTW)[23]. The former was based on a survey of householders in connection with residential energy end use, while the latter was based on odometer readings taken at four parish Island Traffic Authority (ITA) vehicle inspection depots for vehicles (of all types) that were inspected during limited periods. In the latter survey, just over 1000 of the ~2400 odometer data pairs were rejected because of uncertain/incorrectly entered dates or odometer readings. The average VKMT from the two surveys are summarised in Table 3-2. Although the MTW survey data were broken down by fuel type, data for the diesel motor cars and motor cycles are excluded because the sample sizes were too small. VKMT for diesel motor cars were assumed to be the same as for gasoline fuelled cars and for motor cycles were assumed to be the same as used previously.

Table 3-1 Jamaica's Motor Vehicle Fleet in 2000, 2005 and 2008

Vehicle Type	2000	2005	2008#
MOTOR CAR	270,005	355,091	408,269
MOTOR CYCLE	20,272	26,009	33,155
MOTOR TRACTOR	443	818	1,728
MOTOR TRUCK	91,498	120,883	139,481
TRAILER	2,757	3,815	4050
Total	384,975	506,616	586,683

Note – Excludes duplicate records

Table 3-2 Summary of VKMT Estimates From Surveys

Survey	Fuel	Vehicle Type	VKMT (km/y)
MTW	Diesel	Motor Car	
		Motor Cycle	0
		Motor Truck	31,477
MTW	Petrol	Motor Car	29,961
		Motor Cycle	33,786
		Motor Truck	21,193
PIOJ/STATIN	Not Specified	Motor Car	7,956
		Pick up	6,604
		SUV	5,876
		Minivan/Bus	12,740
		Motor Cycle	7,748

In the PIOJ/STATIN survey, the Pickup, SUV and Minivan/minibus vehicle types were aggregated as Motor Trucks in the MTW survey. The VKMT estimates in the PIOJ/STATIN survey are considerably lower than that in the MTW survey. It is likely that the MTW survey included a high proportion of vehicles operated as hackney, public or private which are expected to have higher VKMT. Both surveys are subject to considerable uncertainty,

In applying MOBILE6 we took into account the local data including the age distribution of vehicles in each class, fuel properties, ambient conditions, average road and highway speeds, the diesel vehicle sales by vehicle class, the mileage accumulation by vehicle class, the roadway distribution (freeway, arterial/collector, local roads and ramps). The age distribution of the fleet (based on the "traditional" vehicle classes) is shown in Figure 3-13. Note that in Figure 3-13 vehicles with model years of 1985 or earlier are grouped together.

Figure 3-18 shows CO_2 the loadings from the on road fleet for all scenarios. A breakdown of the CO_2 loadings into the 8 vehicle classes for the Reference Scenario is illustrated in Figure 3-17. The vehicle classes in Figure 3-19 are as follows:

LDGV	Light duty gasoline vehicles	LDDV	Light Duty diesel vehicles LDDT
LDGT12	Light duty gasoline trucks	LDDT	Light duty diesel trucks
LDGT34	Light duty gasoline trucks	HDDV	Heavy duty diesel vehicles
HDGV	Heavy duty gasoline vehicles	MC	Motor cycles

Mitigation measures for the on road fleet are centred on the use of natural gas in some of the fleet but no specific penetration targets were available. It should be noted that the Reference Scenario includes the introduction of E10 (as of 2010[4]), low sulphur diesel and gasoline as well as additional highway construction – both of which would impact emissions. The mitigation measures for *S2* and *S3* were therefore limited to assumed percentage of new vehicle registrations that are equipped to use CNG.

Consideration of CNG for motor cycles (MC) and heavy duty gasoline vehicles (HDGV) was excluded because it is either not feasible (MC) or because the number of vehicles (and hence the expected benefit) in the fleet is small.

The impacts of introducing CNG vehicles on CO_2 emissions are illustrated in Figure 3-20 relative to the Reference Scenario. The CO_2 emissions for scenarios with CNG vehicles (*S2 NG* and *S3 NG*) show reductions with net reductions (i.e., negative differences) after 2020/2021 as sufficient vehicles enter the fleet.

[4] E10 was introduced in November 2009 and the first full year (2010) was modeled.

Figure 3-18 Age Distribution of the Jamaican Fleet in 2008

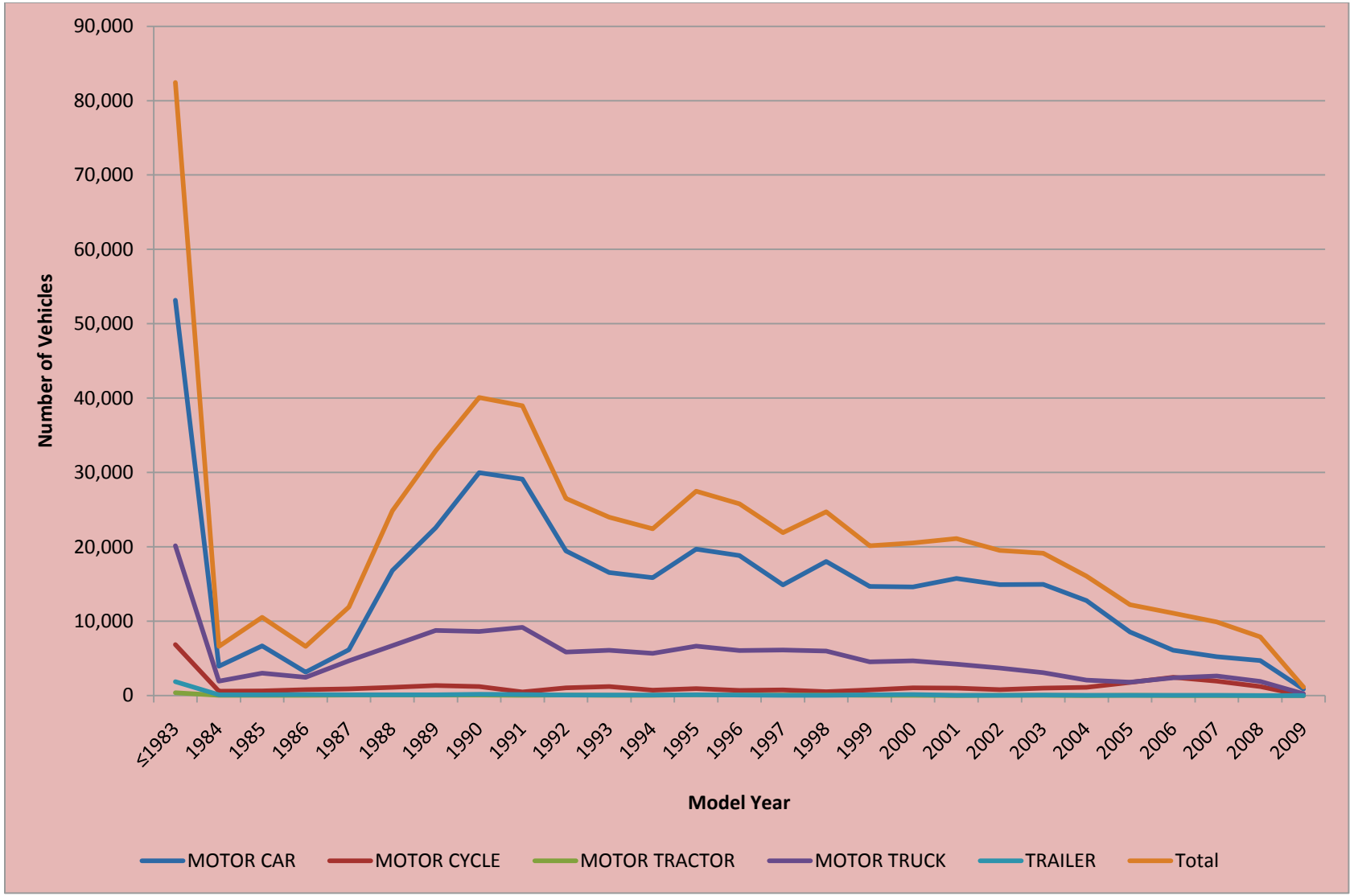


Figure 3-19 Final Environmental Loadings for Demand Categories: On Road Fleet Selected Scenarios

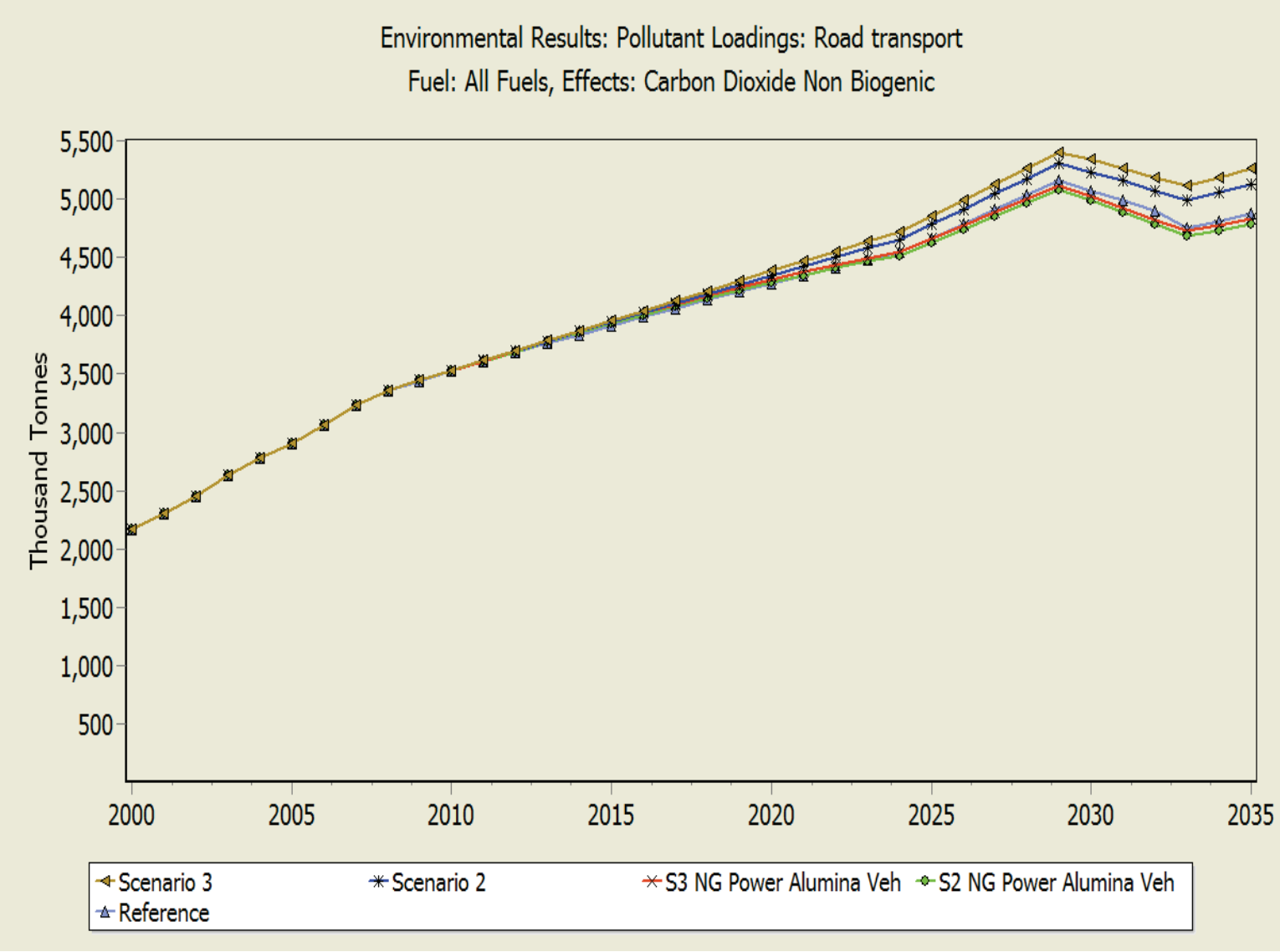


Figure 3-20 Final Environmental Loadings for On Road Fleet Branches: Reference Scenario

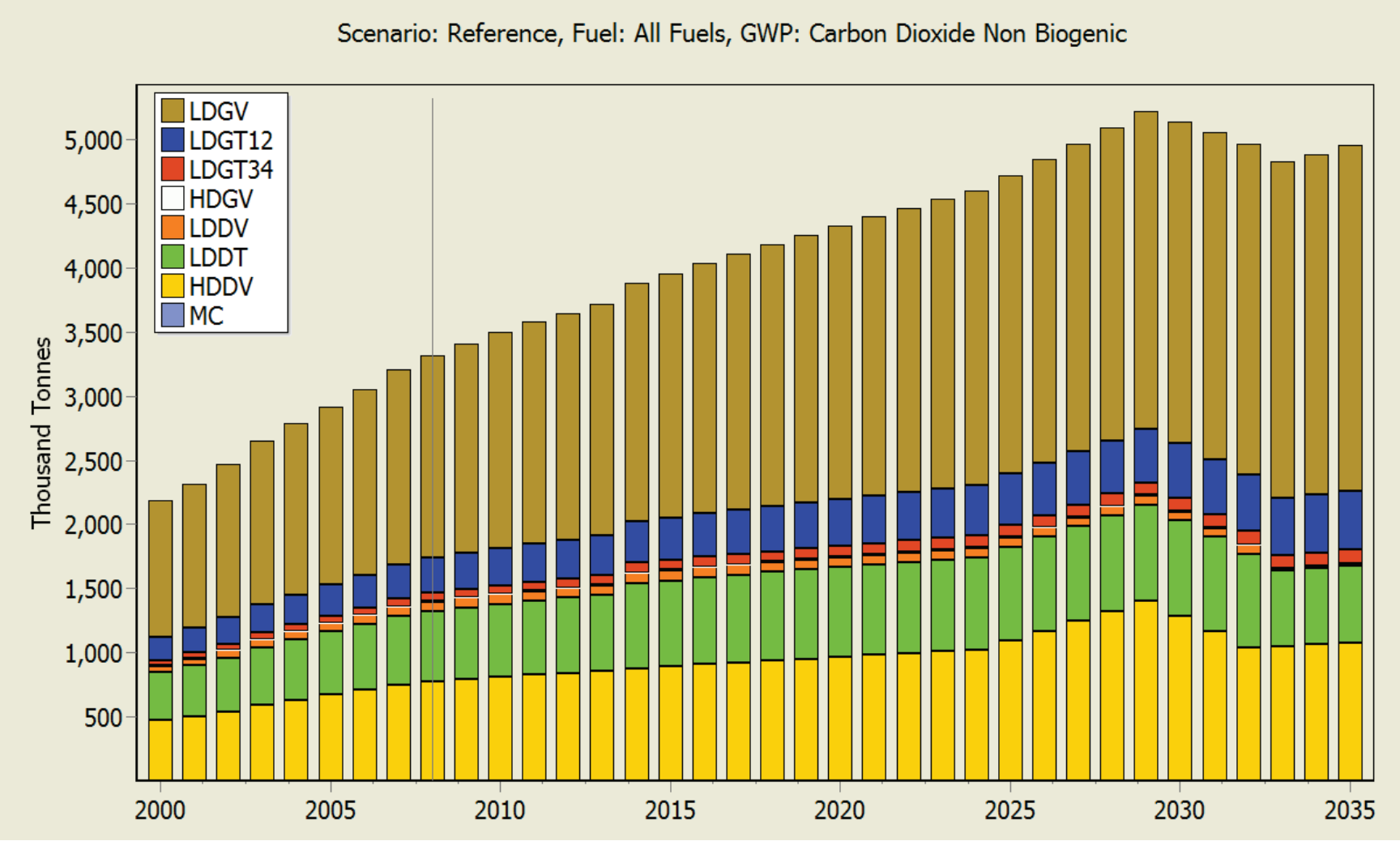
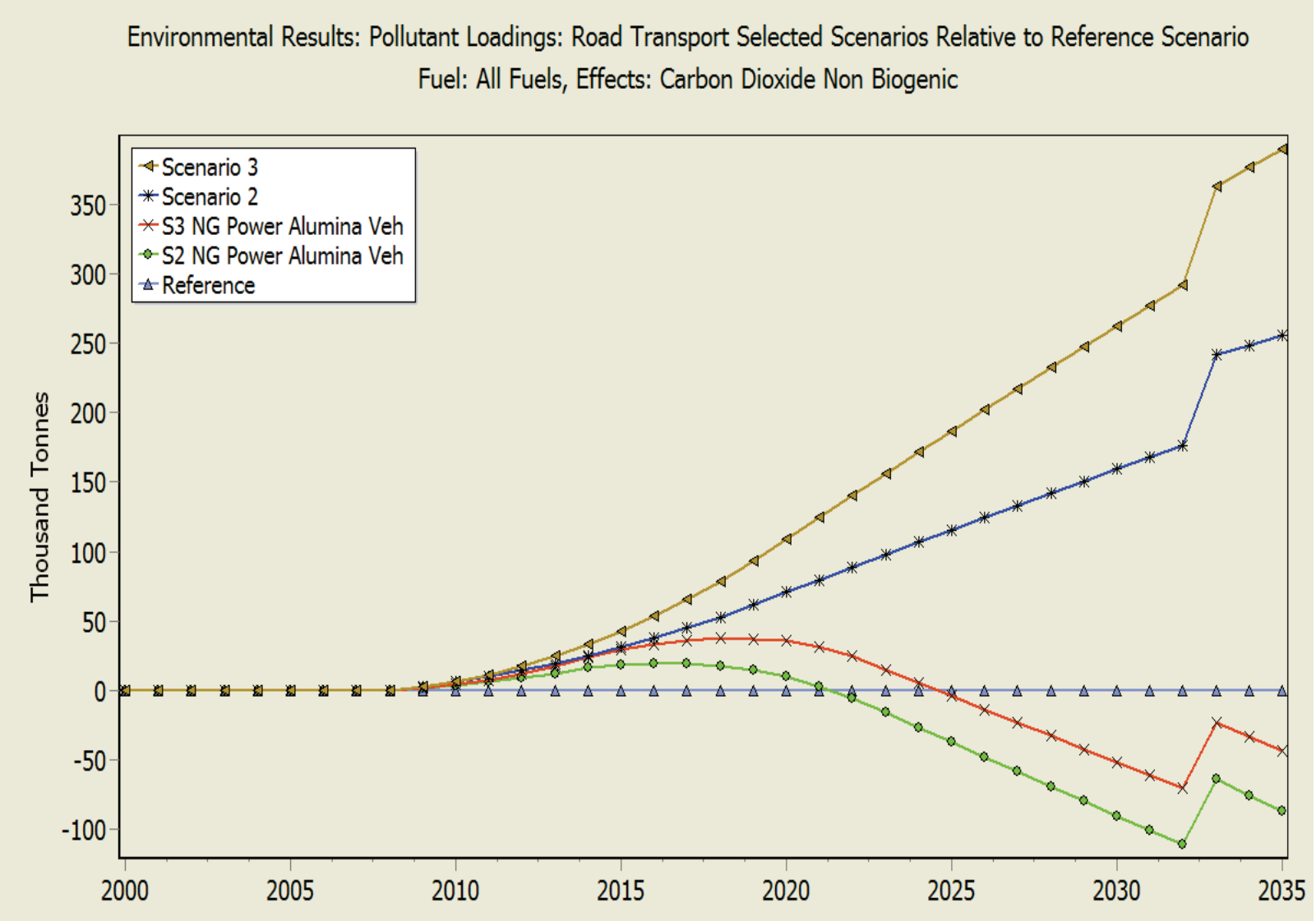


Figure 3-21 Final Environmental Loadings for Road Transport: Selected Scenarios Relative to the Reference Scenario



3.4.1.3 Household Demand

CO_2 emissions from residential demand (see) are driven by population increases as well as by larger percentages of household acquiring appliances such as air conditioners, washing machines etc. This is illustrated in Figure 3-22 where the increases outweigh the mitigation measures such as the additional substitution of incandescent bulbs by CFL bulbs and more efficient appliances.

The contributions to CO_2 emissions allocated to the various demand sub-branches in the household branch is illustrated in Figure 3-23 for the Reference scenario: the highest percentage of the household CO_2 emissions is from "all other" followed by refrigeration, lighting and cooking (all types - LPG, Electric stoves, charcoal and firewood).

There are no mitigation measures proposed for cooking but measures for lighting (additional CFL bulbs), televisions and refrigeration (adoption of Energy Star standards) will reduce annual household emissions. The impacts of these measures are illustrated in Figures 3-24 to 3-26.

3.4.1.4 Government Demand

The government category comprises hospitals, NWC and "Other Government" since electricity and fuel use data are available for these sub branches. An extensive and detailed audit of hospitals provided detailed energy consumption and "activity" (types of energy consuming devices) data for 2006. The purpose of the audit was to develop energy conservation strategies. These consisted of a number of "investment packages" for which energy savings and implementation costs were developed. These packages were used in LEAP to determine the implications for environmental loadings (GHG emissions) and energy demand savings.

Figures 3-27 shows the overall changes in the Government branch CO_2 emissions for all scenarios. These figures show the reductions in CO_2 emissions that would be achieved. In the absence of details for the energy conservation measures that NWC would undertake, it was assumed that there would be reductions of 5% in each of three years starting in 2009 for Scenario 2 and 10% in each of two years starting in 2012 for Scenario 3.

For the "Other Government" category the public sector energy conservation program was assumed to meet its target of a 15% reduction in energy use over 5 years.

3.4.1.5 Other Branches – Rates 20, 40A, 50 and 60

These branches use only electricity and there were no specific mitigation measures other than general energy conservation. Although significant energy conservation measures have been undertaken at UWI[24] (a Rate 50 customer) the vast majority of the measures (refrigerant substitution, lighting changes, energy management) were undertaken between 2006 and 2008. The impacts on CO_2 emissions of projected growth and additional energy conservation measures are illustrated in Figure 3-28.

Figure 3-22 Final Environmental Loadings for Residential Demand Category: All Scenarios, Non Biogenic CO_2

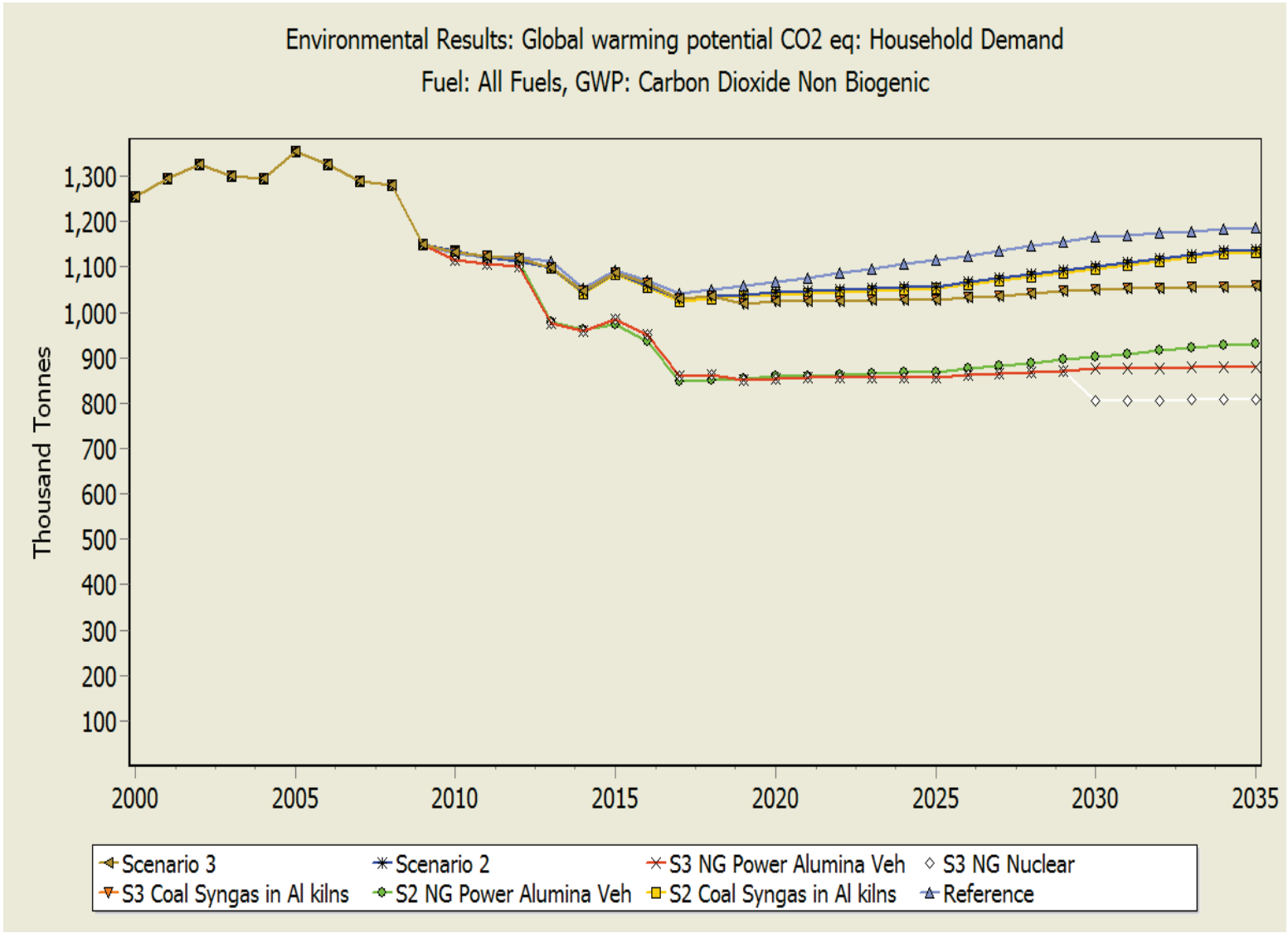


Figure 3-23 Final Environmental Loadings for Residential Demand Sub Branches: Reference Scenario, Non Biogenic CO_2

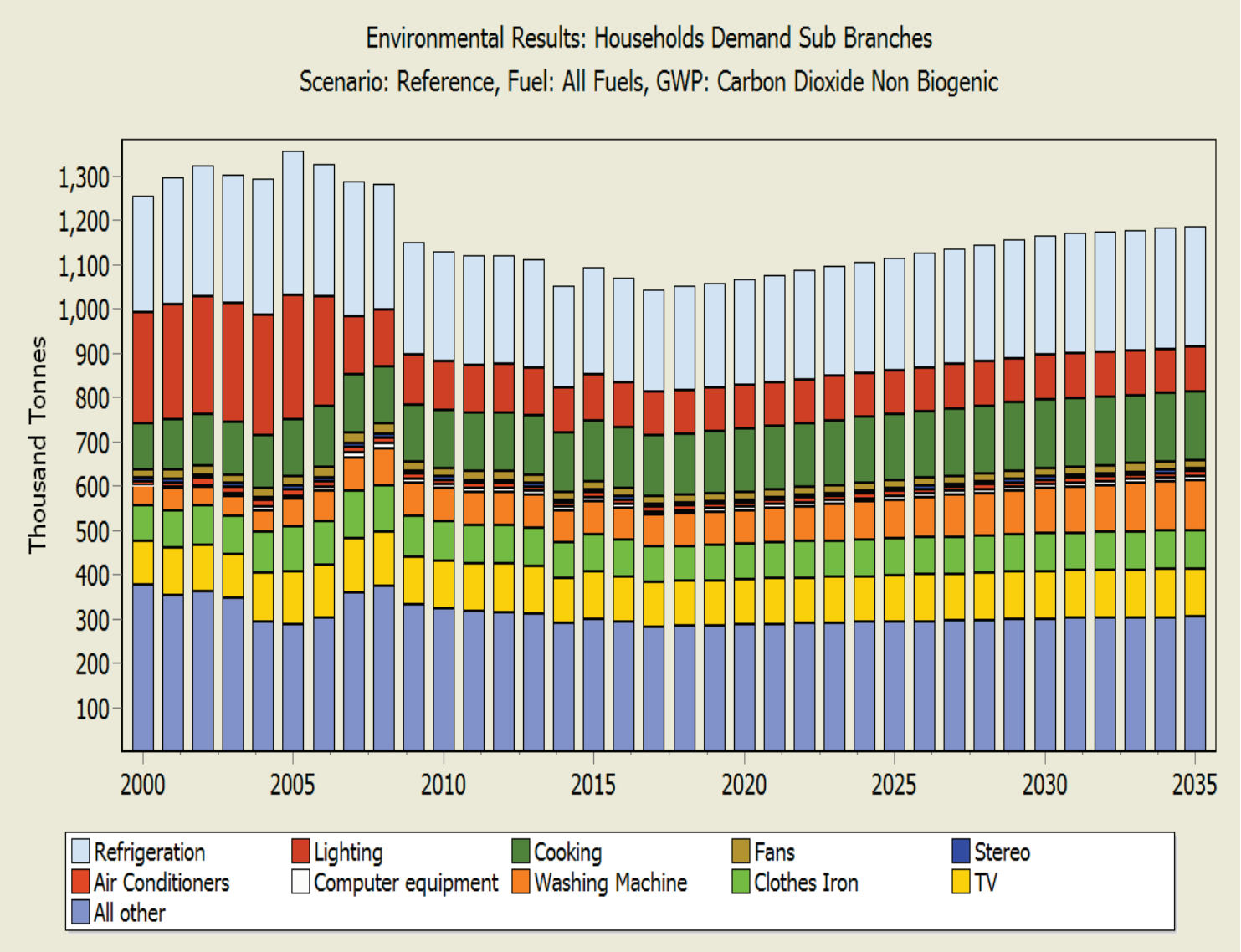


Figure 3-24 Mitigation Measures Household Demand Category: Lighting, Non Biogenic CO_2

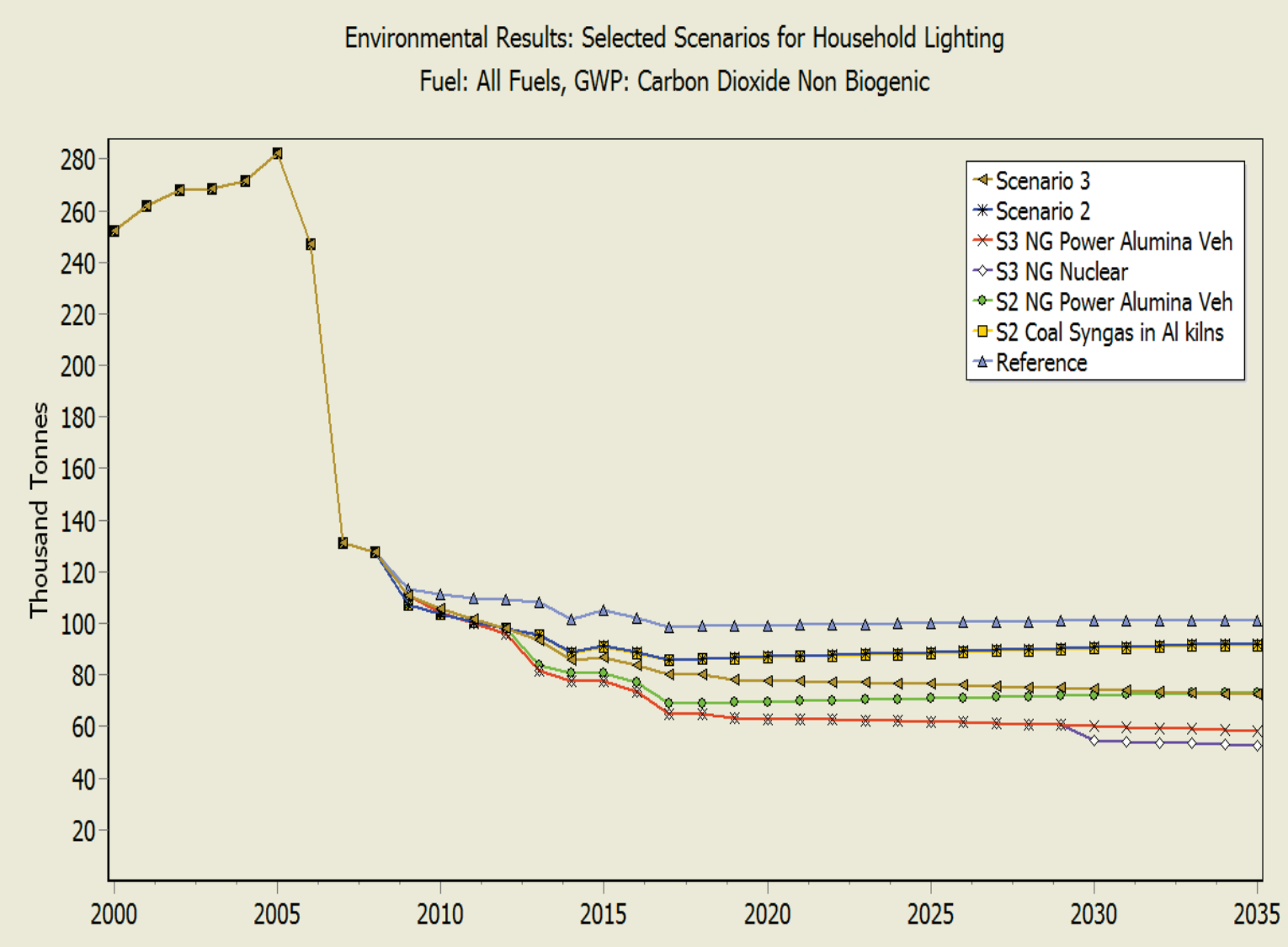


Figure 3-25 Mitigation Measures Household Demand Category: Televisions, Non Biogenic CO_2 Relative to Reference Scenario

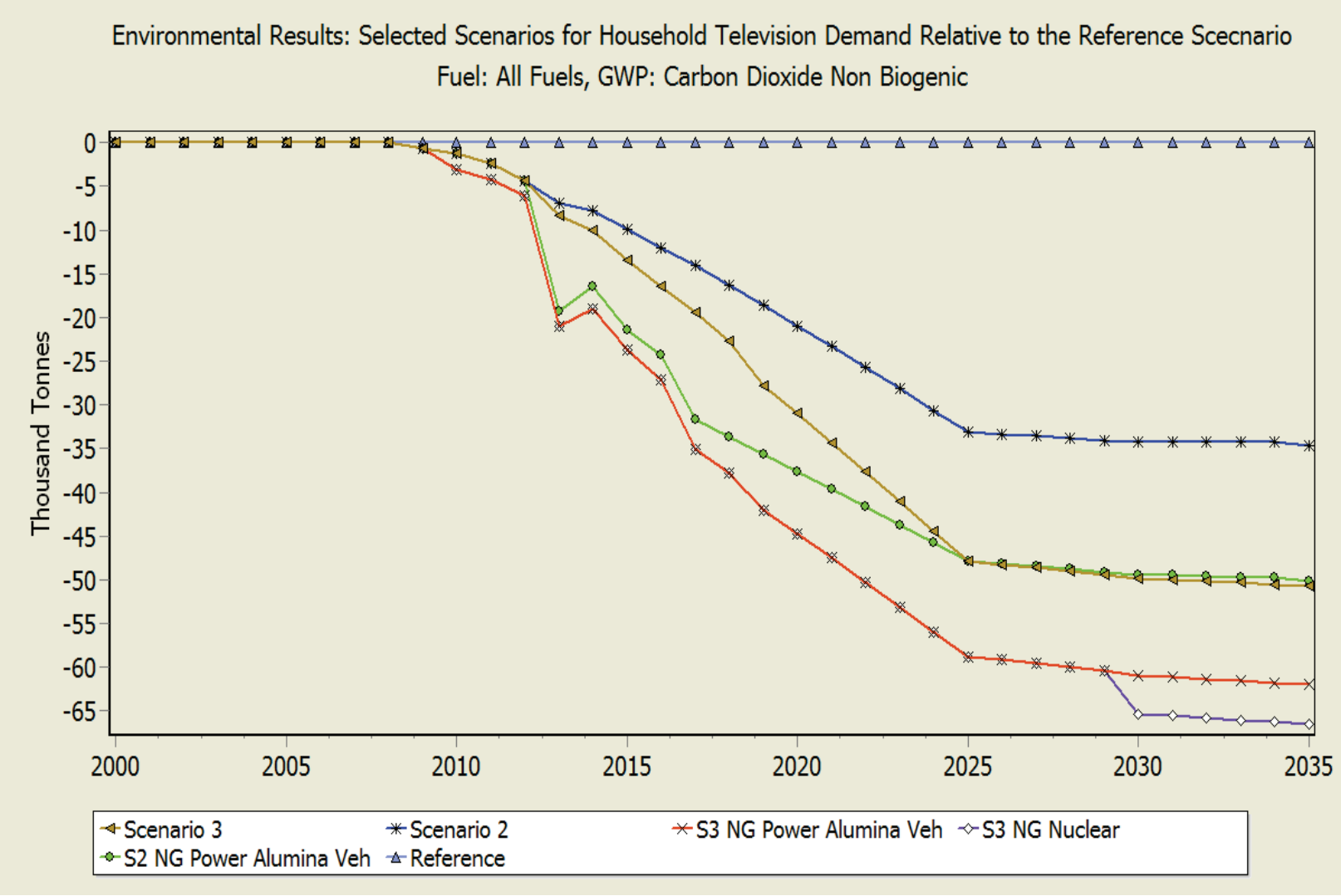


Figure 3-26 Mitigation Measures Household Demand Category: Refrigeration, Non Biogenic CO_2 Relative to Reference Scenario

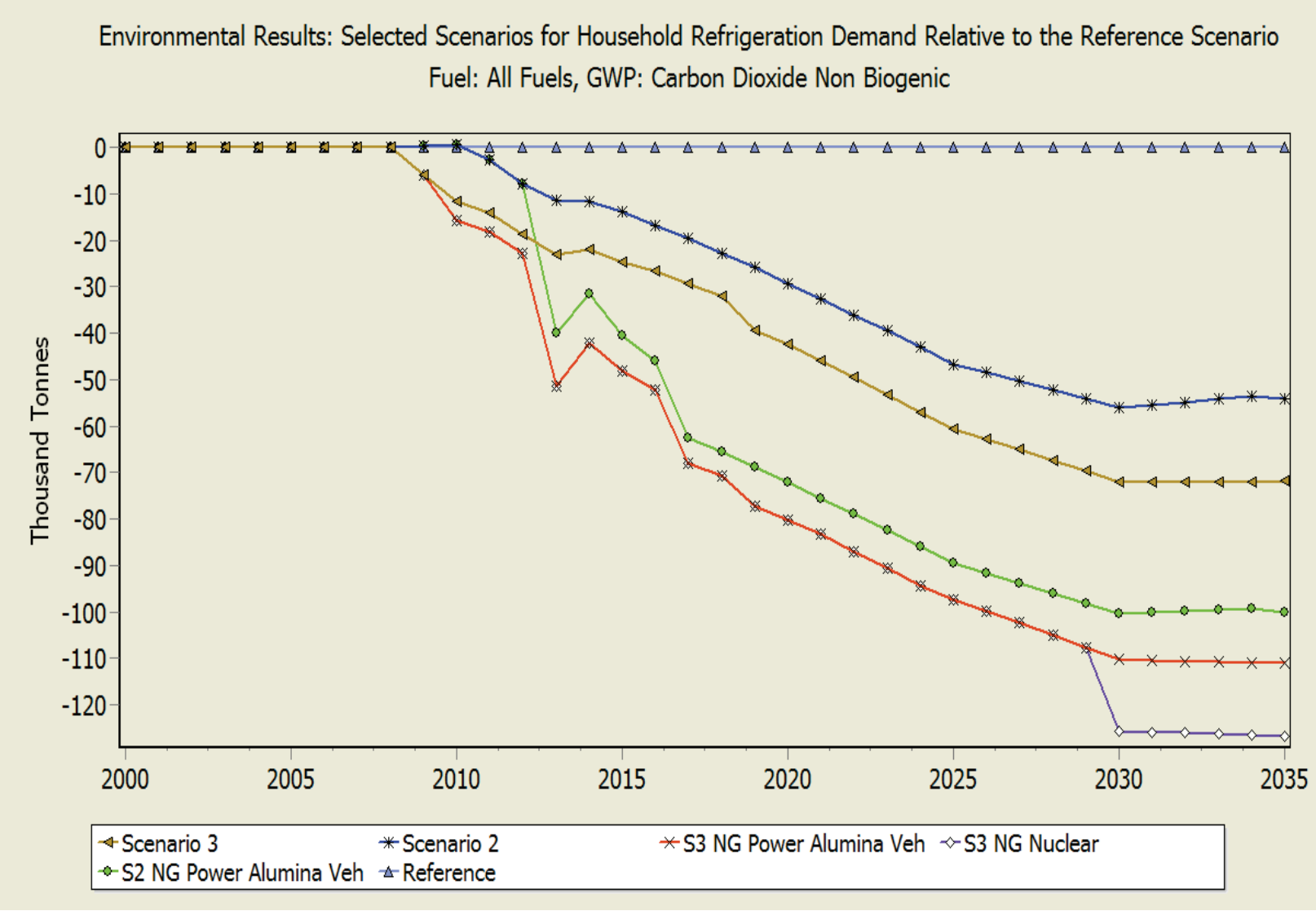


Figure 3-27 Mitigation Measures Government Demand Category: Selected Scenarios Non Biogenic CO_2

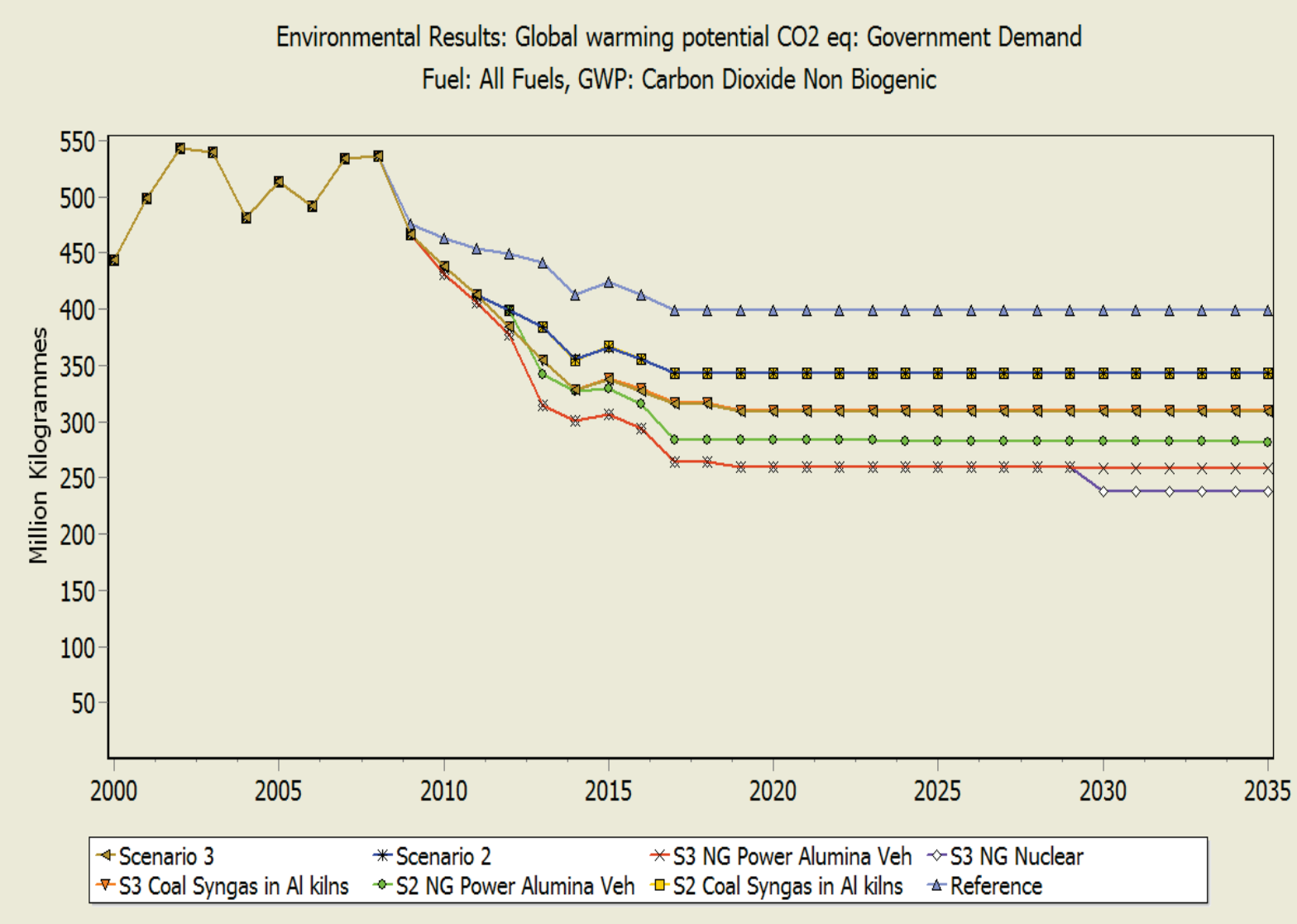
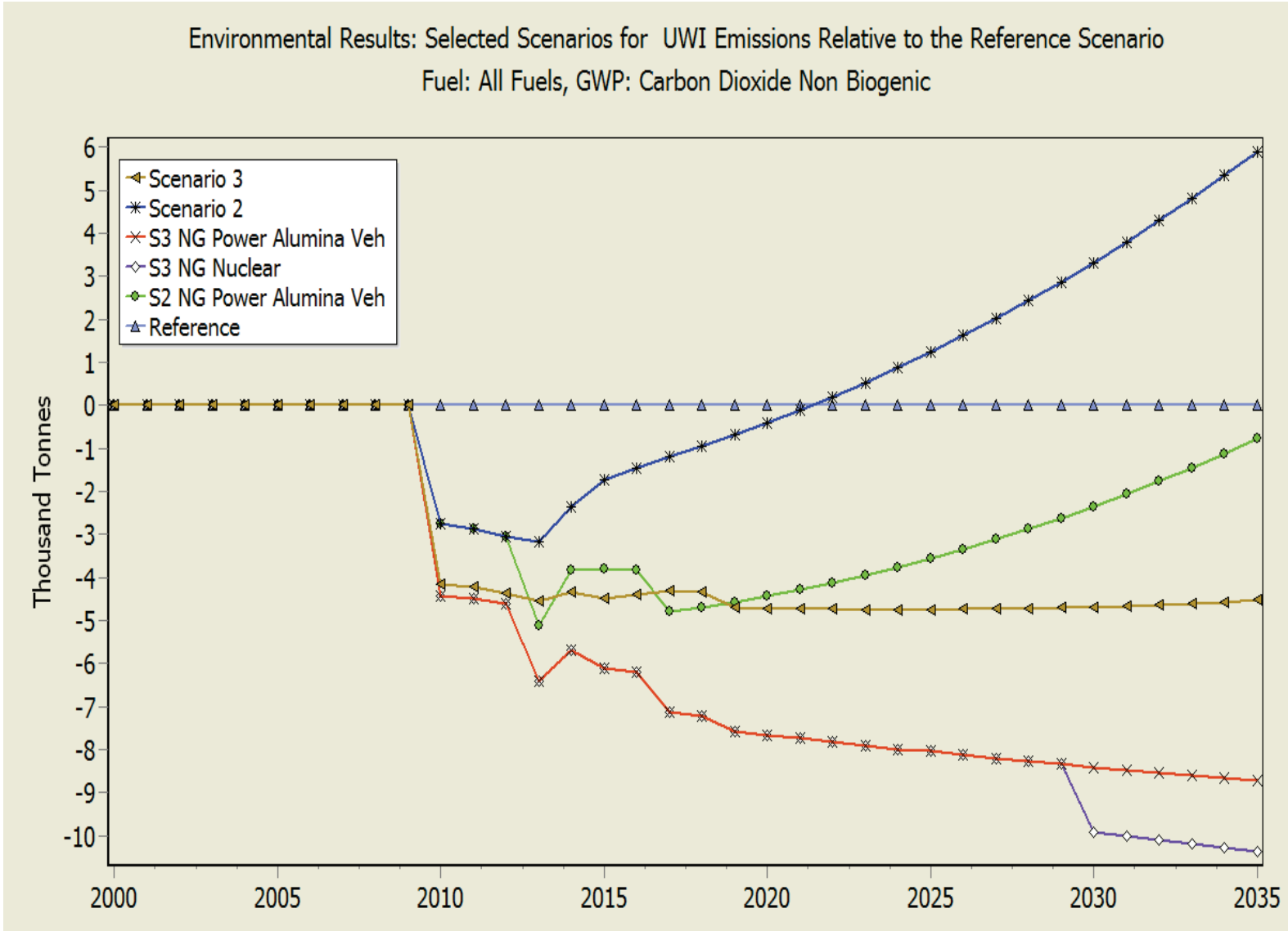


Figure 3-28 Mitigation Measures UWI Initiatives: Selected Scenarios Relative to Reference Scenario, Non Biogenic CO_2



3.5 TRANSFORMATION

The transformation categories consist of transmission (of electricity) and transformation (petroleum refining and electricity generation and charcoal production) activities.

Although the emissions directly associated with these activities are allocated to demand categories it is instructive to indicate the emissions directly associated with these activities. The model produces electricity outputs to match the demand based on (among other things) on the load shape, the availability of generating units and the order of dispatch etc.

3.5.1 Environmental Loading of Transformation Processes

Figure 3-29 shows the CO_2 emissions associated with transformation activities namely petroleum refining, electricity generation, coal gasification and charcoal making for the various scenarios. Figure 3-30 illustrates the contributions from the transformation processes for Scenario 3 (which includes significant energy from coal gasification for use in alumina kilns.

3.5.2 Other Selected Transformation and Energy Demand Results

Electricity Generation

The electricity generation outputs for the three scenarios are shown in Figure 3-31. A comparison of the actual and modelled generation output for 2000 to 2008 (Figure 3-32) shows a good match. The household uses required the most attention and further refinement of the allocations are in order.

The total electricity generating capacity various additions to capacity and unit closures (retired or mothballed) that were assigned to the various scenarios are illustrated in Figure 3-33 (total capacity), Figure 3-34 (additions) and Figure 3-35 (retirements).

Electricity Generation Mix

The changes in the mix of renewable (wind, hydro, municipal solid waste) and non-renewable fuels (coal, petcoke, oil) used for the electricity generation capacity for the three scenarios are shown in Figure 3-36. The percentage of renewables used for electricity generation in the Reference scenario in 2010 is 5%: in 2020 the percentages of renewables are 11.9%, 12.5% and 13.2% for the Reference, *S2* and *S3* scenarios respectively compared with the Energy Policy target of 15% by 2020 and 20% by 2030 but for all sources of energy.

Final Energy Demand

The mix of fuels in use in the various scenarios is illustrated in Figures 3-37 to 3-40 for scenarios *Ref, S2, S2NG, and S3 NG*. The changes in the mix of fuels are clear when either coal or natural gas is used.

Figure 3-29 Environmental Results: CO_2 Emissions From Transformation Processes; All Scenarios

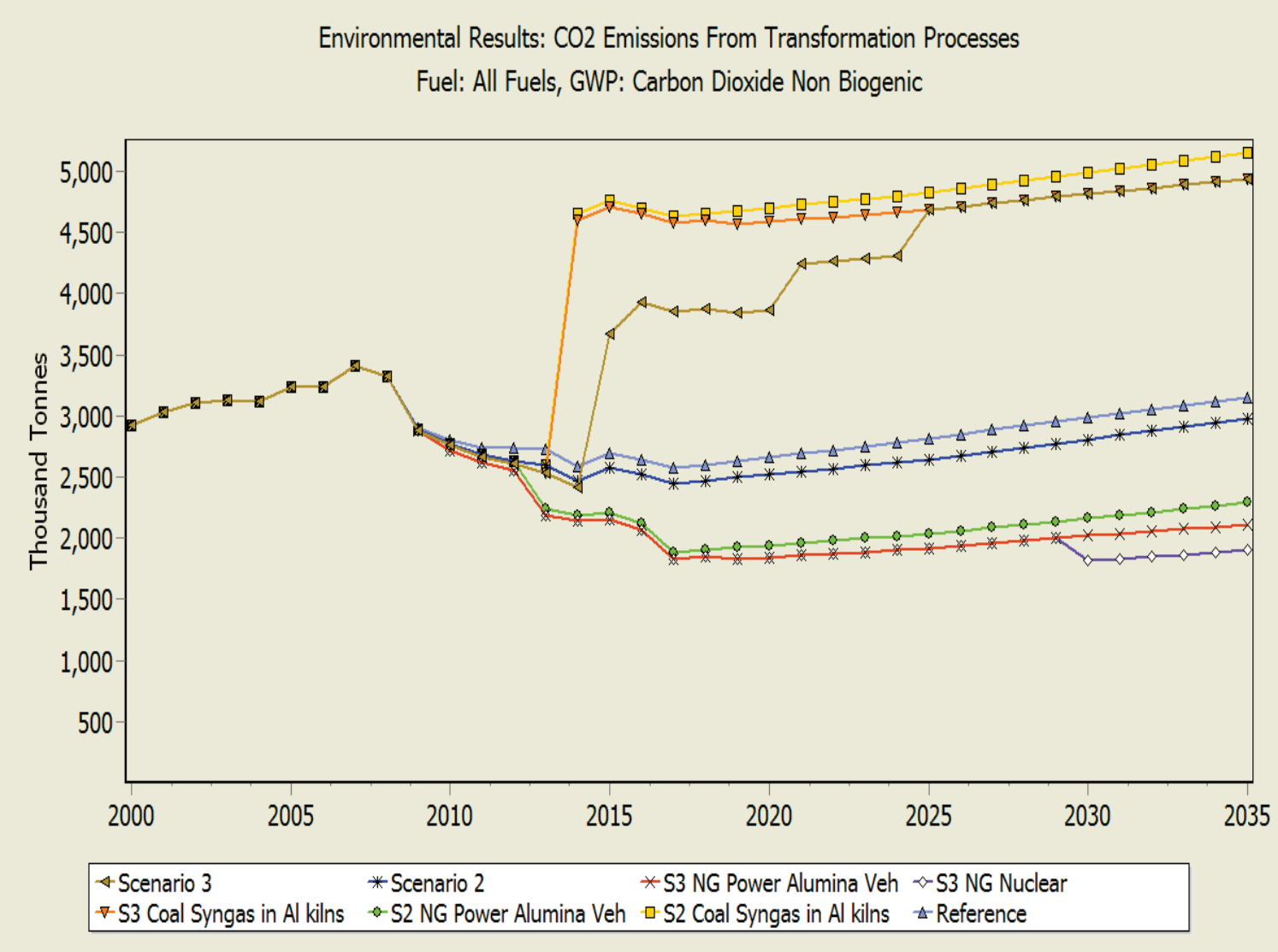


Figure 3-30 Environmental Results: CO_2 Emissions From Transformation Processes - Scenario 3

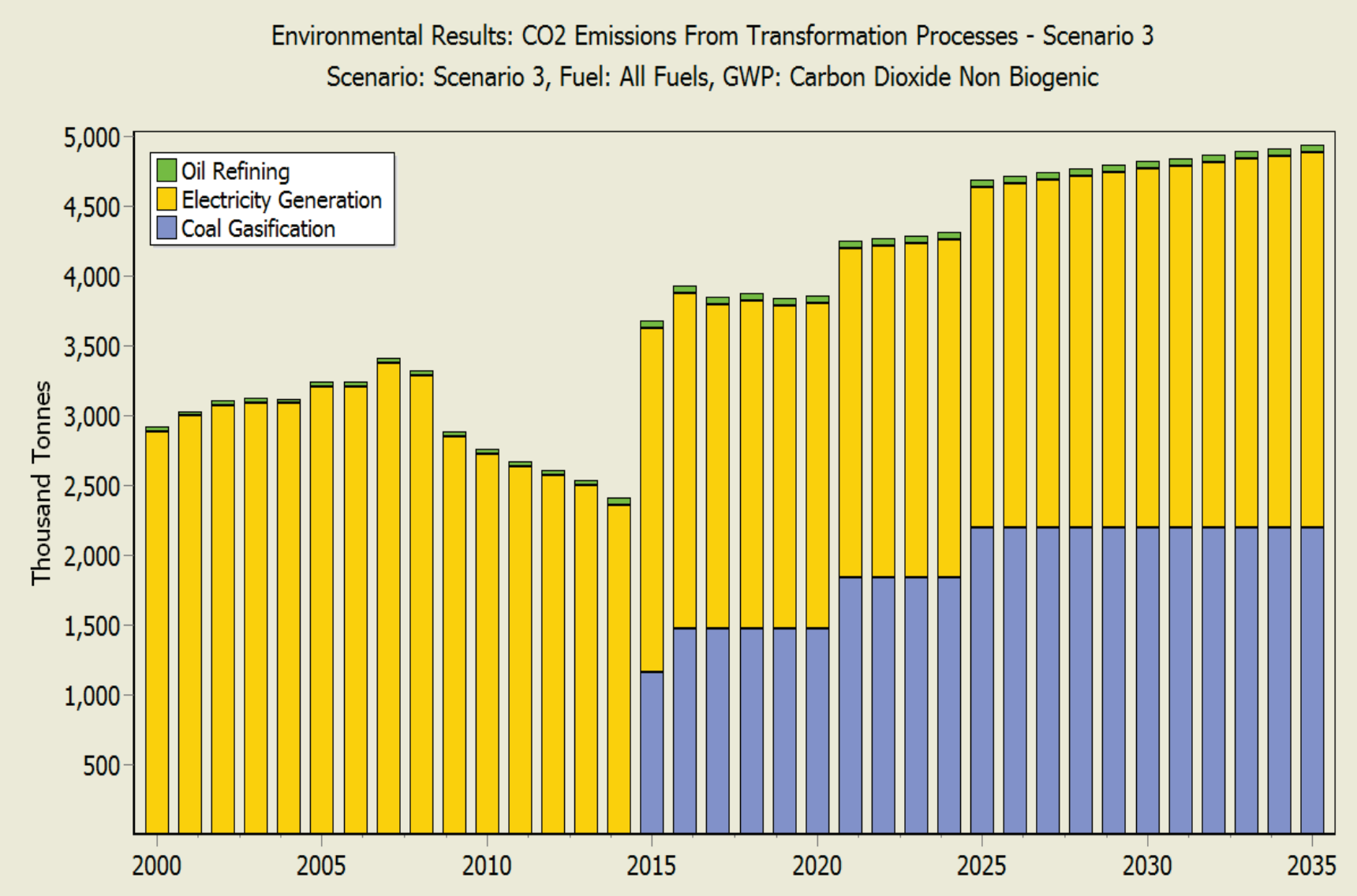


Figure 3-31 Transformation Results: Electricity Generation Outputs, Selected Scenarios

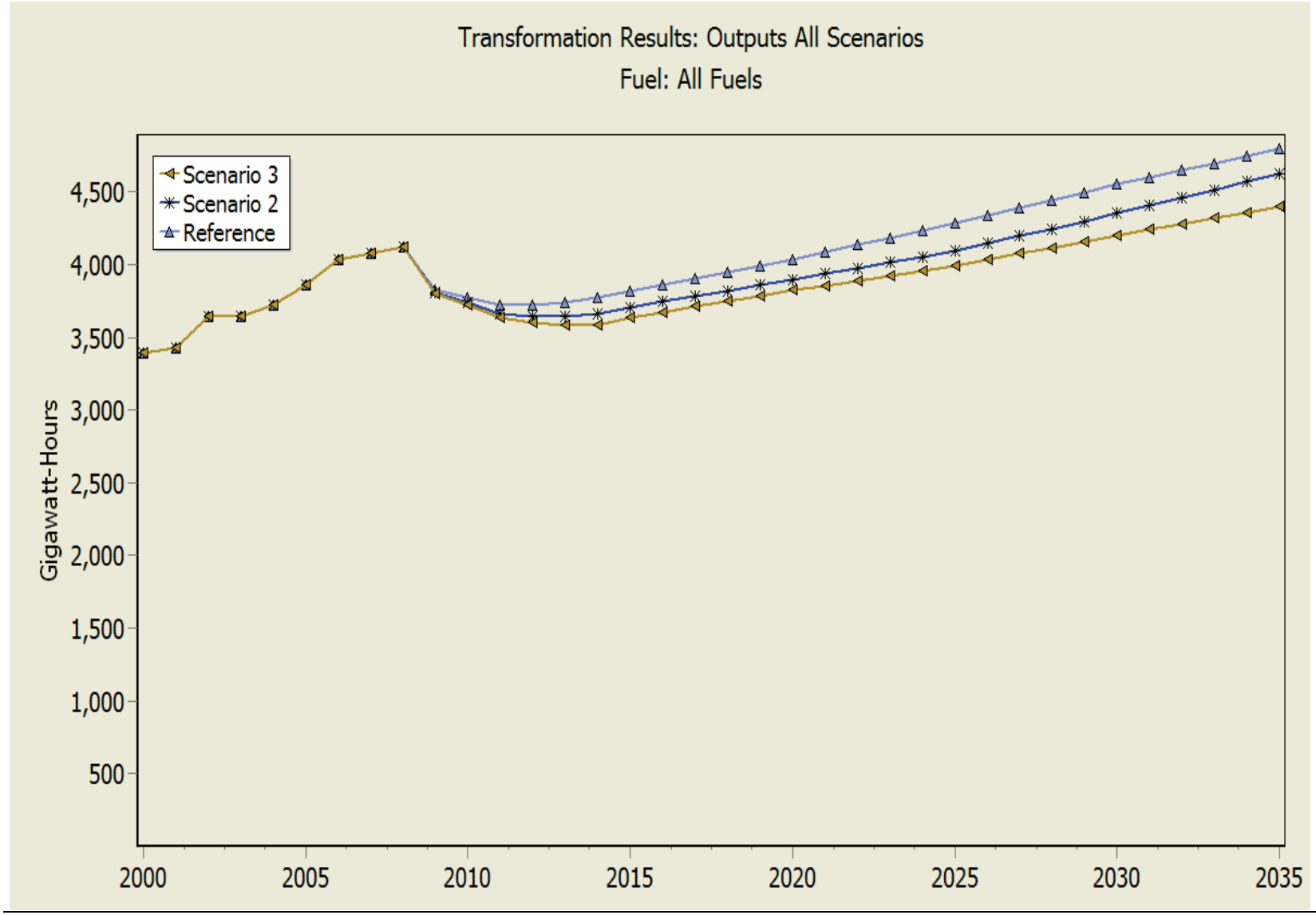


Figure 3-32 Comparison Between Actual and Modelled Electricity Generation Outputs, 2000 to 2008

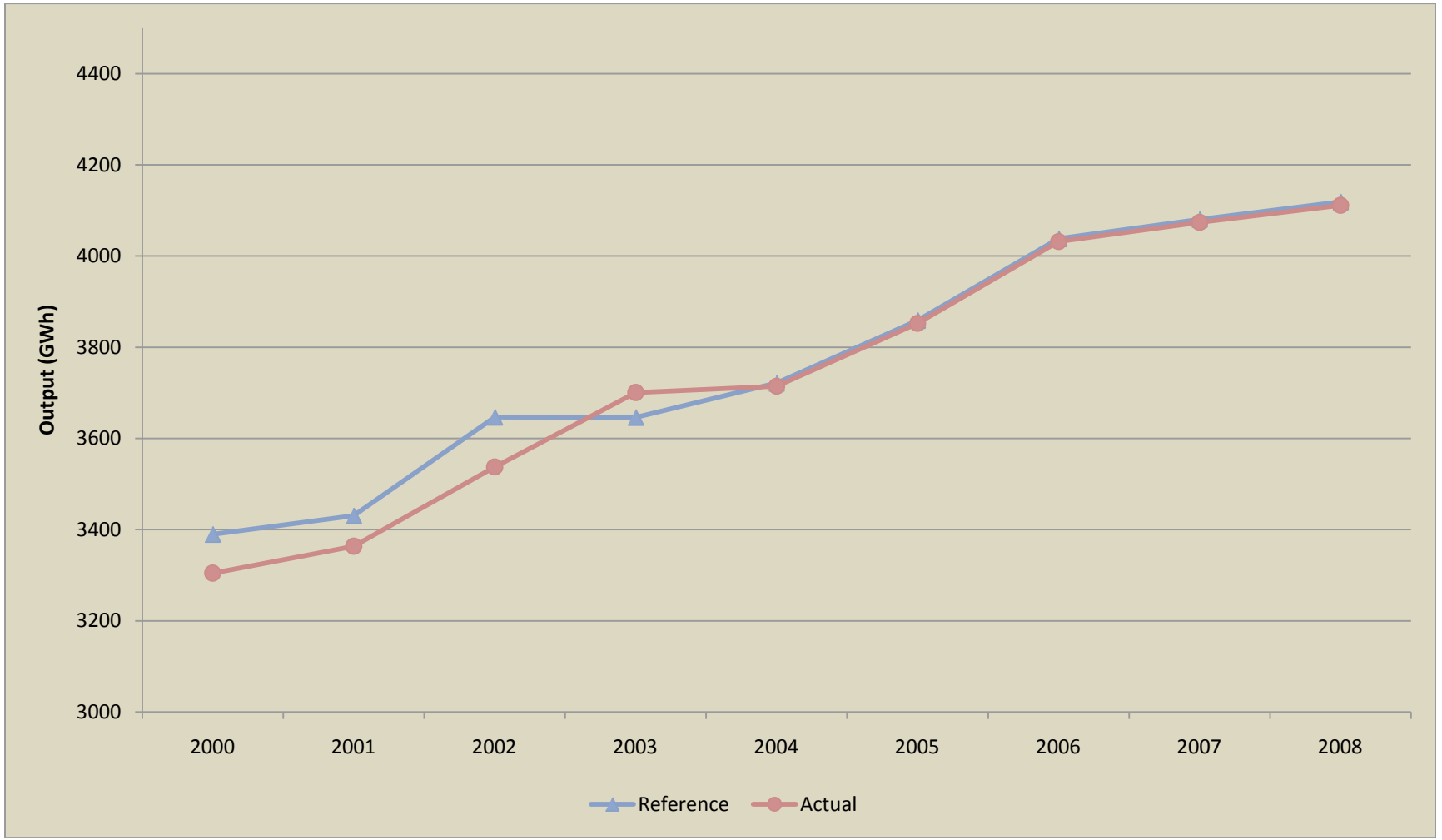


Figure 3-33 Transformation Results: Electricity Generation Capacity, Scenarios Reference, *S2*, *S3* and *S3 NG*NU

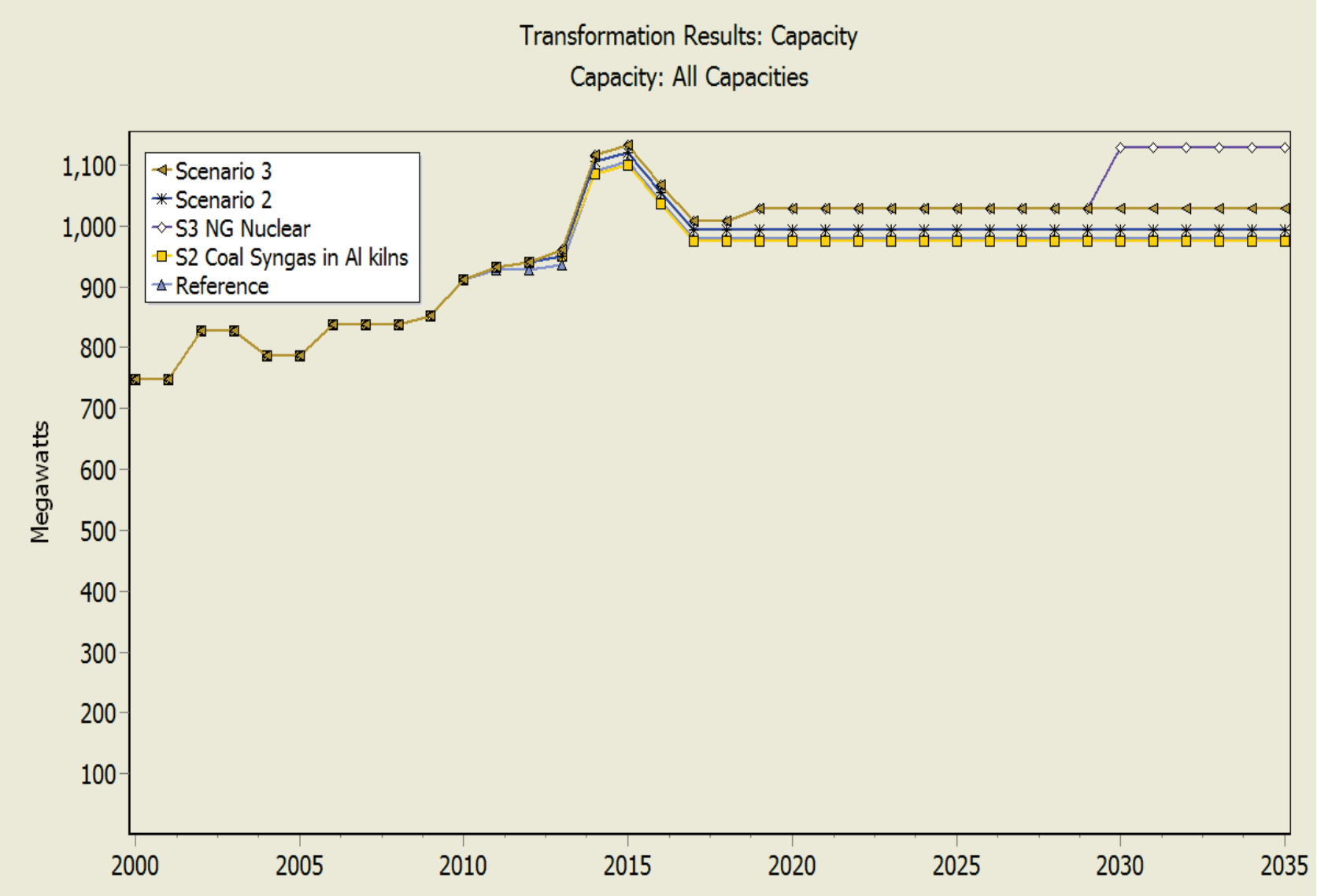


Figure 3-34 Transformation Results: Electricity Generation Capacity Added, Scenarios Reference, *S2*, *S3* and *S3 NG*NU

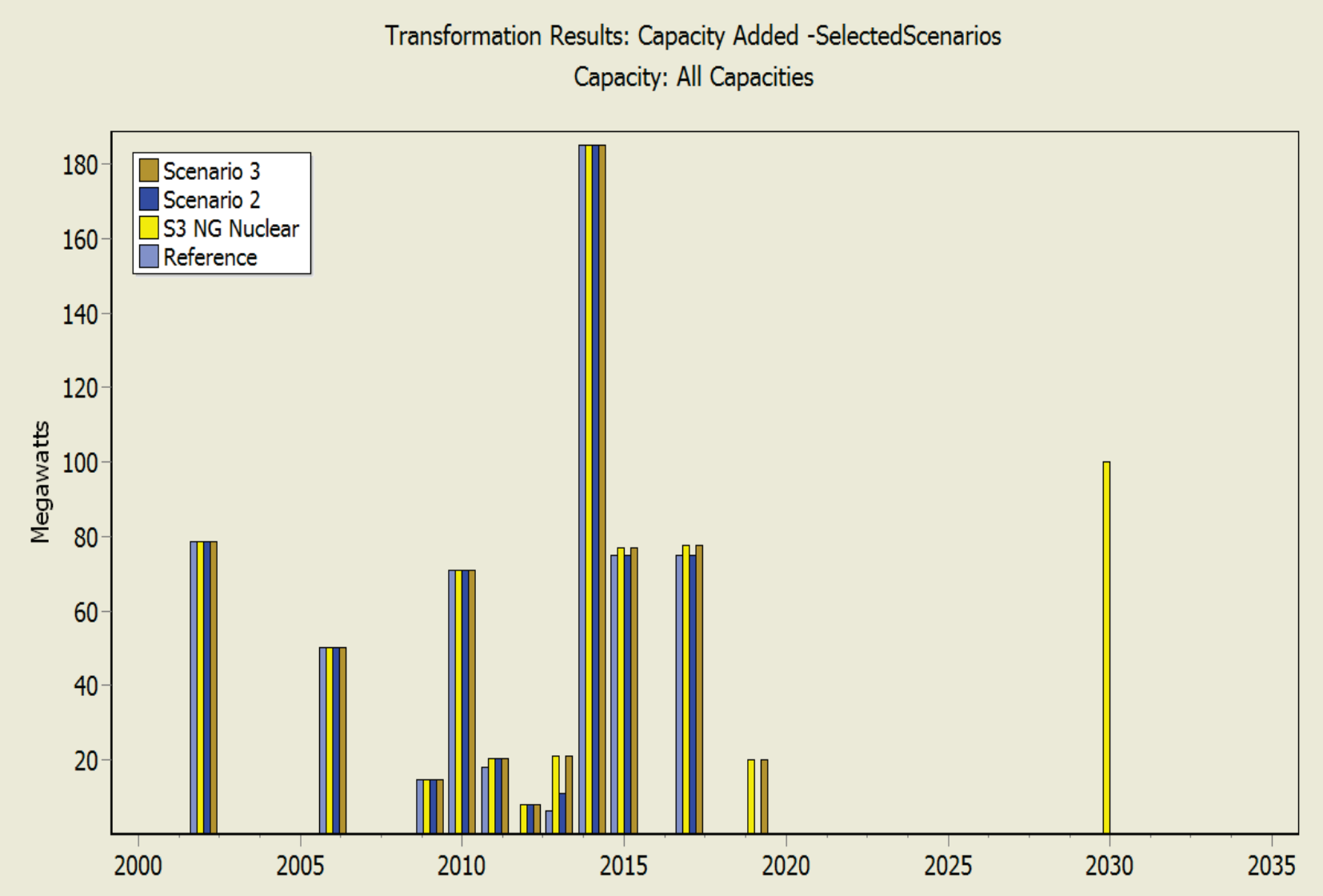


Figure 3-35 Transformation Results: Electricity Generation Capacity Retired/Mothballed, Scenarios Reference, *S2*, *S3*

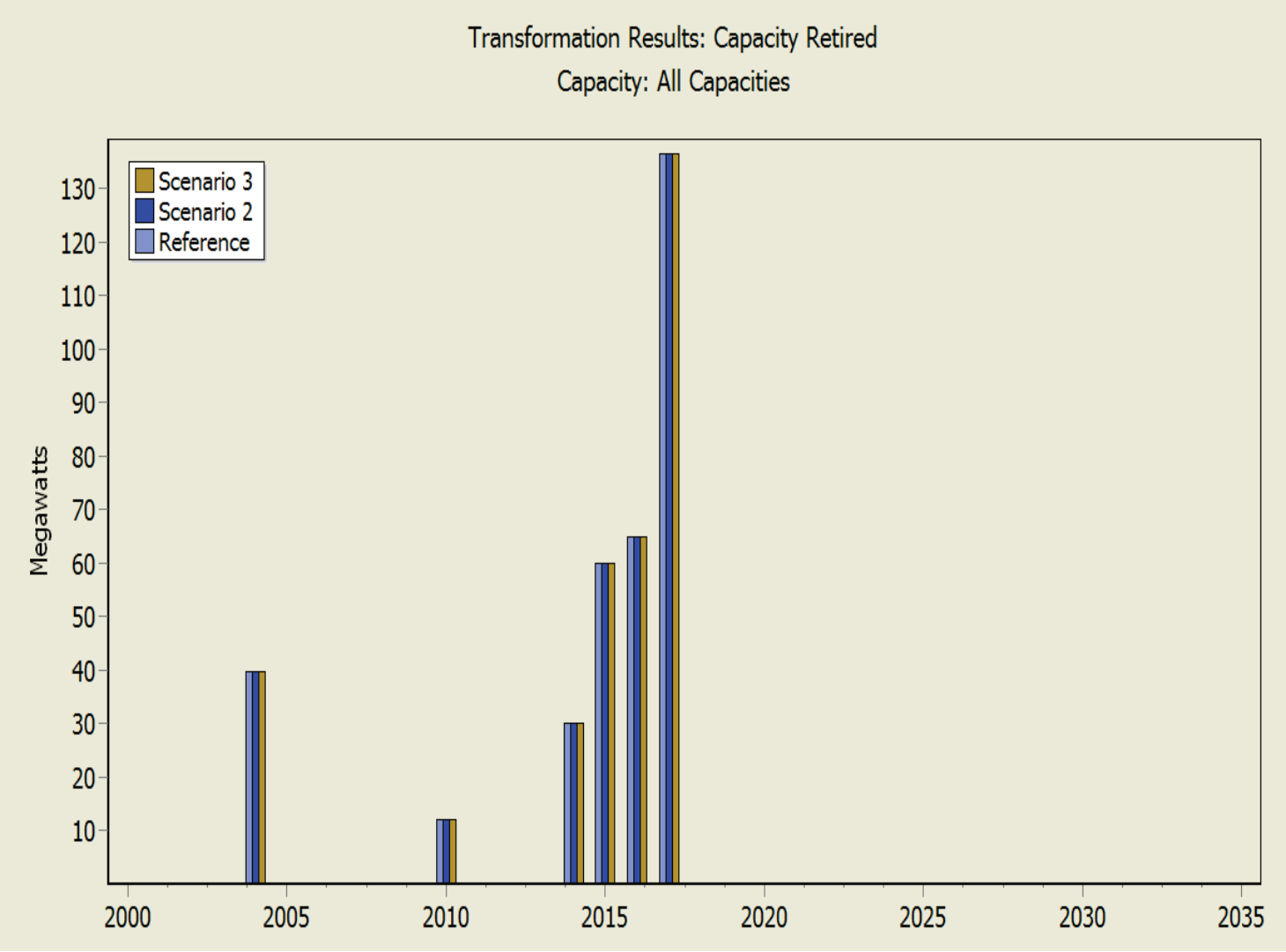


Figure 3-36 Percentages of Fuel Types in the Reference, *S2* and *S3* Scenarios

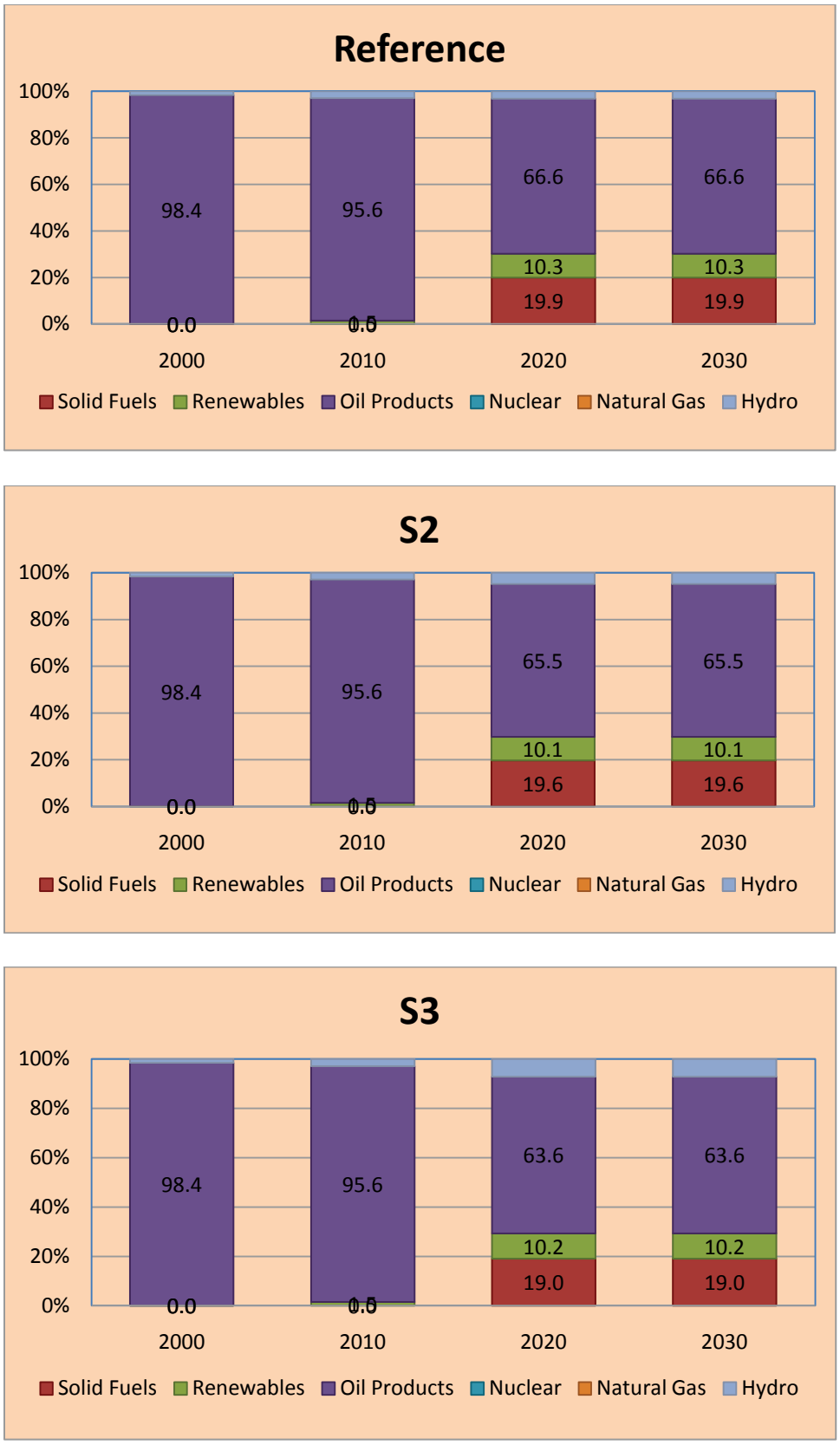


Figure 3-37 Final Energy Demand All Fuels (Grouped): Reference Scenario

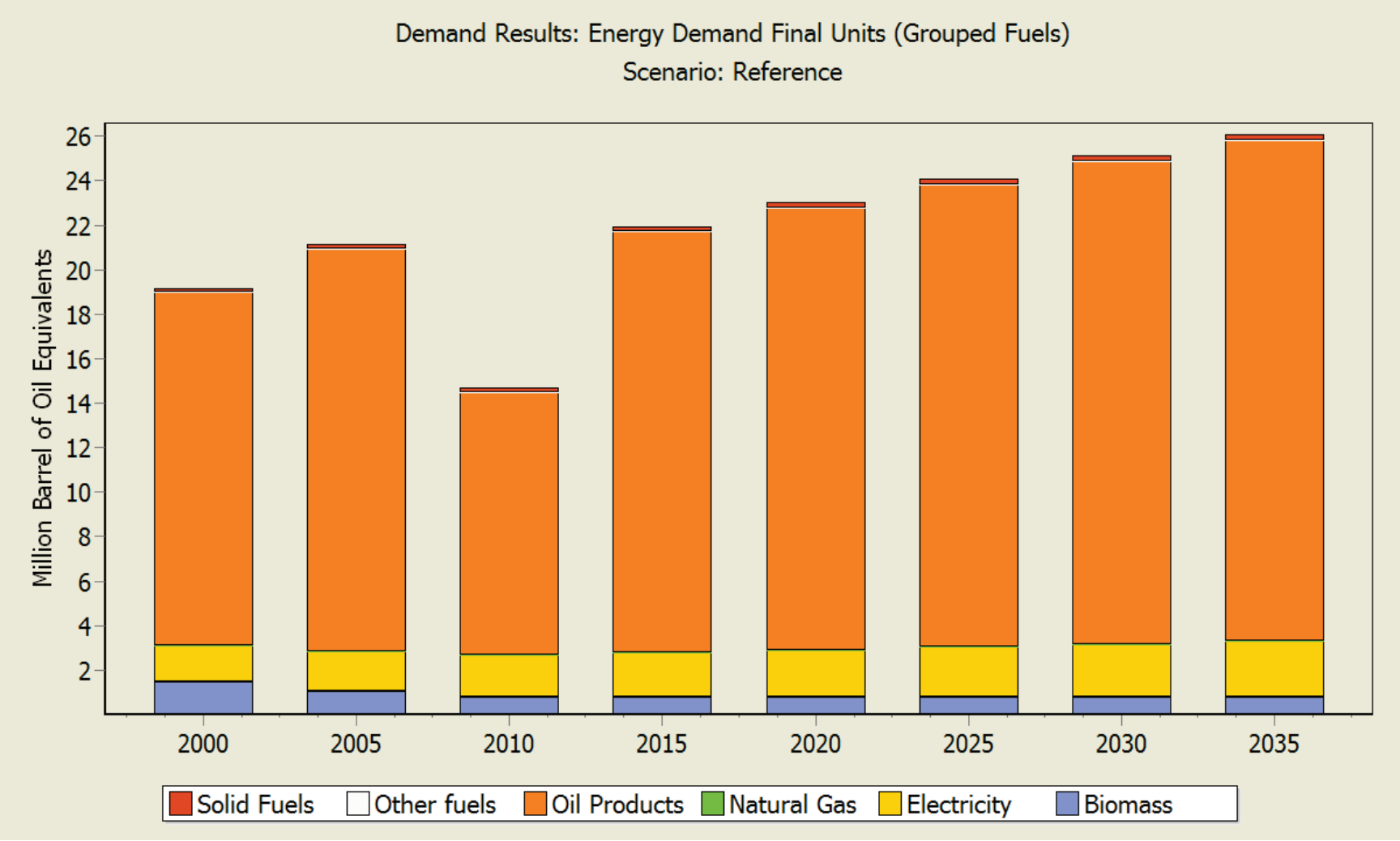


Figure 3-38 Final Energy Demand All Fuels: Scenario *S2* (Coal)

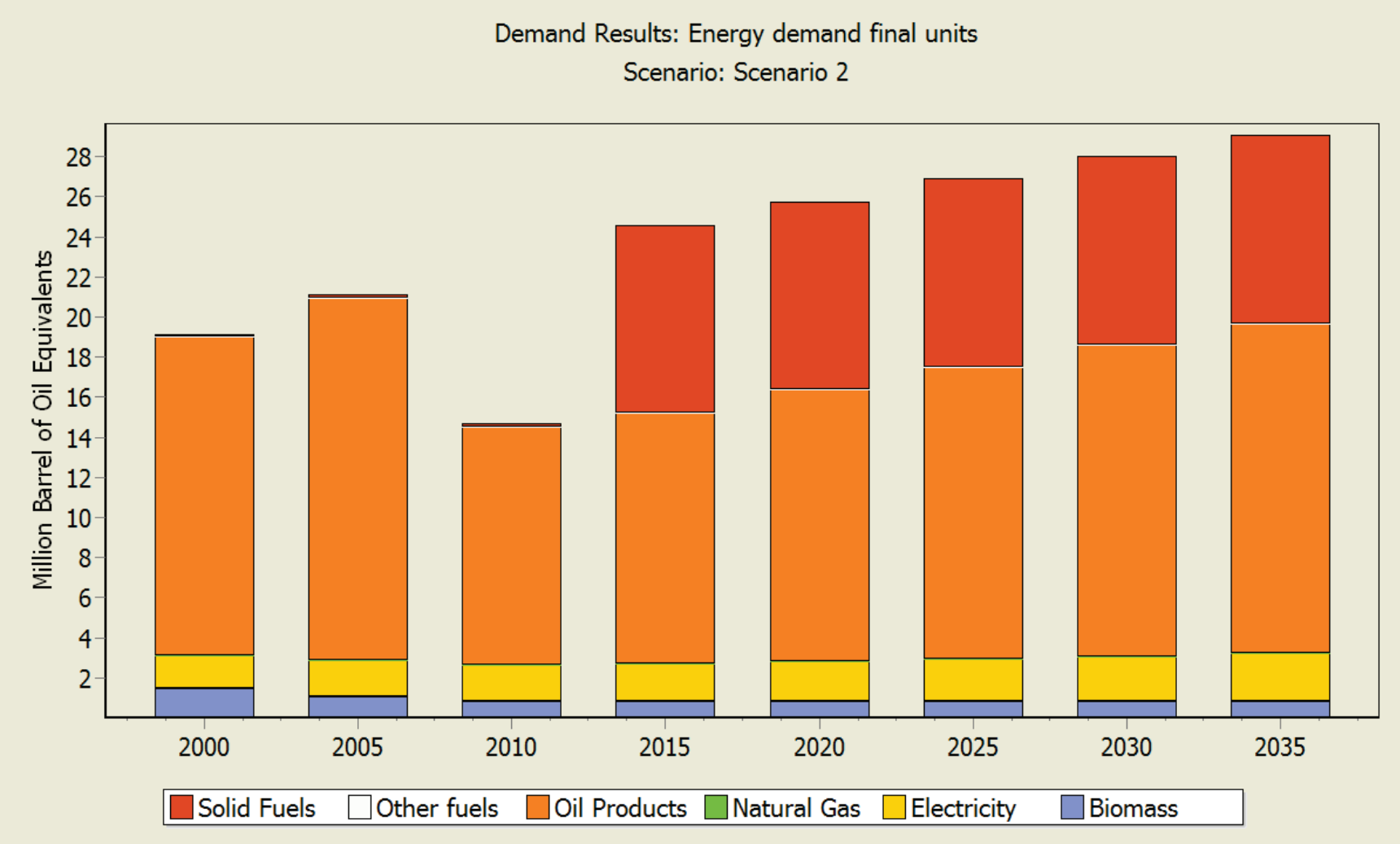


Figure 3-39 Final Energy Demand All Fuels: Scenario *S2 NG* (Natural Gas for Power, Alumina, Vehicles)

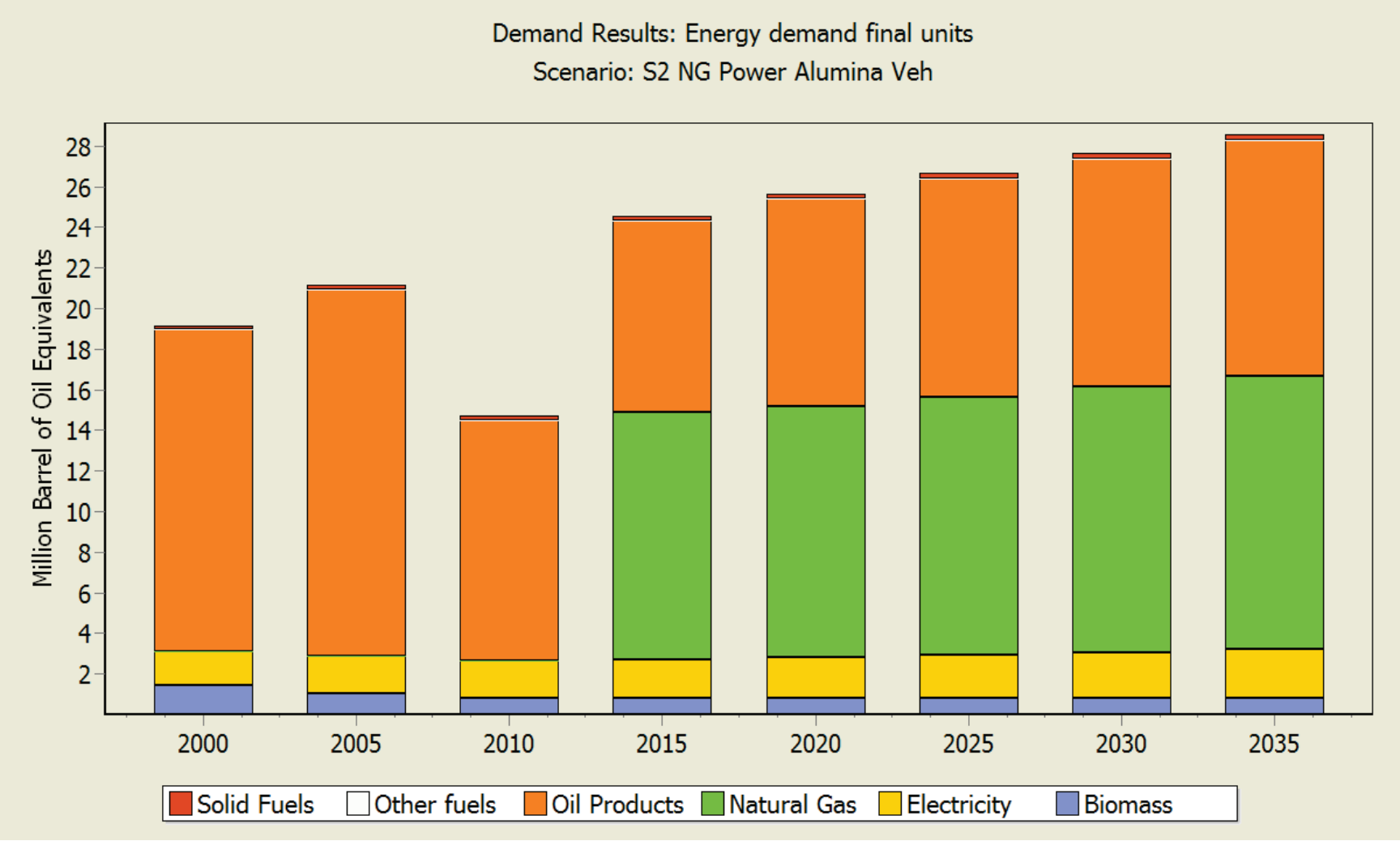
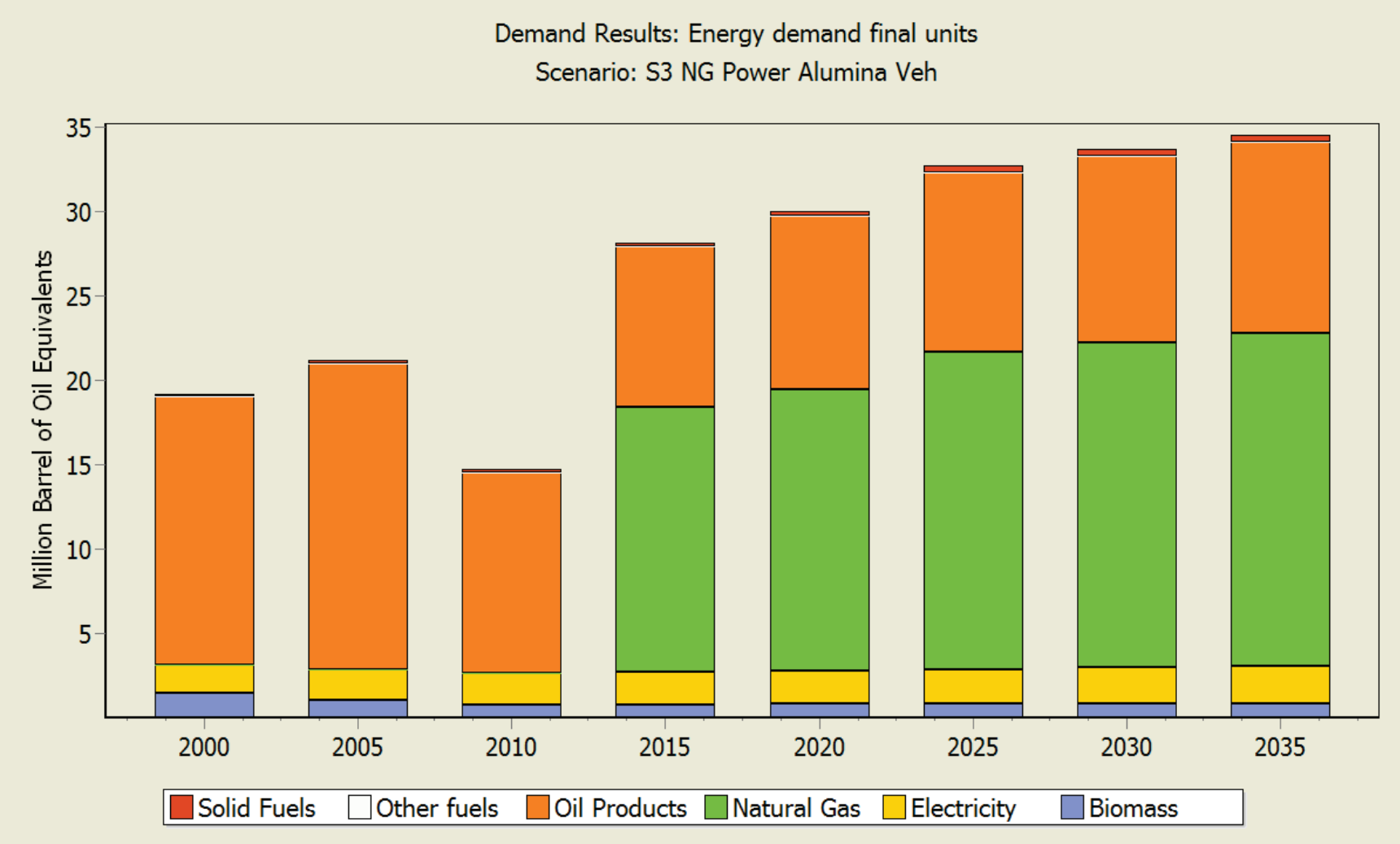


Figure 3-40 Final Energy Demand All Fuels: Scenario *S3 NG* (Natural Gas for Power, Alumina, Vehicles)



Refinery Outputs

The refinery outputs (any including imports) to meet the demand are shown in Figures 3-41 to 3-45 for the *Reference*, *S2, S2 NG, S3* and *S3 NG* respectively. These scenarios all show changes in the fuel requirements (especially for diesel and HFO) relative to the Reference scenario.

3.6 SUMMARY OF HOW MEASURES AFFECT CO_2 EMISSIONS BETWEEN 2000 AND 2035

For all scenarios, the percentage changes in the non-biogenic CO_2 emissions in 2035 relative to the year 2000 (see equation 3-1) for the overall demand, transformation and non energy sector categories provide a measure of the impacts of factors (activity and energy intensity related) that affect emissions.

$$\Delta CO_2 = \left(\frac{E_{2035} - E_{2000}}{E_{2000}}\right) \times 100 \qquad \text{..... 3-1}$$

where E_{2000} and E_{2035} are respectively the CO_2 emissions in 2000 and 2035.

These percentage changes for each scenario are summarized in Figure 3-46. Also included in the figure are the percentage changes for branches in these categories. Note that in the case of electricity use and other secondary fuel use in the demand branches, the emissions occurring in the various Transformation modules are allocated back to the demand branches.

Overall Demand

The left-most grouping in Figure 3-46 shows ΔCO_2, the percentage changes in CO_2 emissions 2035 relative to 2000 for the overall demand in all scenarios. The overall CO_2 emissions in the energy demands for the reference (*Ref*), *S2* and *S3* scenarios increase by 29%, 52% and 98% respectively. This is consistent with the general increase in CO_2 generating (and energy consuming) activities because of population increases, fleet increases and increased bauxite and alumina production. These scenarios all entail additional coal fired electricity generation whose emissions easily outweigh the emission reductions from the much smaller additions of wind and hydro generating stations. In addition *S3* also includes a major expansion in alumina refining capacity.

The major mitigation measure is the introduction of natural gas (scenarios *S2*NG, *S3*NG and *S3 NGNU*) and a nuclear plant in conjunction with natural gas in scenario *S3*NGNU. Because of these measures, the CO_2 emissions in these scenarios are lower than those in the corresponding *S2* and *S3* scenarios.

Cement Kiln Demands

Changes in CO_2 emissions due to cement kilns are driven primarily by increased clinker production. The completion of the new kiln in 2008 resulted in a major improvement in energy efficiency and those changes are therefore present in all scenarios. Note that since the electrical energy use in the cement mills is small (1.8% to 3.5%) relative to the energy used in clinker production a grouping for cement mills is not included in Figure 3-46.

Figure 3-41 Transformation Outputs: Refinery Fuels Outputs (thousand boe): Reference Scenario for Selected Years

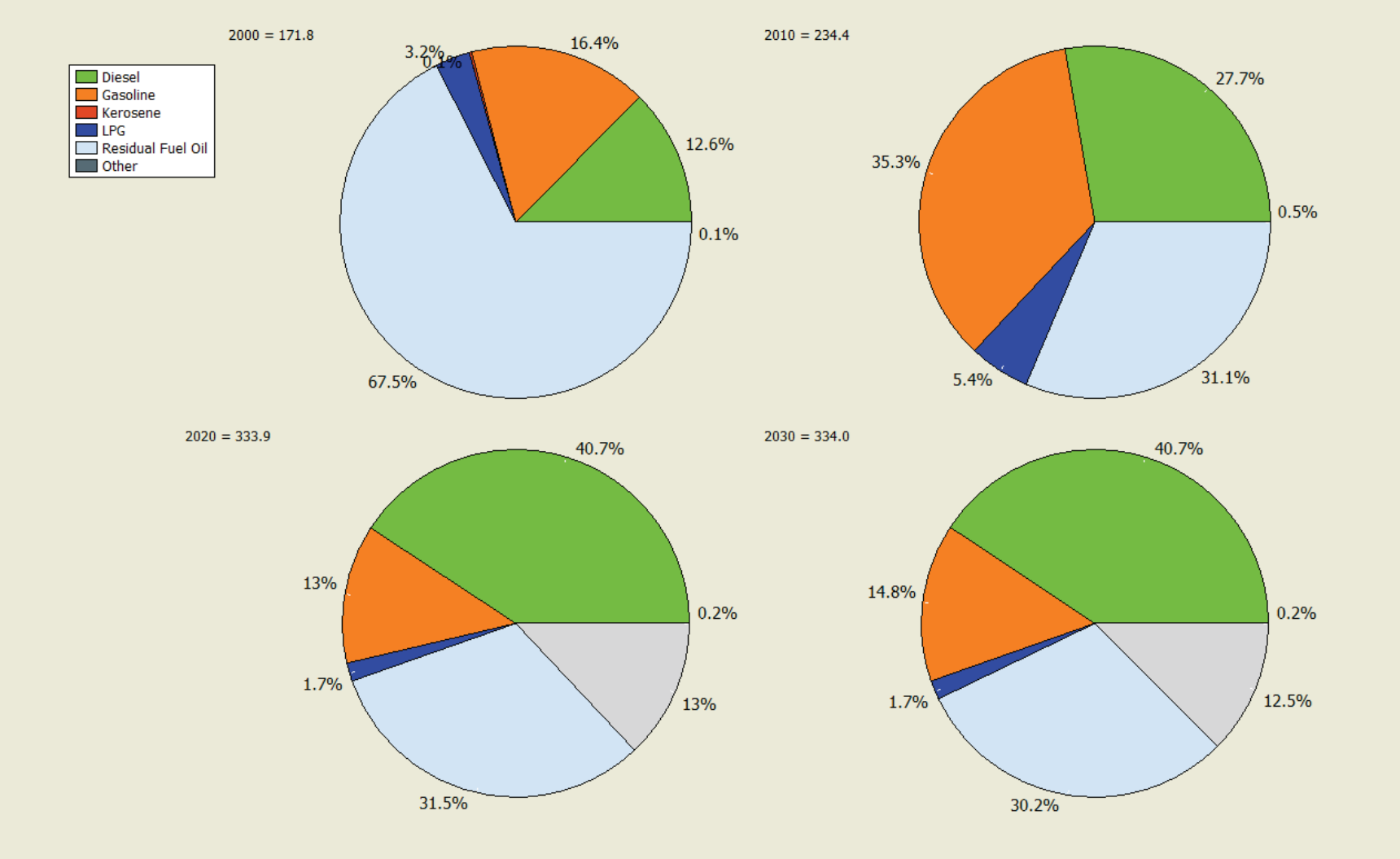


Figure 3-42 Transformation Outputs: Refinery Fuels Outputs (thousand boe): Scenario *S2* for Selected Years

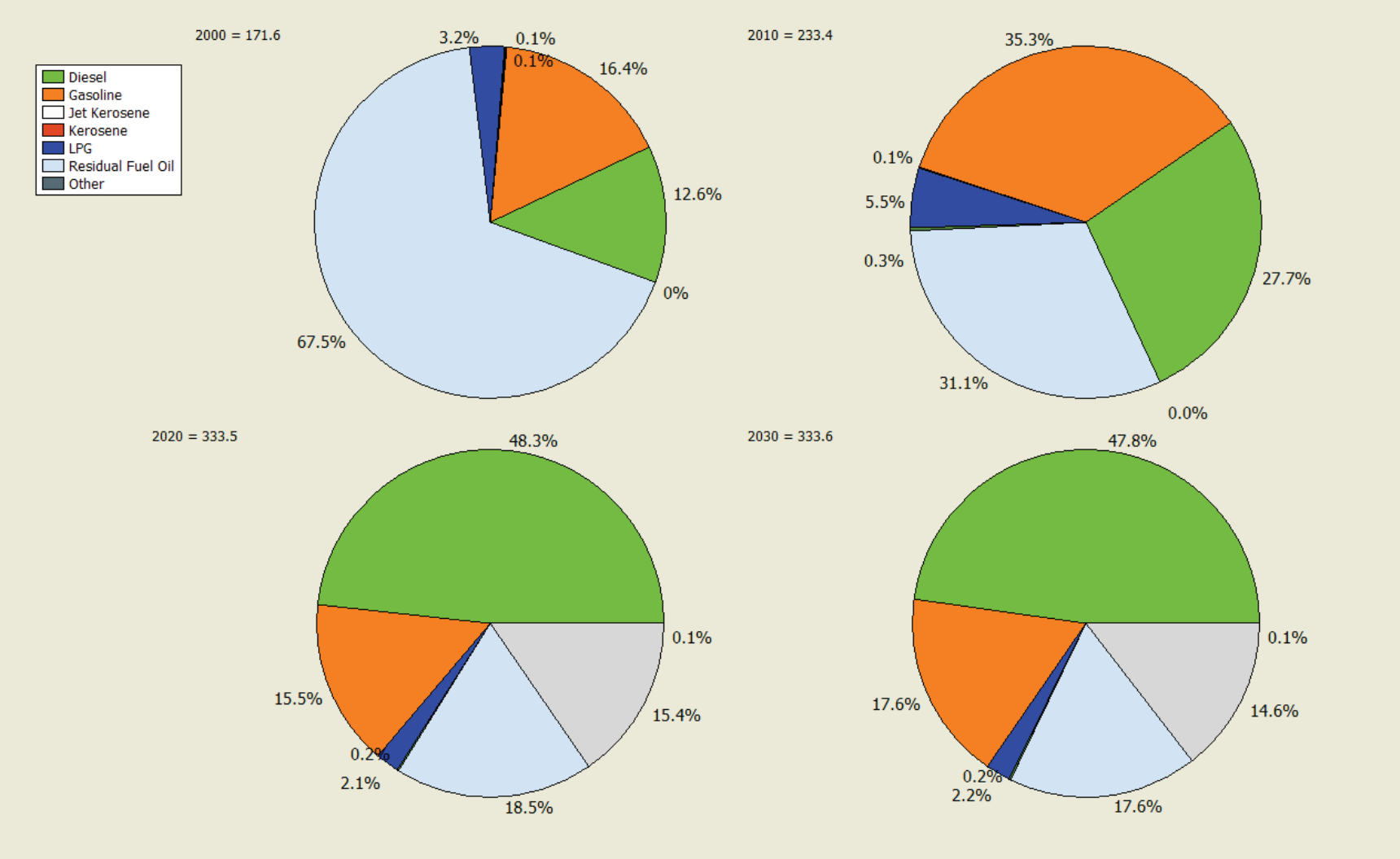


Figure 3-43 Transformation Outputs: Refinery Fuels Outputs (thousand boe): Scenario *S2 NG* for Selected Years

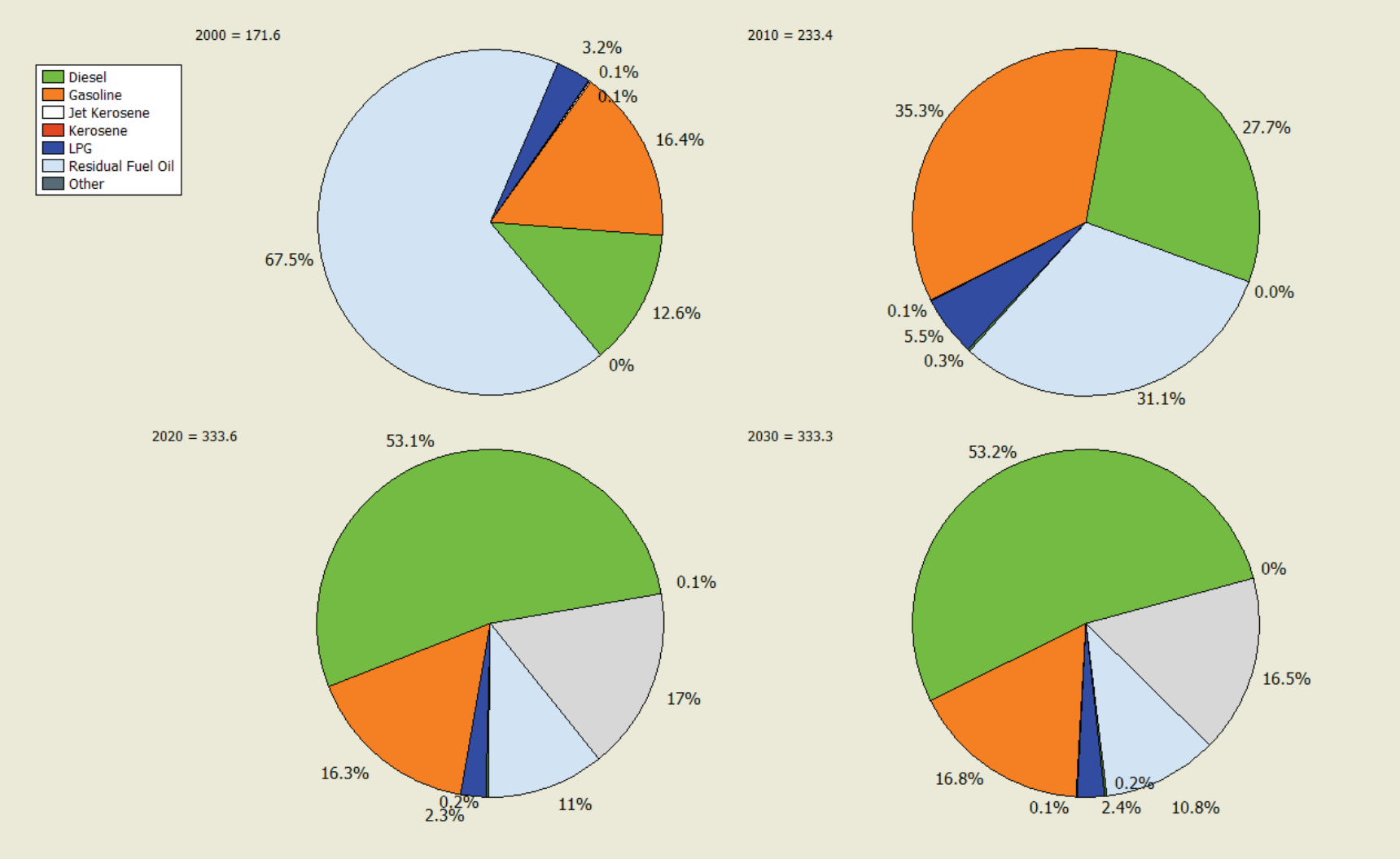


Figure 3-44 Transformation Outputs: Refinery Fuels Outputs (thousand boe): Scenario *S3* for Selected Years

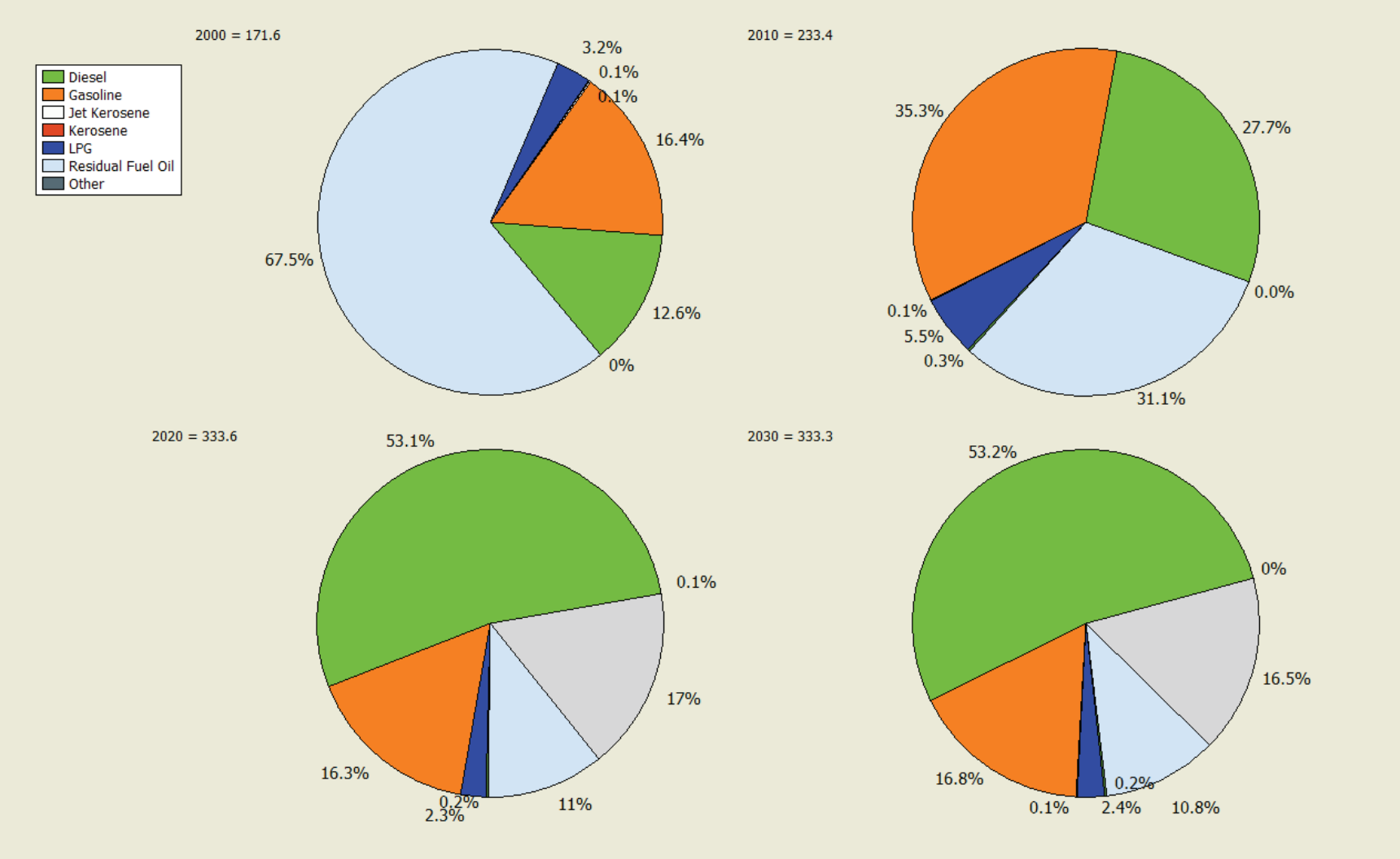
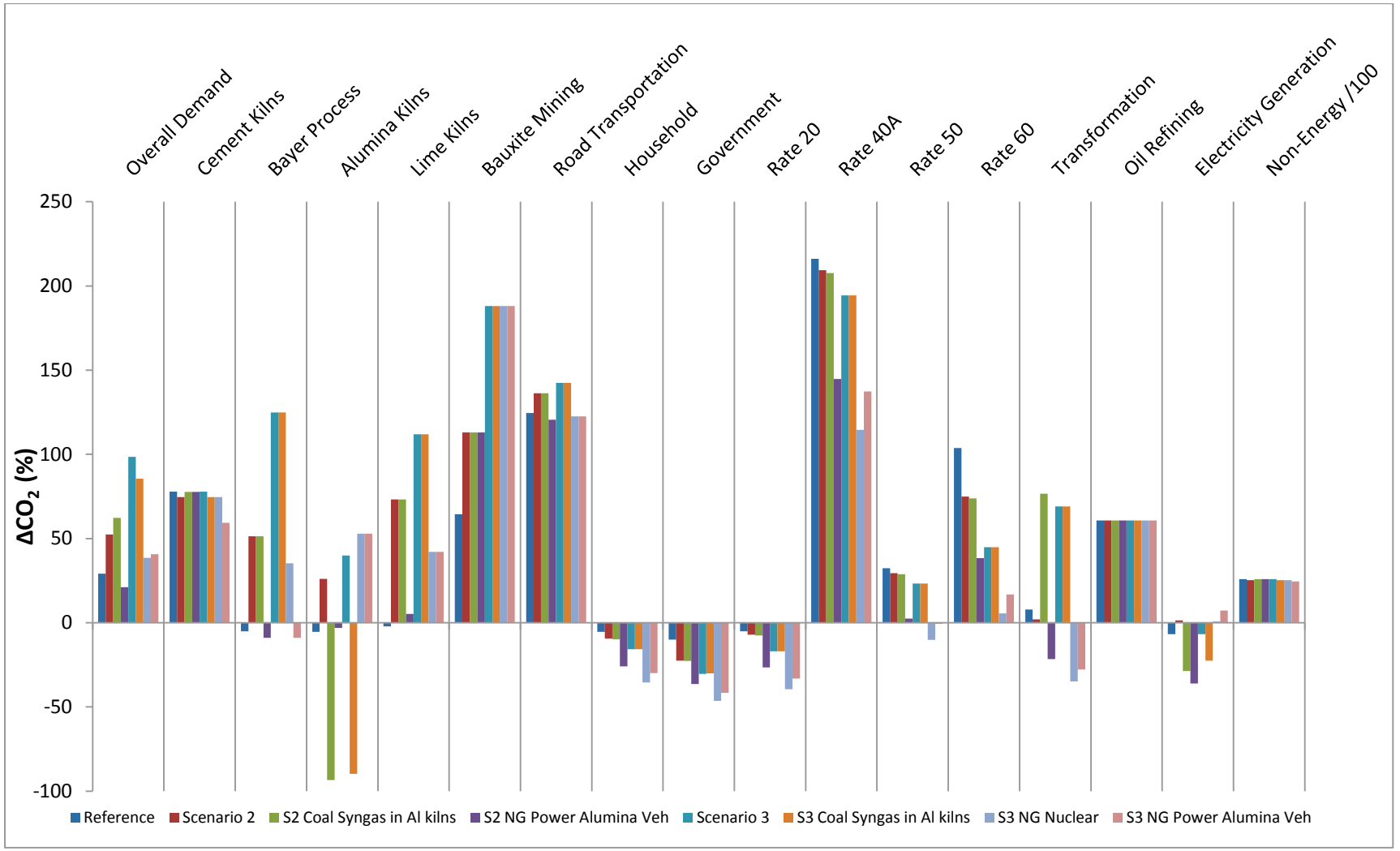


Figure 3-45 Transformation Outputs: Refinery Fuels Outputs (thousand boe): Scenario *S3 NG* for Selected Years

Figure 3-46 Summary of ΔCO_2, (Percentage Changes in CO_2 Emissions in 2035 Relative to 2000) for Overall Demand, Transformation and Their Major Categories For Mitigation Assessment Scenarios



Bayer Process, Alumina Kiln and Lime Kiln Demands

The emissions from the Bayer process and alumina and lime calcination that entail using coal (*S2*, *S2* coal+Syngas, *S3* an d*S3* coal syngas) all result in increased emissions relative to the reference scenario and also the *S3* scenarios having higher emissions than the corresponding *S2* ones because of increased alumina production in the *S3* scenarios.

The mitigation measure due to the use of natural gas in scenarios *S2* NG and *S3* NG and *S3* NGNU all dramatically reduce the CO_2 emissions relative to the corresponding scenarios in which coal is used.

Similar patterns occur in the case of lime and alumina kilns but the reduction is more dramatic in alumina kilns since alumina kilns cannot use coal directly (syngas is used).

In the case of bauxite mining, no change in fuel is contemplated in any scenario and hence emissions increase monotonously with production. It should be noted that the vertical axis in Figure 3-46 is a percentage change and does not reflect absolute emissions.

Household Demand

The CO_2 emissions for the household and government demand show reduced emissions in 2035 relative to 2000 for all scenarios. Although there is population increase (and hence an increase in the number of households or JPS customers) the increased demand because of this is more than offset by more energy efficient appliances, mitigation (energy conservation) measures and lower CO_2 emitting electricity generation when natural gas is used. [Remember that the CO_2 emissions for electricity demand are estimated by allocating the emissions to transformation activities.]

Government Demand

The mitigation measures in the hospitals and NWC as well as a government program to reduce electricity consumption by 15% together lead to the overall reduction in CO2 emissions for all scenarios in the Government category.

Rates 20, 40A, 50 and 60 Categories Demands

No significant mitigation measures have been proposed for these rate categories. Estimates for the changes in energy demand are limited by a lack of information on the types of energy end use equipment and/or a knowledge of the distribution of activities (for example based on a knowledge of industrial classification – i.e., Jamaica Industrial Classification (JIC) Codes - for these customers) on which end use demand estimates could be made. The most notable percentage reduction in CO_2 emission projections is for the street lighting (Rate 60) due to the introductions of energy efficient street lighting (see Figure 3-46).

TRANSFORMATION

The overall changes in CO_2 emissions for transformation processes reflect the introduction of natural gas (lower CO_2 emissions in 2035 relative to 2000 for the scenarios in which natural gas is used for electricity generation.

The CO_2 emissions from oil refining show no variation across scenarios since all assume the refinery upgrade takes place.

The pattern for CO_2 emissions from electricity generation alone also reflects the introduction of natural gas (lower emissions in 2035 than in 2000 for scenarios *S2* NG, *S3*NG and *S3*NG NU).

NON ENERGY SECTOR EMISSIONS

The non energy sector emissions (which are ~2500 times higher in 2035 than in 2000) are dominated by the process emissions from the use of petcoke in electricity generation which is present in all scenarios (Note that the data for the non energy sector emissions are divided by 100).

4. MITIGATION ACTIVITIES FOR IMPLEMENTATION

This section

- describes the main and supporting energy sector institutions, policies and legislation that will facilitate the implementation of mitigation activities;
- indicates the main requirements for implementing mitigation measures;
- identifies some of the gaps, and;
- provides specific recommendations for implementing some of the mitigation measures.

The key institutions involved in climate change mitigation are the same as those that are involved in the energy sector and in the implementation of Jamaica's National Energy Policy. Goal 5 of the Energy Policy speaks to Jamaica having a well-defined and established governance, institutional, legal and regulatory framework for the energy sector that facilitates stakeholder involvement and engagement. The policy also plans to ensure that the (energy sector) institutional framework includes mechanisms for improved coordination and organization between and within energy agencies and capacity building to meet the human resource needs.

Since climate change and mitigation issues affect nearly all public and private sector institutions and every facet of life, it will be necessary to focus on those institutions and their policies and legislation under whose portfolios there are highest GHG emissions and opportunities for mitigation. The highest GHG emissions occur in the transport, transformation (electricity generation and petroleum refining) and the mineral processing (alumina and cement manufacture) sectors and so focus initially will be on the institutions directly associated with these sectors. Implementation of mitigation activities invariably will need facilitating and supporting roles from other institutions to provide suitable financial incentives, assessment and analysis of outcomes, public relations and public education for example. These institutions and the existing policies and legislation are described below in order to identify issues that could present barriers and/or facilitate implementation of GHG mitigation activities.

A detailed analysis of the existing energy sector institutions is beyond the scope of the assessment but it is noted that the Energy Policy includes strategies to review and modify the existing institutional framework and industry structure as well as the legal and regulatory frameworks for the energy sector.

4.1 ENERGY SECTOR INSTITUTIONS, POLICIES AND LEGISLATION

4.1.1 KEY INSTITUTIONS DIRECTLY INVOLVED IN GHG MITIGATION

Ministry of Energy and Mining (MEM)

The Ministry of Energy and Mining (MEM) has the dual responsibilities of articulating Jamaica's National Energy Policy and coordinating the monitoring of its implementation. The Ministry along with its agencies is responsible for establishing the legislative and policy

framework to facilitate the achievement of Jamaica's national energy goals, which have implications for the mitigation activities and projections outlined in this assessment. It also provides the necessary guidelines for its agencies for general medium and long-term energy strategy planning.

MEM in collaboration with its agencies and several other Government entities as well as other partners and stakeholders in the public and private sectors is also leading the development of a carbon trading policy[25].

The Ministry in setting indicators and targets for the energy sector will also be mindful of the mitigation activities as well as the projections and take into account key issues such as need for the use of cleaner technologies in industry as well as enabling a more efficient energy sector in general as well as leading various initiatives for the diversification of energy.

Petroleum Corporation of Jamaica (PCJ)

The Petroleum Act of 1979 established PCJ as a Statutory Corporation, under the Ministry of Mining and Energy with the exclusive right to explore for oil, to develop Jamaica's petroleum resources and to enter all stages of the petroleum industry. The PCJ Group has subsidiaries Petrojam Limited, which operates the oil refinery, Petrojam Ethanol Limited, Petcom Limited, the marketing and retailing company, Jamaica Aircraft Refuelling Services and Wigton Windfarm Limited.

The Petrojam refinery is the only refinery in Jamaica and together with privately owned petroleum marketing companies they supply refined petroleum products for the Jamaica market.

PCJ works proactively to assist with implementing Jamaica's National Energy Policy while promoting sustainable development, not only in energy, but also in other areas of national importance with the aim of fostering energy security. PCJ in its role of undertaking the development and promotion of Jamaica's indigenous energy resources and all forms of renewable energy will have a fundamental role in Jamaica's mitigation efforts especially as it relates to the introduction of as much as 20% renewables in the energy mix by 2030. Towards this end, as of November of this year (2009), all of Jamaica's gasoline will be based on E10.

In 2006, PCJ established a Centre for Renewable Energy (CERE) to support the research, promotion and development of renewable fuels and electricity from renewable sources for the Jamaican market. CERE plans to partner with tertiary institutions and collaborate with government and private sector agencies that strike the proper balance between environmental protection, economic growth and the demonstration of renewable energy sources.

Jamaica Bauxite Institute (JBI)

The bauxite and alumina sector is the largest end user of energy in Jamaica accounting for just over 37% of Jamaica's energy demand in 2008. The sector currently (2009) has one operating alumina refinery (Jamalco) and one company that mines and exports bauxite.

Three alumina plants (Alumina Partners (Alpart) and two Windalco plants (Kirkvine and Ewarton) were closed in 2009. The Jamaica Government owns 45% of the Jamalco, 7% of the Windalco and 51% of the St Ann Jamaica Bauxite Partners (SAJBP) operations.

JBI was established in 1976 as an arm of the Jamaica National Investment Company (now the Development Bank of Jamaica (DBJ), to deal mainly with the sovereign aspects of the Government's participation in the bauxite and alumina industry.

JBI's functions include:

- monitoring and studying the aluminium industry;
- providing technical advice;
- undertaking research and development activities;
- assessing and ensuring rationalisation in the use of Jamaica's bauxite reserves and (bauxite) land; and
- monitoring and making recommendations on pollution control and other environmental concerns in the industry.

JBI also manages the Bauxite Community Development Programme (BCDP), which involves implementation of development projects within the vicinity of bauxite and alumina operations, to foster harmony between the community and the companies.

JBI works in collaboration with other agencies, and is proactive in attaining compatibility between the industry's operations (processes, activities and products) and the environment by:

- ensuring that the operations are conducted with minimal or no adverse impact on the environment;
- ensuring compliance with all local standards and regulations through maintaining a regular and effective monitoring programme;
- conducting regular reviews on the environmental performance of the industry and instituting the necessary corrective actions;
- promoting research and development aimed at identifying new technologies for a cleaner, more efficient production process and waste minimization; and
- fostering and maintaining a harmonious relationship with communities in the vicinity of bauxite/alumina operations.

Electricity Generating Companies

Jamaica's electricity is generated by the Jamaica Public Service Company Limited (JPS) and privately owned, independent power producers (IPPs) – Jamaica Energy partners (JEP) and Jamaica Private Power Company (JPPC). JPS was initially privately owned until 1970 when the Government of Jamaica (GOJ) acquired controlling interest in JPS. In 2001, GOJ retained 20% of the company and sold the remainder of its holdings to Mirant which in 2007 sold its majority shares to Marubeni Caribbean Power Holdings (MCPH) Inc, a subsidiary of Marubeni Corporation of Japan. In early 2009, Marubeni transferred 50% of its shares in MCPH to Abu Dhabi National Energy Company (TAQA) of the United Arab Emirates.

JPS uses steam (heavy fuel oil-fired), gas turbines, combined cycle, slow speed diesel engines and hydropower while the independent power producers (IPPs) use slow/medium speed diesel engines and wind turbines. JPS also purchases power from one supplier (Jamalco) that uses cogeneration. In 2008, the generating capacities of JPS and the independent power producers were 621 MW and 89 MW respectively. The bauxite and alumina companies and sugar factories also generate electricity for their own use.

JPS is the sole distributor of electricity to a customer base of over 600,000. While JPS has the exclusive right to under its Licence "to transmit, distribute and supply electricity throughout Jamaica" until 2021, effective April 2004 the Licence provides for the addition of generating capacity through a competitive process.

Office of Utility Regulation (OUR)

The OUR was established by an Act of Parliament in 1995 to regulate the operations of utility companies in Jamaica. The OUR is responsible for regulating the provision of electricity, telecommunications, water & sewerage, public transportation by road, rail and ferry services. The main objectives of the OUR are to:

- ensure that consumers of utility services enjoy an acceptable quality of service at reasonable cost;
- establish and maintain transparent, consistent and objective rules for the regulation of utility service providers;
- promote the long-term efficient provision of utility services for national development consistent with Government policy;
- provide an avenue of appeal for consumers who have grievances with the utility service providers;
- work with other related agencies in the promotion of a sustainable environment; and
- act independently and impartially.

OUR makes utilities' rate applications and supporting information publicly available and this was a key source of information on the electricity generating sector for this mitigation assessment. OUR also sets the regulatory policy to guide the process for the addition of new generating capacity to the public electricity supply system. Currently, contractual arrangements (i.e., the Power Purchase Agreement (PPA) between the parties) for the supply of power is negotiated between JPS and the investor supplying power but the PPA must be approved by the OUR before being made effective.

Ministry of Transport and Works (MTW)

MTW's primary responsibility is for Jamaica's land, marine and air transport as well as the main road network, including bridges, drains, gullies, embankments and other such infrastructure. MTW has regulatory responsibility for the safety of all publicly or privately operated modes of transportation. This includes airports, aerodromes, airline operators, seaports, shipping traffic, public land transportation as well as road infrastructure and road safety. The infrastructure includes a 15,394 km road network, 330km of rail track, a large

fleet of public passenger buses, two international airports, four domestic aerodromes and ten specialised seaports and three public deep-water ports.

There are currently twenty-one reporting entities that assist the Ministry in fulfilling its mandate. Included among them are the Transport Authority (TA), the Island traffic Authority (ITA), the Civil Aviation Authority (CAA), Airports Authority of Jamaica and the Port Authority of Jamaica (PAJ). The Jamaica Urban Transit Company (JUTC) and the Montego Bay Metro Bus Company (MBM) respectively operate public passenger transport services in the Kingston Metropolitan Transport Region (KMTR) and the Montego Bay.

The Transport Authority regulates licensing of all public and commercial vehicles and the regulating and monitoring of public transportation. The Island Traffic Authority administers the provisions of the Road Traffic Act, and is responsible for the testing of vehicles to ensure fitness, road-worthiness and general compliance with standards of safety. Vehicle registration information for the entire vehicle fleet is maintained by the Inland Revenue Department in the Ministry of Finance and the ITA and TA also have additional data relating to their areas of jurisdiction.

4.1.2 Supporting Energy Sector Institutions and Agencies

Office of the Prime Minister (OPM)

OPM is currently the ministry responsible for the environment and the Environment Management Division is housed in OPM. The last Designated National Authority for the Clean Development Mechanism (CDM) was within the EMD but due to the wording of the DNA assignment and a change in ministerial assignment for EMD the DNA needed to be reassigned. Among the agencies reporting to OPM are the National Environment and Planning Agency (NEPA), National Solid Waste Management Authority (NSWMA), the Statistical Institute of Jamaica (STATIN), the Planning Institute of Jamaica (PIOJ) and the Meteorological Service.

NEPA is the agency entrusted with managing Jamaica's natural and the man-made environment and is the lead government agency responsible for environmental management and spatial planning in Jamaica.

NSWMA is responsible for establishing the standards and criteria that must be attained by operators in the solid waste sector and for the collection and disposal of municipal solid waste. NSWMA currently operates eight waste disposal sites in seven parishes that serve the entire country.

STATIN's main functions are:

- to collect, compile, analyse, abstract and publish statistical information relating to the commercial, industrial, social, economic and general activities and condition of the people;
- to collaborate with public agencies in the collection, compilation and publication of statistical information including statistical information derived from the activities of such agencies;

- to take any census in Jamaica; and
- generally to promote and develop integrated social and economic statistics pertaining to Jamaica and to co-ordinate programmes for the integration of such statistics, in accordance with the provisions of the Statistics Amendment Act (1984).

PIOJ is the foremost planning agency of the government and its functions as stipulated in the PIOJ Act include:

- Initiating and coordinating the development of policies, plan and programmes for the economic, financial, social, cultural and physical development of Jamaica
- Undertaking research on national development issues
- Providing technical and research support to the Cabinet
- Undertaking consultant activities for local and foreign Government entities
- Managing external cooperation agreements and programmes
- Collaborating with external funding agencies in the identification and implementation of development projects
- Maintaining a national socio-economic library

National Meteorological Service

The Meteorological Service – an agency under the Office of the Prime Minister is the focal point of climate change in Jamaica.

The Ministry of Finance and the Public Service

The Ministry of Finance and the Public Service has responsibility for the macro-economy which includes implementing tax related incentives/disincentives for the development of all sectors including the energy sector. The Inland Revenue Department maintains the database with registration information for the licensed motor vehicle fleet.

Forestry Department

The Forestry Department is an Executive Agency of the Ministry of Agriculture and is the lead agency responsible for the management and conservation of Jamaica's forests. Its functions are mandated by the Forest Act, 1996 and are aimed at managing forests on a sustainable basis to maintain and increase the environmental services and economic benefits forests provide. A National Forest Conservation and Management Plan and the Strategic Forest Management Plan 2009 – 2013[26] among other things describe the Department's policy and legal framework, forest management constraints, forest values, the current state of Jamaica's forests and establish goals and a wide range of implementation forest management strategies and activities.

Jamaica Bureau of Standards (BSJ)

BSJ is a statutory body established by the Standards Act of 1968. Its main functions are formulating, promoting and implementing standards for goods, services and processes. The Bureau develops and enforces technical regulations for those commodities and practices which affect health and safety. It is the agency that sets fuels specifications.

Government Electrical Inspectorate

The Government Electrical Inspectorate (GEI) in the Ministry of Industry, Investment and Commerce is the government agency with responsibility for certifying all electrical installations, to ensure that they meet the required standards. GEI certification is needed for all new constructions, for premises that have been rewired or which have undergone any kind of renovation.

4.1.3 KEY POLICIES AND LEGISLATION

4.1.3.1 Policies

Vision 2030 Jamaica: National Development Plan provides the overarching context within which Jamaica's mitigation activities will take place. Under Vision 2030 Jamaica: National Development Plan, two national strategies - *Develop measures to adapt to climate change* and *Contribute to the effort to reduce the global rate of climate change* - specifically speak to the strategies and actions that Jamaica will employ to reduce its greenhouse gas emissions to 2030. Vision 2030 articulates, *"Mitigation, through reducing greenhouse gas emissions, will be addressed through greater energy conservation. Energy conservation in Jamaica will put us in a "win-win" situation as it provides other substantial positive economic, social and environmental benefits. As described earlier in National Outcome 10 of the Plan, energy conservation efforts, use of cleaner technologies and development of alternate energy will result in lower spending on imported oil, less pollution and reduction in pollution-related illnesses. We will engage in reforestation to increase the amount of greenhouse gases removed from the atmosphere, provide improved watersheds and waterways and reduce landslides and soil erosion. These measures (energy conservation and reforestation), if pursued on a global scale, will mitigate and reduce the global rate of climate change".*

Other policies and legislation to which Jamaica's greenhouse gas mitigation activities will be governed include the following.

Jamaica's National Energy Policy 2009 - 2030 defines a strategic framework and comprehensive goals to 2030 and beyond, that address both supply and demand energy issues the country faces and places priority attention on seven key areas:

1. Security of Energy Supply through diversification of fuels as well as development of renewables
2. Modernizing the country's energy infrastructure
3. Development of renewable energy sources such as solar and hydro
4. Energy conservation and efficiency
5. Development of a comprehensive governance/regulatory framework
6. Enabling government ministries, departments and agencies to be model/leader for the rest of society in terms of energy management
7. Eco-efficiency in industries

Each of these seven priority areas, when implemented will reduce Jamaica's GHG emissions and they have been included in this mitigation assessment. Other policies to be developed include the Renewable Energy Policy, the Biofuels Policy and the Energy Conservation and

Efficiency Protocol (ECE) for the management and use of energy in the public sector. The ECE speaks to the operation of public sector facilities and entities. All of the aforementioned policies when implemented will help in the reduction of GHG emissions.

Jamaica's Draft Carbon Emissions Trading Policy (2009) sets out a comprehensive framework for Jamaica's participation in the carbon trading market. It presents Government's positions, defines investment priorities, establishes the institutional and legal framework and facilitates structures necessary for the effective management of the regime involving the participation of all sectors in a manner that is mutually beneficial to all. The overarching objective of this draft policy is to position Jamaica to capitalize further on other opportunities for partnerships with other developed countries, private organizations, as well as relevant regional or international institutions. This will generate social, economic and environmental benefits for the country through investment in initiatives that will foster our sustainable development goals.

The OUR issued the **Regulatory Policy for the Addition of New Generating Capacity to the Public Electricity Supply System** that guides the process for the addition of new generating capacity to the Jamaican electricity grid. The policy is a necessary complement to the ***All Island Electric Licence, 2001*** which gives JPS the exclusive right to transmit and distribute electricity and as of 2004, the right to compete with other electricity producers for the opportunity to develop new generation capacity. This OUR policy has accompanying schedules that detail the procedures by which capacity can be added to the system and it is intended to facilitate the long term expansion of generation at the least economic cost while giving due regard to the relevant policies and applicable legislation. According to the policy, the addition of new capacity to the grid can be achieved by:

- the installation of conventional technologies,
- the utilization of renewable sources, and;
- the setting up of co-generation installations

The **Policy on Environmental Stewardship of Government Operations** has been drafted as part of the Government of Jamaica's goal of enabling GOJ entities to become more efficient in their operations, generating significant cost savings while eliminating or minimizing adverse impacts on the environment. The Environmental Stewardship Policy speaks to among other things, Energy Conservation, Water Conservation and Fleet Management - aspects of government operations that have an impact on the overall use of energy.

The **National Transport Policy** (draft) is designed to encourage measures such as energy conservation, including: efficient traffic management; car pooling; park and ride; use of clean fuels to minimize pollution; flexi-work hours and tele-commuting; an efficient public/urban mass transit transport system; and use of non-motorized transport; and, promoting vehicle and road maintenance programs. Supporting legislation and infrastructure for use of biofuels will be put in place. The transport policy also will encourage more efficient modes of transport such as barges especially for bulky materials like aggregates. The possibility of enhanced coastal and rail transport will be kept under constant review. The policy foresees that once natural gas is introduced into Jamaica's

energy supply mix, the transport fleets, where applicable, will be converted to CNG and in the longer term a CNG supply network will be developed to enable private motorists to convert to natural gas based motor vehicles.

4.1.3.2 Legislation

The agencies and institutions described in Section 4.1.2 all have enabling legislation that empowers them to undertake their functions. Implementing the various mitigation measures and assessing the current and future mitigation options require institutions and agencies with the institutional and legislative frameworks that will facilitate the construction and operation of mitigation projects and activities as well as the collection and analysis of relevant information that will monitor their implementation and assess new development possibilities.

Only those pieces of legislation that are important for relevance to the mitigation assessment are described below.

The **Electricity Survey Act (1956)** allows for the collection, compilation and analysis of information relating to the generation, distribution and use of electricity, and the quantities and types of electrical apparatus in use.

The **Petroleum Quality Control Act** includes regulations that require reporting of fuel sales information by petroleum marketing companies. Licences issued by OUR also have reporting requirements.

Natural Resources Conservation Authority Act (1991) provides for the management, conservation and protection of Jamaica's natural resources. The Act establishes the Natural Resources Conservation Authority (NRCA), whose functions include the taking of such steps that are necessary to ensure the effective management of the physical environment of Jamaica. Section 9 of the Act gives Ministerial discretion to declare parts of or the entire island a 'prescribed area', in which specified activities require a permit, and for which activities an environmental impact assessment may be required. The **Natural Resources Conservation Authority (Permits and Licences) Regulations (1996)** sets categories of enterprises that will require a permit for their development or construction and the requirements for licences for those enterprises. The **Natural Resources Conservation Authority (Air Quality) Regulations (2006)** sets out the criteria that determine which facilities require a licence to discharge certain pollutants and prescribe discharge fees. The regulations also include a requirement that licensees provide annual emissions reports for emissions of the so called regulated pollutants **and** greenhouse gases.

4.2 IMPLEMENTATION OF MITIGATION MEASURES

Successful implementation of the mitigation measures will *inter alia* depend on:

- The provision of incentives/disincentives for the development and use of innovative technologies that improve/worsen efficiency
- Implementation of other energy related policies that will support the achievement of the goals of the national energy policy – namely the biofuels policy, waste-to-energy policy and the carbon emissions trading policy.

- Creation of relevant legislation to support the required investments in efficiency in sectors such as transportation and bauxite
- A review of previous and existing demand side management programmes for performance, strengths and lessons learned
- Stronger institutional capacities in the energy and environment sectors
- Development of programmes designed to influence market behaviour towards more efficient use in energy across all sectors
- Development of mechanisms to efficiently share energy related information and for public and private sector entities to collaborate on energy related projects
- Establishment of a system to identify and replace old inefficient electricity equipment and (especially) generating units/plants with more fuel efficient and cost efficient technologies and plants
- Promotion of strategic partnerships between the public and private sectors to finance and develop energy diversification projects
- Introduction of national vehicle emission standards and regulations to reduce vehicular emissions and promote introduction of cleaner transportation fuels (especially CNG).

Vision 2030 Jamaica: National Development Plan provides the context and goals for national development and the National Energy Policy 2009-2020 gives the framework within which the mitigation measures indicated in Scenarios 2 and 3 will take place. All of the initiatives included in the scenarios are included or implied in the Energy Policy.

The Energy Policy also provides the overarching framework for the development and management of the energy sector and presents a range of options and strategies for energy conservation which the Government is committed to pursue over the short, medium and longer term. The policy also identifies fuel diversification (with explicit targets) among key goals to improve energy security and reduce energy costs.

Some of the specific strategies included in the Energy Policy that will facilitate the mitigation measures in scenario groups *S2* and *S3* are as follows.

- finalizing the energy efficiency and conservation policy;
- creating relevant legislation to support required investments in efficiency;
- infusing energy conservation issues in sectoral policy development (e.g. in tourism policy, health policy, water policy etc);
- implementing a public education programme to encourage energy conservation;
- providing incentives/disincentives for the use of innovative/clean technologies in power generation, mining and manufacturing to improve energy efficiencies
- promulgation of the energy efficient Building Code;
- Introducing national vehicle emission standards;

- promoting greater vehicle fuel efficiency;
- promoting imports of more fuel efficient vehicles;
- levying taxes on petrol at appropriate levels to encourage conservation;
- providing adequate infrastructure for transition to alternative energy vehicles;
- improving infrastructure and enforcing maximum axel weight standards;
- increasing mass transit opportunities and utilization; and
- introducing financial incentives for solar technologies in the public and private sectors and in communities.

The Centre of Excellence for Renewable Energy will facilitate private sector involvement to implement projects in the areas of hydropower, wind, solar, biomass and waste-to-energy.

The National Energy Policy 2008-2020 and Vision 2030 Jamaica: National Development Plan place a high priority on diversifying the country's energy mix and increasing the percentage contributed by renewables. The policy envisages that the supply mix will have marked changes by 2012 when petroleum is expected to represent 67% of the mix, natural gas 15%, petcoke/coal 5% and renewables 12.5%. By 2030, the share of petroleum in the supply mix is expected to be only 30%, with natural gas accounting for as much as 42% of the mix and renewables 20%.

4.3 GAPS

Various gaps currently exist in the energy sector and the Energy Policy clearly articulates them and includes strategies to fill most of these gaps. Some of the critical gaps that affect implementation of mitigation measures are highlighted below.

Carbon Trading

The Draft Carbon Trading Policy includes a proposal to name the designation of the Designated National Authority and to "s*ecure a sustained source of funding to support the provision of DNA related activities and services".* However although the policy recognises that absence of an institution/agency and a CDM governance structure, the nature of the institution or agency that will house the DNA and some of its activities (e.g., whether or not any legislation will be needed; how it would be staffed; a timeline for its establishment and the governance structure surrounding the DNA office) are not clearly articulated.

To date the Wigton Wind Farm is the only project in Jamaica that is engaged in carbon trading and as recognised in the draft policy additional capacity is needed to successfully take advantage of CDM opportunities. Since currently there are several potential projects that could benefit from carbon trading it is essential that the policy be implemented with great urgency.

Coordination Among Energy Sector Stakeholders

The stakeholders involved in the implementation of mitigation measures span the gamut of public as well as private sector agencies and institutions and the general public.

Coordination of mitigation activities and communication of vital information to and among these stakeholders will be vital. Currently there are no formal interagency bodies or other mechanisms that will coordinate mitigation activities that span various agencies or that would facilitate information flow.

Policy and Regulatory Gaps

Some of issues and challenges the energy sector faces include legislation that lack adequate enforcement provisions and clearly articulated policies or protocols that address the pricing of electricity and petroleum products; decision making about retirement or mothballing old inefficient electricity generation plants; tax and pricing structure for road users; how to (better) address electricity system losses; and the development of renewable generation capacity. This has resulted in incremental decisions and has limited the introduction of diverse sources of energy and providing integrated monitoring and enforcement of regulations. Currently, there are also no legislative provisions for the net metering, carbon trading (as indicated above) and energy efficiency standards but it is envisaged that these will be addressed in the near future as the National Energy Policy is implemented.

Data Collection and Information

In general various pieces of legislation include provisions that require reporting of fuel sales, electricity generation parameters and emissions and for acquisition of production and other "activity data' that are needed for estimating emissions and for planning purposes.

Data on historical electrical energy use and fuel consumption are collected by various entities, including STATIN, PIOJ, JPS, OUR, NEPA, Ministry of Transport and Works, and the Ministry of Energy and Mining.

There are however critical gaps in the collection of information that will allow forecasting of energy and fuel consumption. Recently MEM has been engaged in energy forecasting but it appears that the effort is constrained by the lack of suitable data.

Notwithstanding the collection of historical data, the energy sector is not effectively supported by databases that are accurate and precise to enable analysis, forecasting and overall management of the sector. There also are significant delays in accessing reliable information on various aspects of the energy sector. This has adverse effects on the ability to plan and make decisions on informed judgment.

The annual data compiled by STATIN in the decanal censuses and annual surveys of living conditions (e.g., ESSJ and JSLC reports) provide some of the data required for forecasting purposes based on analysis of historical trends. The JSLC surveys include good data on penetration of household electrical appliances and other amenities. *Similar survey data that would be useful for estimating electricity consumption for non-residential sectors are not available.* A recent survey of residential energy end use was a missed opportunity to obtain energy intensity data for the residential sector.

Enhancement of the survey approach is needed so that energy intensity data can be obtained on a routine basis. Specific examples include the enhancement of the JSLC surveys

to include collection of information on the age ranges and numbers in each household of selected high energy consuming appliances (refrigerators, television sets, air conditioners). The approaches used in the U.S. Residential Energy and Consumer Survey (RECS) or National Resources Canada (NRCAN) residential energy end use surveys are examples of the approaches that would be suitable and easily adapted.

Since nearly all electrical appliances and equipment are imported, enhancement of the import classification to clearly distinguish between various categories of appliances (based on technology and ranges of energy use) would be useful. Examples are as follows:

- Motor vehicles – to distinguish fuel used (i.e., diesel, gasoline, CNG, hybrid, electricity only etc.)
- Refrigerators (range in SEER value, refrigerant (HC or HFC)
- TVs (based on technology and/or energy intensity)

While various energy sector projects and programmes over the years have been planned not many were undertaken and there was limited coordination of activities and timeliness in implementation of projects. Additionally, over the years, while some emphasis has been placed on the promotion of energy conservation in commercial sectors and industries such as tourism, the emphasis was not sustained and pilot projects (such as the Environmental Audits for Sustainable Tourism (EAST)) were not effectively institutionalized across other sector(s).

Although there have been least cost (electricity) expansion plans (LCEPs) the expansions that have taken place have been determined by expediency granted external factors have in some cases driven the decision making process.

Although there have been several sectoral plans or policies (e.g., tourism, transportation, a (albeit dated) national industrial policy) until recently[5] there was nominal effort directed at national or sectoral energy (apart from the electricity generating sector) or emissions forecasting. For example there appears to be little if any reliable national or sectoral energy demand projections (and hence potential savings from energy conservation initiatives for example in the tourism sector or among JPS Rate 40 and 50 consumers). In the case of electricity generation the forecasting of electricity consumption among various rate categories was based on macroeconomic data rather than on knowledge of end use equipment.

It is to be noted that information on more immediate or shorter term energy requirements is sometimes included in environmental impact assessments and could also be included in NEPA's permit applications.

Low levels of research in the energy sector can also be identified as a gap, resulting in low levels of adoption and adaptation of new and emerging energy technologies, improvements in energy infrastructure, and appropriate legislation.

[5] MEM is in the process of preparing national energy forecasts using the ENPEP model but results are not yet available.

There is also a lack of a comprehensive and sustained public education programme that would encourage Jamaicans to use energy wisely and to aggressively pursue opportunities for conservation and efficiency. As a result of this, the Jamaican public has a relatively low level of awareness of the importance of energy and its use in their daily lives and the contribution that each can make to the responsible and efficient use of this vital resource. This low level of awareness also could explain the low intensity of use of solar energy for water heating in Jamaican households.

4.4 RECOMMENDATIONS

For several countries, particularly developed countries with emission reduction targets, their energy policy is linked to or framed within the context of climate change mitigation and moving towards a low carbon economy. Although developing countries such as Jamaica do not have emission reduction targets at present, "no regrets" mitigation actions such as energy conservation and development of renewable energy sources have positive impacts in terms of economic, social and environmental considerations. This section provides specific recommendations to improve the enabling environment, build institutional and human resource capacity, encourage adoption of suitable energy conservation/GHG mitigation technologies and fill data gaps create that will facilitate cost effective energy use and implementation of GHG mitigation measures.

4.4.1 Enabling Environment

Improving the enabling environment within which GHG mitigation and other energy sector activities take place will entail streamlining some legislation or policies and in some cases additional legislation. These include the following.

- Strengthen the regulations so that there are adequate enforcement provisions and clearly articulated policies or protocols that address the pricing of electricity and petroleum products; decision making about retirement or mothballing inefficient electricity generation plants; how to (better) address electricity system losses; and the development of renewable generation capacity
- Develop and implement the regulatory framework to allow carbon trading to take place. This should include legislation establishing the DNR and associated entities and specification of the trading modalities for local and international entities (e.g., licensing, certification or regulation of such entities, owning certified emission reductions (CERs) and Verifiable Emissions Reductions (VERs) etc.)
- Establish an enabling environment to encourage local and foreign financing of innovative energy projects, especially in renewables. This could entail developing policies and programs that will encourage use of biogas and solar heaters as well as other alternate energy sources such as photovoltaic systems. These could for example entail revolving loans, and/or import duty concessions and incentives for energy efficiency improvements

- Implement incentives that will encourage tertiary level institutions to develop research programmes for the application and implementation of renewable energy projects
- Adapt/adopt or develop energy efficiency standards for consumer and industrial electrical equipment (e.g. by adopt the Energy Star program) and base import duties for such equipment in part on energy efficiency standards.
- Introduce national motor vehicle emission standards and regulations
- Develop regulations and safety standards in anticipation of the introduction of CNG infrastructure and CNG use in industry and in vehicles
- Revise the bases for tax/customs duties so that they are based on vehicle weight class and fuel type (not cc rating)
- NEPA in collaboration with MEM and PCJ should include as a requirement in selected permit applications and environmental impact assessments the provision of projected electrical energy and fuel use and associated technologies and appropriate benchmarking information. In order to focus attention on energy conservation NEPA should rename the EIA as an Environmental and Energy Impact Assessment (EEIA).
- Make use of the energy efficiency fund to increase energy projects such as those related to renewable energy
- Implement the building code

4.4.2 Capacity-building Needs

Capacity building in the energy sector institutions will be required if mitigation measures are to be effectively implemented. The capacity building needs in the public sector centre on institutional arrangements for the collection, compilation, reporting and analysis of energy information and for public education. Implementation of private sector measures requires increased private sector technology awareness and capability and an environment that facilitates and encourages investment for implementation of mitigation measures. Public sector agencies with regulatory or other responsibility for the energy and environment must also be aware of the technologies, be able to assess them and to develop policies that are responsive to private sector and national needs.

The following specific capacity building needs are identified:

- Enhance capacity to compile GHG (and other) emission inventories and the capacity to perform energy and GHG emissions forecasting/modelling
- Develop an energy information clearing house
- Train staff to perform functions of the DNA and the supporting institutions (National Carbon Trading Promotional organization)

- Establish the DNA institutions and identify and enact any necessary legislation (e.g., to enable certification or licensing of trading modalities)
- Expand the role of the Energy Efficiency Unit (EEU) within the Petroleum Corporation of Jamaica to provide technical assistance for ECE initiatives in the public and private sectors
- Empower the regulatory agencies with enforcement powers to improve the efficiency of the system and comply with established benchmarks, procedures and standards
- Develop stronger links with the energy sector and academic institutions to drive the adoption and adaptation of new technologies in the energy sector
- Develop the capacity of local companies to improve their processes and energy efficiencies and to take advantage of carbon trading opportunities

4.4.3 Adoption of Clean and Energy Efficient Technologies

- The currently clearly identified renewable energy projects for electricity generation are not likely to meet the targets for renewables set in the Energy Policy. Although there have been several studies on cogeneration in the sugar industry firm plans remain elusive. It has been estimated that increasing sugar cane production to 3.36 million tonnes cane could provide an additional 47.4 MW for sale to the grid[27]. A more modest target for increased sugar cane production to yield an additional 30 MW would likely be more achievable[6]. Other biomass projects are in the conceptual stages but need further development. The inclusion of additional cogeneration in the sugar industry with sale of electricity to the grid would help to achieve the energy policy targets for renewables.
- Develop capacity to facilitate greater energy efficiency in the bauxite and alumina industry and the manufacturing sector (Rate 40 and Rate 50 JPS customers). Initiatives such as the recently announced partnership between JPS and NWC could be applied an a sectoral basis (once suitable information is available)
- Engage in research towards adoption and adaptation of new and emerging technologies and improvements in energy infrastructure. This should include distributed energy generation from solar and wind energy and low grade heat for cooling/air conditioning
- Implement incentives/disincentives to enable the development and use of innovative technologies to improve energy efficiencies in all sectors and in households

[6] A crude estimate would be to increase the current (2008) 1.65 million tonnes sugar cane milled to 2.2 million tonnes

- Research and develop alternative fuels for the transport sector, including the use of biofuels and CNG when it becomes available
- Encourage the use of solar powered water pumping by the NWC
- Mandate that all new hot water installations be solar in all public buildings
- Promote more widespread use of solar water heating in the hotels
- Promote the adoption of solar powered cooling/air conditioning especially in the hotel/tourism sector
- Implementation of demand side management programme including the use of energy-efficient appliances, equipment, and building designs, setting and enforcing standards for public sector organizations, and public awareness and educational programmes

4.4.4 Address Data and Information Gaps

- Improve motor vehicle fleet database (ensure correct assignment of fuel type, add off road categories, weight units; clearly distinguish between non-motorised trailers and motorised trailers, add allowance (categories) for hybrid and CNG vehicles. This could be achieved by quality assurance checks during data entry and use of databases with manufacturers' specifications.
- Compile statistics for annual vehicle kilometres travelled (VKMT)[7] through periodic surveys or routinely collect and record odometer readings during vehicle inspections for certificates of fitness
- Develop mechanisms that would facilitate or require fleet management companies to report VKMT and other general non-confidential vehicle data
- Code JPS customers (at least the Rate 40 and 50 customers) by JIC and require reporting of energy use statistics by JIC accordingly. This type of information will inform the design of appropriate end use surveys in the commercial/manufacturing sectors and in planning/forecasting demand
- Survey industrial and commercial customers for end use equipment
- Conduct periodic surveys for charcoal and wood use
- Conduct proper residential energy use survey in conjunction with data from JPS smart meters
- Compile data on appliance imports or sales for refrigerators
- Assess impact of distributed electricity generation and water storage and if appropriate develop a suitable program to promote its implementation
- Develop and sustain Public Education on energy efficiency and conservation

[7] A study is currently under way

- Review the sustainable development and energy conservation curriculum needs throughout the (primary, secondary and tertiary levels) in the educational system and enhance the curriculum accordingly

5. APPENDICES

5.1 APPENDIX 1: TERMS OF REFERENCE

ANNEX II
TERMS OF REFERENCE (TOR)

CONSULTANT: CLIMATE CHANGE MITIGATION EXPERT
Location: KINGSTON, JAMAICA
Application Deadline: 02-Aug-07
Type of Contract: SSA
Languages Required: English
Starting Date: (date when the selected candidate is expected to start (13-Aug-2007 Duration of Initial Contract: Nine months
Expected Duration of Assignment: Nine months

Background
The preparation of the Mitigation Assessments identifies the basic sets of activities that the Mitigation expert/consultant will be responsible for under the supervision of the Project Manager reporting to National Communication's Coordinator. Non- Annex I Parties according to paragraph 40 of the Guidelines for the preparation of national communications from Parties non included in Annex I of the Conventions are encouraged to provide; "to the extend their capacities allow, information on programs and measures implemented or planned which contribute to the mitigation of climate change by addressing anthropogenic emissions by sources and sinks of all greenhouse gases (GHGs) not controlled by the Montreal Protocol, including as appropriate, relevant information by key sectors on methodologies, scenarios, results, measures and institutional arrangements."
Duties and Responsibilities
The National GHG Abatement expert and Team Leader should work in consultation with and under the guidance and supervision of the National Project Coordinator (NPC). Specifically, his\her responsibilities will include but are but not limited to the following:

- With the assistance of the NPC establishes the team for performing the GHG abatement analysis;
- Prepares a detailed work-plan for GHG abatement analysis on the basis of the overall project work plan;
- Develops the scope of work and respective terms of reference for the team members;
- Leads the data and information collection process;
- In consultation with NPC decides on methodologies for the elaboration of scenarios for the priority sectors;
- Leads and oversees the scenario development and update;
- Facilitates consultations/workshops and ensure their success;

- Facilitates training and capacity building activities;
- Ensures synergy with other relevant national, regional and international projects;
- Ensures the timely and effective management of the activities as scheduled;
- Incorporates comments received from the review process;
- Drafts the GHG Abatement Analysis Report and respective chapter of the SNC along with the respective part of executive summary;
- Presents the final draft of the report.
- Competencies
- Good understanding of the process for preparing national inventory of greenhouse gases and projection;
- Good understanding of the projections for the use of energy and the energy mix for the years 2015, 2030 and 2050;
- Demonstrable knowledge of the relevant methodologies and tools for preparing mitigation assessments and models including IPCC 1996, IPCC GPG, LEAP etc.
- Demonstrated ability of analytical and drafting work including a good track record of consulting for several recognized international project activities;
- Good communication and management skills;
- Computer skills.
- Required Skills and Experience
- An advanced degree in environmental management or other field relevant to the project;
- A minimum of 5 years of working experience in the relevant area;
- Fluency in English is required.

5.2 APPENDIX 2: MINISTRY OF ENERGY AND MINING ENERGY PROJECTS / PROPOSALS FOR CO-OPERATION, FUNDING AND MONITORING AND ASSIGNMENT TO MITIGATION ASSESSMENT SCENARIOS

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
	POLICIES			
1	National Energy Policy 2008 - 2030	MEM	Task Force meets weekly as well as work in between meetings to deliver on very aggressive schedules. Inputs from Draft Green Paper, Prime Minister's National Energy Committee, Prime Minister's Task Force on Energy, and Public Consultation on Energy Policy Green Paper	Task Force established to fast track completion of the Energy Policy by mid June, 2009 [Not applicable to Scenarios]
2	Energy Conservation and Efficiency Policy 2008 - 2022	MEM	Draft Policy was Tabled in Parliament in July, 2008 as an addendum to the (previous) Energy Policy Green Paper	[Not applicable to Scenarios]
3	Development of Net Metering Policy and Legislation.	MEM	Petrocaribe Financing is one of the sources identified. Active participation in negotiations is ongoing through the Petrocaribe Technical Work Group on Renewable Energy. The proposed project was approved but will be implemented under a regional programme.	Appropriate legislation is required to standardize and regularize the way distributed generation sources are interconnected to the national electric grid. This will facilitate greater penetration of renewable energy sources and help to achieve government targets for fuel diversification and renewable energy development [Not applicable for Scenarios]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
4	Carbon Policy Development	MEM/PCJ	Task Force established to develop Jamaica's position on Carbon emissions and trading	[Not applicable to Scenarios]
5	Bio – Fuels Policy Development	MEM/PCJ/Ministry of Agriculture	Development of Bio-Fuels Policy and Action Plan aimed at Bio-Fuels Policy Support Capacity Building for public and private sector representatives Land Research and Mapping to support locally grown feedstocks Font Hill Bio-Diesel Experiment and pre-feasibility assessment for the national bio-diesel plan Bio-Fuels Pricing and Taxation Study Biomass Study	[Biodiesel introduction as fuel; penetration to be determined. No data to allow inclusion in scenarios]
6	Revision of GOJ Procurement Policy (Some energy components)	MEM/MF&PS		Policy completed and implemented [Not applicable to Scenarios]
7	GOJ Policy on Environmental Stewardship - Draft Environmental Management Systems Policy	OPM/EMD		[Not applicable to Scenarios]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
	LEGISLATIONS, STANDARDS AND CODES			
8	Primary Legislation for the Electricity Sector	MEM/OUR	This Legislation will replace outdated Legislations and Acts governing the Electricity Sector	[Not applicable to Scenarios]
9	Equipment Standards and Legislation for Energy End Use Devices	MEM/BSJ	Development of Standards and codes for End Use Devices and the requisite Legislation to enforce compliance	Scenarios 2 and 3 – Assume Jamaican energy efficiencies for new appliances sold lag US or Canadian by 2 to 4 years
10	National Petroleum Standards and Codes	MEM/BSJ	Development of National Standards and Codes to regulate the Petroleum Sector	[Not applicable to Scenarios]
	PETROLEUM			
11	Petrojam Refinery Expansion	PCJ/Petrojam	Expansion of the Refinery from production of 35,000 bbl of oil per day to 50,000 bbl per day capacity	Petcoke Cogeneration Project to generate 120MW of electricity [All scenarios]
12	E-10 Storage Capacity Expansion	PCJ/Petrojam /Petrojam Ethanol	Installation of Storage facility in Western end of the island to facilitate E – 10 Roll-out	[All scenarios after 2010 (first full year)]
13	Oil and Gas Exploration	PCJ		[Not applicable to Scenarios – assume none is found]
14	Oil Trading	PCJ		[Not applicable to Scenarios]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
15	Proposal for data exchange and technical assistance regarding Oil and Gas Exploration activities.	Petroleum Corporation of Jamaica	The Petroleum Corporation of Jamaica is interested in establishing a program of data/information exchange and technical assistance as it relates to Oil and Gas Exploration. Jamaica and Cuba partly share a similar geological history. Oil and Gas exploration activities are being conducted in 12 offshore blocks in Jamaica. Cuba has made important economic finds in its offshore acreage to the north. The strategy for fuel diversification requires that all viable options are considered. The introduction of Natural gas is one option being considered for regional cooperation for its introduction/expansion in the region through Petrocaribe initiative through the Working Team on Gas.	It is proposed that dialogue between technical personnel in Cuba and Jamaica be initiated to discuss the scope of technical (mainly geological) issues faced. A sharing of experience with regards to the administration of exploration contracts will also be welcomed. It is anticipated that such dialogue could take place mainly via written correspondence with the exchange of technical data by parcel post if necessary. Future work in the latter phase of this project could see the exchange of technical personnel between the two countries, if this is deemed cost effective. [Not applicable to Scenarios]
16	Liquefied Natural Gas (LNG)	MEM/PCJ	Development of facility to distribute LNG Secure long term contract for the supply of Natural Gas	[Scenarios 2 and 3]
17	Ethanol Blended Fuel (E10)	MEM/PCJ	10% Ethanol Fuel Blend introduced in the transport sector in October, 2008	Full roll-out dependent on additional storage capacity installation in Western end of the island [All scenarios after 2010 (first full year)]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
18	PETCOM Rationalization	PCJ/PETCOM	Programme to rationalize the operations of PETCOM to create a more viable business	[Not applicable to Scenarios]
19	Bilateral and Multilateral Relations	PCJ	Strengthen Bilateral and Multilateral Ventures	[Not applicable to Scenarios]
20	Russian - Nuclear		Nuclear Power barge facility	[Scenario *S3* NGNU after 2025 – but no assumption of source though]
	ELECTRICITY GENERATION EXPANSION			
21	Petroleum Coke 120MW Plant	PCJ/Petrojam		[All scenarios]
22	JEP 60MW Plant	MEM/OUR		[Reference Scenario]
23	Compressed Natural Gas for JPS Power Plants	MEM/OUR		[Scenarios 2 and 3]
24	Merit Order Dispatch Study to identify an appropriate Model for Jamaica	MEM/OUR		[Insufficient cost data to allow economic dispatch to be used in LEAP]
25	National Energy Planning and Efficiency Study	MEM/Cabinet Office	ACRES Management Consulting completed study on the electricity power sector and provided a road map for developments within the sector	Study was completed in 2007 [Not applicable/relevant to Scenarios]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
26	Improvements in the Operations of JPS	OUR	Consequent to the All Island Blackout in electricity supplies on July 15, 2006 the Government of Jamaica instructed that a Forensic Investigation be conducted into the circumstances which led to the failure of the electricity system and how to prevent such occurrence in the future	Some recommendation implemented but others are outstanding [Not applicable/relevant to Scenarios]
27	Transmission and Distribution Code for JPS operations	MEM/OUR	Development of a Transmission and Distribution code in progress. A consultant is engaged by JPS to develop the Code	[Not applicable to Scenarios]
	ENERGY CONSERVATION AND EFFICIENCY (ECE) AND RENEWABLE ENERGY (RE) SOURCES			
28	IBD Technical Assistance for Energy Conservation and Efficiency in the Public Sector	MEM/PIOJ	Technical Assistance to be executed jointly by the IDB and MEM to evaluate energy consumption within the Public Sector and develop Plan to implement corrective measures	Work to start during Second Quarter of FY 2009/10 [Not applicable to Scenarios – note separate measures for hospitals, NWC and Other Govt electricity use]
29	Technical Assistance from the World Bank	MEM	Discussions to be continued with the objective to get additional assistance from the Bank to assist Jamaica with its energy challenges	Video Conference set for June 2, 2009 [Not applicable/relevant to Scenarios]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
30	Technical Assistance from the United States Embassy	MEM	Discussions to be continued with the objective to get assistance from the Embassy to assist Jamaica with its energy challenges	Opportunities identified in the areas of Waste to Energy, Bio-Fuels Cooperation, Renewable Energy Public Awareness, Ethanol Exports, and the Petcoke Power Plant expansion Project [Not applicable/relevant to Scenarios]
31	Improve lighting energy efficiency in hospitals and schools.	Ministry of Energy / Petroleum Corporation of Jamaica	Project already identified and proposal submitted for Petrocaribe financing. The proposed project was approved but will be implemented under a regional programme. Energy audits already completed for 22 hospitals and 8 schools. The projected cost saving for all the hospitals is US$131,687 per year and the associated implementation cost is US$213,235. This gives an overall simple payback period of 1.6 years. The projected cost saving for all the schools is US$3,591,464 per year and the associated implementation cost is US$5,815,500. This gives an overall simple payback period of 1.6 years.	Replacement of T12 fluorescent tubes with T8 tubes and replacing magnetic ballasts with electronic ballasts in hospitals and schools. [Scenarios 2 and 3] Petrocaribe Financing is one of the possible sources identified. Active participation in negotiations is ongoing through the Petrocaribe Technical Work Team on Savings and Efficient Use of Energy.

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
32	Improve energy efficiency of street lights	Ministry of Energy / Petroleum Corporation of Jamaica	Solar Photovoltaic technology will be applied for powering and / or switching of street lights and for general lighting in public spaces to improve efficiency and ensure that the lights are not left on in daylight. In addition, discussions are underway with several business interests (private) that have expressed willingness to provide solar voltaic powering of street lights throughout Jamaica. A pilot project is to be commenced in the community of Portmore for which some preliminary engineering and economic analyses are been done.	Petrocaribe Financing is one of the sources identified. Active participation in negotiations is ongoing through the Petrocaribe Technical Work Group on Renewable Energy. [Scenarios 2 & 3]
33	Improve energy efficiency of traffic lights.	Ministry of Energy / Petroleum Corporation of Jamaica	The proposed project for replacing incandescent light bulbs used for traffic signals with Light Emitting Diodes (LED) was approved for Petrocaribe financing but will be implemented under a regional programme.	Petrocaribe Financing is one of the sources identified. Active participation in negotiations is ongoing through the Petrocaribe Technical Work Team on Savings and Efficient Use of Energy. The traffic lights in Jamaica use 75 watt incandescent bulbs. When these bulbs are replaced the energy savings will be very significant. [No data available to allow inclusion in scenarios (in Government sub-branch?]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
34	Improve energy efficiency in the National Water Commission (NWC) by using energy efficient pump motors and carrying out power factor correction	Ministry of Energy / Petroleum Corporation of Jamaica/NWC	Energy Auditors to undertake the audits were pre-qualified and recommendation for contract award was made by the NWC to the National Contracts Commission (NCC). Petrocaribe Financing is one of the sources identified. Active participation in negotiations is ongoing through the Petrocaribe Technical Work Team on Savings and Efficient Use of Energy. The proposed project was approved but will be implemented under a regional programme.	The NWC accounts for 47% of public sector energy consumption. It is planned to reduce energy cost in this area by installing energy efficient pump motors and power factor correction equipment, as well as explore the opportunity for using solar and wind driven pumps. In this respect, Jamaica hopes to learn from the Cuban experience. [Scenario 2 in 2 phases – need phase reductions [made assumptions]] Other sources of finance will help to expand the scope and impact of this programme
35	Energy Education Programme	Ministry of Energy/PCJ	Cuba has indicated that it has a very developed Energy Education Programme which targets all sectors of the Society. Jamaica's efforts at Public Education on Energy Conservation and Efficiency could be enhanced.	A plan will be put in place to ensure development of a cohesive and sustainable public education programme throughout Jamaica [Not specifically included]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
36	Waste to Energy Project	PCJ/CERE/NSWMA	Request for Proposal and information on Jamaica's waste were made available to local and international potential investors on January 19, 2009 On April 30, 2009 at the closing date of the process, submissions were received from four (4) international firms, some with local counterparts. Proposals were received for Waste to Electricity, Waste to Ethanol and Gasification of Waste to produce Syngas for sale to the electricity power stations	Evaluation of proposals in progress. Anticipated Outcomes include 65MW of electricity from two plants, one in the Eastern and the other in the Western side of the island, or alternately 20 million gallons of fuel based on the proposals received. Avoided importation of 260,000 bbl of crude oil annually [Scenario 65 MW EFW in all scenarios]
37	Mini Hydro Development to get 44.7MW and avoid importation of 202,000Bbls of crude annually	PCJ/CERE	Eight (8) sites identified by PCJ for development within Jamaica. Focus is on the following three (3): Lauhghlands Great River – 2MW Back Rio Grande – 25 – 28MW and Great River – 8MW	Other projects to be pursued include the following: Spanish River – 2.6MW Yallahs River – 2.5MW Martha Brae – 4.6MW [Scenario 2 and Scenario 3]
38	Bio – Diesel Pilot Project	MEM/PCJ/CERE	In collaboration with tertiary stakeholders a pilot project is to be undertaken involving cultivation of 80 – 100 acres of marginal lands with bio-diesel feedstocks such as castor, jatropha and sun flower	The bio-diesel produced is expected to satisfy ASTM standards and will be tested in bus engines [Not applicable]
39	Use of Biomass to generate electricity	PCJ	Project proposal for the use of Biomass for the production of up to 200MW of electricity	Memorandum of Understanding signed between PCJ and Biomass Investment Group (BIG) for approximately 30MW of electricity. Need additional info

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
40	Dr. Morris Wallen - Wind	PCJ	Wind Farm and Coastal Protection Project for the Palisadoes Strip	[Could include in Scenario 3 – need proposed MW]
41	Biogas Assessment Study	PCJ/SRC	Feasibility Study to bio-digest all organic waste on the Font Hill Farm and Property in St. Elizabeth for Bio-gas production	
42	Barma, America LLC	PCJ	Proposal for 19.5MW wind power generation to JPS through Wigton Wind Farm Ltd.	The project is self financing and presents no financial or other risk to Wigton, PCJ or Jamaica. Estimated cost is [Scenario 2]
43	Energy Knowledge Management	Ministry of Energy	Initial contact was established and preliminary discussion for data definition and specification for system requirement began.	Cuba's Energy Data base Management system provides a system of energy data collection and gathering, information analysis and management for strategic planning of the energy sector is commendable. Information at different levels and for different target groups provides a basis for sound planning and development of the sector. [Not applicable /relevant for scenarios]
44	Public Awareness Programmes	PCJ		[Not specifically included]
45	Science Competition in Schools	PCJ		

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
46	Energy Conservation and Efficiency (ECE) and Renewable Energy (RE) in Private Sector	PCJ		
47	Rural Electrification Programme (REP)	REP	Complete construction of 47Km of distribution lines Complete wiring of 850 houses under GOJ 2006/07 Phase II Construct 50Km of distribution lines Complete wiring of 750 houses under Revolving Loan Fund Continue to pursue Private Projects Secure funding under the Bandes Agreement for US$9.4M	[All Scenario – as penetration of households with electricity]
48	Rural Electrification for rural houses and communities using Renewable Energy (RE) solutions	Ministry of Energy / REP	Petrocaribe Financing is one of the sources identified. Active participation in negotiations is ongoing through the Petrocaribe Technical Work Group on Renewable Energy. The proposed project was approved but will be implemented under a regional programme. Additional financing will be required to extend this programme	Cuba's use of RE and alternative energy systems to provide electricity and energy in general to rural residents and those not having easy access to the electricity grid has demonstrated significant reach to thousands of communities. Their innovative strategies to improve the quality of life for its people provide models for replication. [See above – item 48]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
49	Capacity Building for RE technologies and their development	Ministry of Energy/CERE	Petrocaribe Financing is one of the sources identified. Active participation in negotiations is ongoing through the Petrocaribe Technical Work Group on Renewable Energy. The proposed project was approved but will be implemented under a regional programme.	The knowledge base on RE in Cuba is developing and, while Jamaica has a Centre of Excellence for Renewable Energy (CERE), the human resource and technical facilities and capacity available in Cuba provides for synergies that can be beneficial to Jamaica [Not applicable /relevant for scenarios]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
50	Manufacturing Plant for Solar Photovoltaic modules / panels and Solar Water Heaters.	Ministry of Energy/Ministry of Industry, Investment and Commerce	A proposal for a manufacturing facility for the production of solar photovoltaic models and panels as well as solar water heaters in Jamaica was prepared. Petrocaribe Financing is one of the sources identified. Active participation in negotiations is ongoing through the Petrocaribe Technical Work Group on Renewable Energy. The proposed project was approved but will be implemented under a regional programme. It is further proposed that Jamaica and Cuba work together in the development and use of solar energy systems as a means of providing a solution to supplementing our energy requirements. Opportunity exist for expanding the product lines to include manufacture and production of other solar powered equipment such as : o Solar Crop dryers o Solar cooling equipment o Other photo voltaic solutions.	A limited capacity exists for the production of PV Modules in Cuba. This capability needs to be strengthened and Jamaica could play a part in order to provide mutual benefits. Both Jamaica and Cuba are located in the same geographic zone that has an abundance of sunshine. The partnership between our two countries would facilitate growth in solar utilization within the Region. Cuba has done significant work in this area and the results are quite impressive. Jamaica can benefit from such experience. Collaboration on research and testing of solar devices and equipment, in addition to improving solar equipment efficiencies is another area for bilateral cooperation with Cuba [Not applicable /relevant for scenarios]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
51	Replacement of incandescent Light Bulbs with Compact Fluorescent Lamps (CFLS)	MEM/PCJ	The next phase of the distribution of CFLS as part of the gift from Cuba will commence in another few weeks. Dialogue and cooperation with the Cuban Embassy in Jamaica is ongoing and the Cuban government has agreed for the remaining bulbs to be distributed to improve the lighting efficiency within government buildings and facilities. After an audit to determine the requirements per Ministry and their respective agencies is completed, the appropriate control and accounting mechanisms will be adhered to.	The Gift of 4,000,000 CFLS from Cuba to help improve Savings and Efficient use of energy in Jamaica is by far the largest energy conservation and efficiency programme undertaken in Jamaica. The remaining (approximately 365,000) bulbs are to be distributed as replacement for the inefficient bulbs currently in use. [All scenarios]
52	Cool Green House Technology	Ministry of Energy	Cool Green House technology for planting vegetables and other food produce is being developed in Cuba. An opportunity exists for Jamaica to participate and benefit in this new technology. Liaison will continue with the Cuban officials to see how best this partnership can be developed	The world food crisis and Jamaica's challenge dictate that any partnership in this regard could reap significant benefits for both Countries in energy and food security [Not applicable /relevant for scenarios]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
53	Green House Technology	Ministry of Energy/Ministry of Agriculture	A proposal for cooperation with Cuba is prepared and as soon as funding is identified and secured, Cuba will be invited to come and support Jamaica in the use and further development of this technology	Green House technology is important to Jamaica's food and energy security. [Not applicable /relevant for scenarios]
54	Capacity Building for Carbon Trading	Ministry of Energy/PCJ	A Task Force was established comprising members from several Ministries and State Agencies to develop a Policy Framework Document.	The capacity for Carbon Trading must be strengthened so that as Jamaica develops its renewable energy potential and implement effective energy conservation and efficiency programmes the country's contribution to environmental protection will be demonstrated. [Not applicable /relevant for scenarios]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
55	Wind Farm Development (Retractable Tower)	Ministry of Energy/PCJ/CERE	The recent project launch for the expansion of the Wigton Wind farm generation plant is a reminder that Jamaica has the capacity and will to develop our renewable energy sources. When completed this will result in the increase capacity of the farm by 18.0MW Petrocaribe Financing is one of the sources identified. Active participation in negotiations is ongoing through the Petrocaribe Technical Work Group on Renewable Energy. The proposed project was approved but will be implemented under a regional programme.	Cuba is seriously expanding its Wind Energy contribution to electricity production. Their use of Retractable arm wind turbines is a safeguard against damage by Hurricane Force Winds. Jamaica needs this technology for future wind energy development [Not applicable /relevant for scenarios]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
56	Determination of Jamaica's Wind Energy Potential	MEM/Energy/PCJ/CERE/Wigton Wind Farm Ltd.	A MOU has been signed between PCJ and UWI for partnership in updating Jamaica's Wind Energy Potential. As soon as funding is identified and secured a consultant will be engaged to conduct the study of Jamaica's wind potential in order to determine the current potential for development. Petrocaribe Financing and IDB's Sustainable Energy and Climate Change Initiative (SECCI) are two of the sources of finance identified.	Active participation in negotiations is ongoing through the Petrocaribe Technical Work Group on Renewable Energy. The proposed project was approved but will be implemented under a regional programme. Also, an application for financial support was made to SECCI for their consideration. The last study conducted will be updated and made available for investment opportunities. [Not applicable /relevant for scenarios]
57	Hydro and Waste To Energy development	MEM/OUR	Proposal for development of up to 80MW of Hydro Power electricity Plant and 10Mw of Waste to Energy Power plant by investor Global Green Energy Services (GGES)	Investor will do entire development without any guarantee from the GOJ or any payment required until electricity is sent to the national electric grid [Not applicable /relevant for scenarios]
58	Solar Radiation and Intensity Mapping	Ministry of Energy	Initial discussions started with Cuba and will continue. Financial support will be provided under the Petrocaribe initiative through the Technical Work Group on renewable energy.	Cuba's achievement in this area provides a basis for further collaboration. [Not applicable /relevant for scenarios]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
59	Wigton Wind Farm Reactive Power (MVARS) Improvement.	Ministry of Energy/PCJ/CERE	Petrocaribe Financing is one of the sources identified. Active participation in negotiations is ongoing through the Petrocaribe Technical Work Group on Renewable Energy. The proposed project was approved but will be implemented under a regional programme.	Successful implementation of this project will significantly improve the efficiency, availability and profitability of the State owned Wind farm. [Scenario 2]
60	Wigton Wind Farm Expansion	MEM/PCJ/WWFL	Expansion of Wind Farm by 18MW	Power purchase Agreement (PPA) with JPS to be negotiated for the expanded Wind Farm [Scenarios 2 & 3] Negotiate Carbon Trading Arrangements for expanded facility to be done [Not applicable /relevant for scenarios]
61	Carbon Trading Framework	PCJ/CERE/WWFL	Development of a framework for future Wind Projects	[Not applicable /relevant for scenarios]
62	Demonstration project for a 2.0MW gearless box wind turbine (turbine without gear box).	Ministry of Energy/PCJ/CERE	Petrocaribe Financing is one of the sources identified. Active participation in negotiations is ongoing through the Petrocaribe Technical Work Group on Renewable Energy. The proposed project was approved but will be implemented under a regional programme.	This new technological application in Jamaica will increase the options for wind energy development. [Not applicable /relevant for scenarios]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
63	Development of a Market Driven Initiative to Encourage Greater Use of Renewable Energy and Energy efficiency Technologies			[Not applicable /relevant for scenarios]
64	Solar PV Systems to supply electricity for Schools	Ministry of Energy/ PCJ	A project to supply electricity to schools is developed. Petrocaribe Financing is one of the sources identified. Active participation in negotiations is ongoing through the Petrocaribe Technical Work Group on Renewable Energy. The proposed project was approved but will be implemented under a regional programme.	The proposed PV systems will be grid – tied without energy storage solutions therefore is dependent on the development of Net Metering Policy and Legislation to support implementation [Need additional data – include in Government sub-branch?]
	ENERGY DATA BASE AND PLANNING			
65	Planning and Data Base Management for Sustainable Development	OPM/EMD		[Not applicable /relevant for scenarios]
66	Energy Database Management System	MEM	International Atomic Energy Agency (IAEA) Module for Assessment of Energy Demand - MAED	[Not applicable /relevant for scenarios]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
67	Vision 2030 Jamaica National Development Plan	PIOJ	PIOJ let a Task Force to develop Vision 2030 Development Framework for Jamaica	Final report circulated [Not applicable]
68	Carbon Emissions Database (Software) for Monitoring and Managing Energy Consumption Data in Ministries and Agencies (LPG, Electricity, and Fuels – Gasoline and Diesel Oil)	OPM/EMD		[Not applicable for scenarios]
69	Public Education Initiatives on Energy	NEPA		
70	Energy Conservation Officers	MEM/Cabinet Office	Assignment of Energy Conservation Officers in each Ministry, Agency and Department to monitor and control public sector energy consumption	Reduce public sector consumption by 15% [Scenarios 2, 3]
71	Training in Energy Management	MEM/Cabinet Office		[Not applicable /relevant for scenarios]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
72	Second National Communication to the United Nations Framework Convention on Climate Change (UNFCC) Project in Jamaica	OPM/EMD/Meteorological Office		[Not applicable /relevant for scenarios]
73	Jamaica Productivity Centre – Monitoring of Energy Use	Ministry of Finance and the Public Service		[Not applicable]
74	Energy and Power Evaluation Programme (ENPEP)	MEM		[Not applicable]
75	National Energy Coordinators Committee	MEM		[Not applicable]
76	End – Use Survey for Commercial and Public Sectors	MEM/STATIN/PIOJ		[Not applicable]
77	GOJ Energy Management Guidelines	OPM/EMD		[Not applicable]
78	Renewable Energy Development	PCJ/CERE	Research on renewable energies, assessment, design and implementation of renewable energies projects	[Not applicable]

	Project/Initiative	Implementing Agency	Status	Remarks [Scenario Assignment or comment]
79	Inner City Schools Energy Conservation Programme	PCJ	Adapting conservation and energy efficiency for local use, involved in project on energy saving bulbs, public sector energy systems upgrade, energy conservation incentive programmes for inner-city schools	[Not applicable]
	OTHER			
80	JMA Energy Conservation Programme	MIIC/Jamaica Manufacturers Association (JMA)	Enhancing the Competitive Advantage of the Manufacturing Sector through Energy Conservation (Paper)	[No data available]
81	Chicago Based Project			[No data available]
82	Virginia Based Project			[[No data available]
83	Ethanol – Project		Ethanol Plant Development	Colombian Embassy [No data available]

5.3 APPENDIX 3: ATTENDEES AT THE GHG MITIGATION ASSESSMENT WOPRKSHOP

The table below provides the list of participants who were in attendance at the review workshop for the Jamaica's Greenhouse Gas Mitigation Assessment Report held at the PCJ Auditorium on Wednesday October 21, 2009. The workshop was facilitated by Claude Davis and Associates.

Participant	Organization
Amsale Maryam	Association of Development Agencies
Sophia Lowe	Caribbean Cement Company Limited
Nicole O'Reggio	Environmental Management Division, Office of the Prime Minister
Suzanne Shaw	Independent Consultant
Worrell Lyew-You	Jamaica Bauxite Institute
Dwight DaCosta	JPSCO
Raymond McFarlane	JPSCO
Marlene Forbes	JPSCO
Clifford Mahlung	Meteorological Service
Jeffrey Spooner	Meteorological Service
Fitzroy Vidal	Ministry of Energy and Mining
Yvonne Barrett-Edwards	Ministry of Energy and Mining
Elizabeth Grant	Ministry of Energy and Mining
Shernette Sampson	Ministry of Transport and Works
Dorothea Clarke	Ministry of Transport and Works
Winsome Townsend	National Environment and Planning Agency
Oswald Chinkoo	National Environment and Planning Agency
Nicole Walker	National Environment and Planning Agency
Sheries Simpson	National Environment and Planning Agency
Karen Muir	PETROJAM Limited
Jodi Morris	PETROJAM Limited
Cassandra Gibson	PETROJAM Limited
Denise Tulloch	Petroleum Corporation of Jamaica
Richard Lumsden	Planning Institute of Jamaica
Hopeton Peterson	Planning Institute of Jamaica
Jacob McLean	Red Stripe
Janet Geoghagen-Martin	STATIN
Elaine Manning	Sugar Industry Research Institute
Lancelot White	Sugar Industry Research Institute
Nicole Brown	UNDP
Margaret Jones Williams	UNDP
Michelle Chin Lenn	Wigton Wind Farm

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