Greenhouse gas baseline and mitigation options for the residential sector

MARK DE VILLIERS
KHOROMMBI MATIBE

EDRC REPORT NO: EDRC/00/R17

JANUARY 2000
ENERGY AND DEVELOPMENT RESEARCH CENTRE
University of Cape Town

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1. Introduction

The United Nations *Framework Convention on Climate Change* (FCCC) was adopted in 1992, with the objective to "stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". South Africa ratified the Convention in August 1997 and is obliged to develop and submit a National Communication that contains an inventory of greenhouse gas emissions for a base year and a strategy to address climate change. This report provides baseline greenhouse gas emissions and mitigation options in the residential sector, and serves as an input for a macro-economic analysis of South African greenhouse gas mitigation scenarios and for South Africa's National Communication.

2. Scope of work

Deliverables required for the residential sector study are:

- a baseline scenario of greenhouse gas emissions from 1990 to 2030;
- selection and technical description of relevant mitigation options;
- a financial evaluation of mitigation options;
- quantification of evaluation criteria for mitigation options;
- consultation with relevant stakeholders (list given in Appendix A).

Greenhouse gas emissions are to be reported for 1990, 1994, 1998, 2000, 2005, 2010, 2015, 2020, 2025 and 2030.

3. Definition of sectoral activity

The residential sector includes all activities performed in the household including cooking, space heating, water heating, lighting, refrigeration and use of other electrical appliances. The residential sector excludes private and public transport, and any commercial activities.

4. Baseline methodology and data collection

4.1 Introduction

The following methodology was used for the baseline:

1. Residential energy use was divided into 31 appliances.
2. The number of households using each appliance was estimated.
3. Average annual household fuel consumption for each appliance was estimated.
4. Annual household energy consumption for each appliance was multiplied by the number of households using the appliance, to give annual energy consumption.
5. Annual total energy consumption for each appliance was multiplied by greenhouse gas emission coefficients for the appliance to calculate greenhouse gas emissions.

The most detailed data was available for 1995, and so a complete picture of residential energy consumption and GHG emissions was developed for that year. The 1995 data for each appliance had to then be projected backwards to 1990 and forwards to 2030. All calculations were done using Excel spreadsheets.

4.2 Number of households

Population figures from 1991 to 1998 were obtained from Clark and Fecher (1999) and population growth rates were obtained from Roux (1998). Average persons per household for 1996 were obtained from Statistics South Africa (1996). Together these give the number of households in South Africa from 1990 to 2030 assuming the number of persons per household remains constant. The total number of households was divided into established grid electrified households (defined as grid electrified households that use more electricity than other fuels), newly grid electrified households (defined as grid electrified households that use less electricity other fuels), non-grid electrified households (excluding battery use) and non-electrified households. Grid connections from 1990 and 1998 were obtained from the National Electricity Regulator (1998) and projected grid connections were obtained from Cowan et al (1996). The number of non-grid electrified households in 1995 was obtained from Statistics South Africa (1996). It is assumed that under the baseline scenario no further non-grid electrification would occur (dealt with as a mitigation option). Although the Department of Minerals and Energy has indicated that they will support a significant non-grid electrification programme, Cowan (1999) believes that many hurdles have to still be overcome before their ambitious plans can be realised. It was assumed that in 1990 80% of grid electrified households were established electrified, and that 25% of new houses will be in the established grid electrified group. Although 25% is higher than the proportion of new houses that were established grid electrified households in the 1990s, it is expected that with the projected high economic growth of South Africa after the year 2000 (IDC 1999) more and more new houses will fall in the middle and upper income groups. It is also assumed that it will take 15 years for a newly electrified household to become established electrified. Appendix B shows projections of the total number of established electrified, newly electrified, non-grid electrified and non-electrified households.

The number of households using each appliance in 1995 was obtained from Eskom (1996). In order to project future use of appliances, each appliance was specified as a proportion of each type of household, based on Eskom (1996), and it was assumed that these proportions would remain constant for each type of household. Appendix C shows baseline projections of the number of households using each appliance.

4.3 Household appliance energy consumption

The average energy consumption per household per year was obtained for electrical appliances by multiplying average electricity consumption by average duration of use, and obtained for other appliances by estimating the average quantity of fuel used for each appliance. Various sources were use to estimate appliance energy consumption including Eskom (1999), Thorne (1996), Thorne (1997) and Cowan et al (1996). Where relevant, energy efficiency improvements in appliances and changes in average appliance energy consumption were estimated. Projections of annual energy consumption per appliance are shown in Appendix D and assumptions for appliance energy consumption are shown in Appendix E.

4.4 Residential energy consumption

Appendix F shows projections of residential energy consumption. Table 1 compares annual residential energy consumption calculated in this study with other sources of data. The largest discrepancy is in wood consumption, but the bottom-up approach of this study is likey to be more accurate than previous estimates.

Table 1. Annual energy consumption by the residential sector (PJ)

Source	*Year*	*Elec.*	*Coal*	*Paraffin*	*LPG*	*Wood*	*Dung*	*Solar*
This study	1990	72.9	55.8	25.5	4.2	89.0	5.0	0.2
GHG inventory (Scholes 1999)	1990		62.3	23.1	6.2			
Dept. of Min. & Energy (1998)	1990	72.0	61.0	32.0	1.0	274.0		
This study	1995	87.4	57.9	26.6	4.3	80.3	4.3	0.2
Energy Research Inst. (1999)	1995	88.0	59.0	24.0	3.4	82.0	0.0	0.1
Dept. of Min. & Energy (1998)	1996	89.0	59.0	28.0	0.5	0.0		
National Electricity Reg. (1996)	1995/96	114.0						
SA National Energy Ass. (1998)	1995	85.0	122.0	30.0	5.0	380.0		

4.5 Greenhouse gas emission coefficients

Greenhouse gas emission coefficients, shown in Appendix G, were divided into two categories:

1. Direct emissions – emissions produced from energy consumption in the appliance itself. Direct emission factors were obtained from Howells and de Villiers (1999). It is estimated that 25% of biomass is not used sustainably (Scholes 1999).
2. Indirect emissions – emissions produced in order to supply a fuel to households. Indirect emission coefficients were obtained from the Energy Sector Baseline Study (Howells 1999). Indirect emissions were used to determine the total benefit of each greenhouse gas mitigation option.

5. Greenhouse gas emissions

Direct residential sector carbon dioxide equivalent emissions in 1990 were calculated to be 10.0 million tons whereas Scholes (1997) calculated it to be 9.80 million tons. Direct residential sector carbon dioxide equivalent emissions are projected to decline to 6.3 million tons by 2030 in the baseline scenario. Total direct and indirect residential sector carbon dioxide equivalent emissions in 1990 were calculated to be 32.0 million tons and projected to increase to 94.9 million tons in the baseline scenario. Direct greenhouse gas emissions for the Baseline Scenario are shown in Appendix H in IPCC format (the required IDC format is the same).

6. Mitigation options

6.1 Introduction

Mitigation options in the residential sector essentially either involve using energy more efficiently or fuel switching. Mitigation options that involve switching to gas assume that bottled LP gas is used. The establishment of a natural gas network in residential areas was not considered although the effect of switching to LP gas or natural gas would be similar in terms of emissions savings. Table 2 shows the mitigation options considered in this study.

Table 2. Mitigation options considered

Baseline technology	*Mitigation technology*
Incandescent lighting	Compact fluorescent lighting
Standard lighting practices	Efficient lighting practices
Standard wood/coal stove	Energy efficient coal/wood stoves
Electric hot plate	Gas ring
Electric geyser	Hybrid solar water heater
Fuel-based water heater	Stand-alone solar water heater
Standard geyser	Well insulated geyser
Standard geyser	Centralised heat pump systems
Standard hot water use	Efficient hot water use
Standard housing	Thermally efficient housing
Electrical space heater	Gas space heater
No appliance labeling or standards	Appliance labeling and standards
Non-electrified households	Solar home systems
Non-electrified households	Distributed wind generation
Paraffin wick stove	Gas ring

For all mitigation measures, the total technical potential is first estimated, and then a scenario for the realistic potential estimated based on previous reseach or simply the 'best' estimate of the authors. Implementation of mitigation options was considered from 2001 to 2015, but greenhouse gas implications were assessed until 2030.

6.2 Energy prices

Current and projected energy prices used in the mitigation option calculations are shown in Appendix I. Commercial residential fuel prices, excluding coal, were taken from Howells (1999). The residential coal price was taken from Spalding-Fecher (1999) and the residential wood price from Praetorius and Fecher (1998), and both were assumed to remain constant in real terms. Dung costs were assumed to be the same as wood.

6.3 Access costs

Access costs are involved with fuel switching. Access costs are included with the initial investment costs. In order to switch to gas a deposit of R156 is required for a gas bottle (Praetorius and Fecher 1998). Access costs for solar and wind electricity are included under the solar home system and distributed wind mitigation options.

6.4 Implementation costs

It is assumed that all mitigation options will involve implementation costs, since by definition the Baseline Scenario represents business-as-usual, and some form of intervention is required to alter the Baseline Scenario. Implementation costs are often ignored or only superficially examined in previous research and therefore implementation costs were often estimated in this study. Implementation costs exclude any form of financial assistance provided to households.

6.5 Description of mitigation options

6.5.1 Replace incandescent lights

All incandescent light bulbs can be replaced with compact fluorescent lights (CFLs), but the less a light is used, the less feasible it becomes to use a CFL. Clark (1997) assumes that 500 000 CFLs could be introduced into the market per year, based on early estimates for Eskom's efficient lighting programme. This penetration is over and above business-as-usual CFL penetration, was used for this study. It is assumed that replaced lights are used for 3.2 hours on average (Spalding-Fecher 1999). The average cost of a 75W incandescent light is R3.00 with an average life of 0.9 years and the cost of a 15 W CFL is R27 and a replacement cost of R13 with an average life of 6.3 years (Spalding-Fecher 1999). A large promotional campaign and financing programme would be required to achieve savings. It is assumed that implementation costs are R5 per CFL.

The main barriers to the use of CFLs are the lack of awareness of their cost and benefits, the high initial cost of the CFL and the risk that the CFL will not perform as promised.

CFLs are starting to be manufactured locally, and it is likely that they will be exported as well (independently of local consumption). CFLs used less electricity and therefore also reduce non-greenhouse gas emissions from electricity generation. Because CFLs have a lower life cycle cost than the incandescent light, they can reduce expenditure on energy and help to alleviate poverty.

6.5.2 Efficient lighting practices

Efficient lighting practices include switching off lights when a room is unoccupied, fitting lower power light bulbs where possible and controlling security lighting with light or movement sensors. It is estimated that incandescent lighting energy use can be reduced by 20% through efficient lighting practices, but it is assumed that realistically achievable savings are 10% of total electricity lighting energy. It is assumed that it will take five years of intense promotion to realise these savings and that continued promotion will be required to maintain these savings. The cost of promotion is assumed to be R1 million per year.

The main barrier to more efficient lighting practices is lack of awareness of users.

Efficient lighting practices can reduce expenditure on energy and help to alleviate poverty. Non-greenhouse gas emissions in energy supply will be reduced.

6.5.3 Efficient wood/coal stove

Many projects have been carried out to improve the efficiencies of stoves. The efficiency of a stove can either be calculated as the cooking efficiency or the overall (cooking and heating) efficiency. Graham (1997) measued the cooking efficiency of a wood stove to be 3.8% and the overall efficiency to be 38.5%, and the cooking efficiency of a coal stove to be 2.0% and the overall efficiency to be 27.8%. His results illustrate the large potential for efficiency improvement. Allison (1994) tested three coal stoves and found overall efficiencies to vary from 28 to 46%. Baldwin (1986) designed a stove with an efficiency of 55%. In this study it is assumed that the average stove efficienc is 35% and that this can be improved to 50% (a 30% reduction in fuel use). The cost of a standard coal stove is R873 with a life of 17.0 years and an efficient one costs R1 400 with a life of 16.9 years (Thorne 1996). In the baseline scenario many wood/coal stove users will convert to electrical appliances. It is assumed that half of wood/coal stove users who will continue to use these appliances until 2030 can be converted to efficient stoves over the next ten years, and that 40 percent of existing coal/wood stove users will continue to use wood/coal stoves until 2030. Implementation costs are estimated to be R1 million per year.

The main barriers to the use of efficient wood/coal stoves are initial cost and lack of awareness.

Efficient wood stoves can reduce depletion of vegetation. Harmful local air pollution such as particulates could be reduced significantly. Efficient wood/coal stoves can reduce expenditure on energy and help alleviate poverty. The technology for efficient stoves is readily available.

6.5.4 Hot plate to gas cooking

Total greenhouse gas emissions from gas are about half of that of electricity in South Africa, so fuel switching could significantly reduce emissions (the same would not be true of France, where the electricity is nuclear). Only those households with grid electricity will be able to use hot plates. The cost of a hot plate is R100 (Spalding-Fecher 1999) with a life of 4.4 years and the costs of a gas ring is R40 with a life of 4.8 years (Thorne 1996). It is assumed that 50% of hot plate sales can be substituted over 10 years. Baseline Scenario hot plate sales are estimated at 100 000 per year (sales were 50 000 in 1991 (Marbek Consultants 1997)). The implementation cost is assumed to be R1 million per year.

The main barriers to gas cooking are the poor distribution networks, inconvenience of obtaining LPG, non-availability of LPG in some areas and the initial cost of switching.

Switching from hot plates to gas for cooking can reduce expenditure on energy and help alleviate poverty (shown later in the financial analysis). Non-greenhouse gas emissions in energy supply will be reduced.

6.5.5 Hybrid solar water heaters

The hybrid solar water heater is supplemented with electricity to ensure continuous hot water supply all year through. Venter (1999) estimates that that about 90% of hot water requirements are generated by solar energy and 10% by electricity. The cost of a standard 200l electrical geyser is R1 953 with a life of 21.9 years and the cost of a 200l hybrid solar water heater is R7 980 with a life of 17.1 years (Thorne 1996). If an existing 200l electric geyser is retrofitted, the equipment and installation cost is about R5 500 in Cape Town (Venter 1999). In areas that experience frost a special heat exchange system is required which costs an additional R940 (Suncol 1999). Only electrified households are considered for this mitigation option. A 20% penetration of the electrical geyser market is assumed to be achievable over the next 15 years. It is assumed that implementation costs are R2 million per year.

The main barrier to the use of hybrid solar water heaters is the high initial cost of conversion and the risk of it not performing as promised.

Solar water heaters could create demand for labour through the manufacture and installation of solar water heaters. Technical support for solar water heaters already exists in South Africa and will grow with demand. Non-greenhouse gas emissions in energy supply will be reduced.

6.5.6 Stand-alone solar water heaters

These are stand-alone solar water heaters that replace coal, wood, paraffin and gas that would have been used for water heating. Meyer (1997) says that developed dwellings use about 75 litres/person of hot water while traditional dwellings consume about 7 litres/person. The efficiency of a gas geyser 84%, paraffin stove 43%, wood stove 25% and coal stove 40% (Thorne 1996). Based on fuel usage patterns the proportion of fuels substituted are estimated to be 40% coal, 38% wood, 20% paraffin and 2% gas. The cost of a stand-alone standard solar water heater is R1 806 with a 17.1 year life (Thorne 1996). However, a low-cost solar water heater, called the ‘Madiba Heatbarrow’ has recently been developed. Production costs for test barrows are R1500 per barrow, but if the system were mass produced costs could be reduced to as low as R350 per barrow (Niewoud 1999). The life of a barrow is expected to be five to ten years (Niewoud 1999). It is assumed that the barrow will cost R500 with a life of 7.5 years. It is assumed that 25 000 barrows annually penetrate the market for the next 15 years. It is assumed that implementation costs are R2 million per year.

The main barrier to stand-alone hot water heaters is the high initial cost and lack of affordability by non-grid electrified households who would use them.

Stand-alone hot water heater will provide low-income households with more hot water than they would be able to boil on a stove or fire. They will reduce harmful local air pollution such as particulates by reducing fuel consumption. Non-greenhouse gas emissions in energy supply will be reduced. Stand-alone solar water heaters could create demand for labour through the manufacture solar water heaters. A problem may be experienced with accessing technical support in rural areas for a sophisticated solar water heater, but the ‘Madiba Heatbarrow’ would not require technical support.

6.5.7 Insulation of hot water cylinders

It has been estimated that extra geyser insulation could be applied to 2.2 million geysers with savings of 400 to 470 kWh per year per geyser (about 12% of total geyser consumption) with a payback of one year (Mathews et al 1998). Holm and Lane (1998) estimate that by 2018 a technical potential of a 15% reduction in geyser electricity consumption exists, but a realistic reduction potential of 4.2% exists for existing houses and 6.0% for new houses. In this study it is assumed that by 2015 existing geysers could improve efficiencies by 4.2% and by 2015 all new electric geysers could have their efficiencies improved by 6%. The cost of insulation is assumed to be R92 per geyser (Mathews et al 1998) and the insulation is assumed to last for 20 years, the same as the life of the geyser. Implementation costs are estimated to be R1 million per year.

The main barriers to hot water cylinder insulation are lack of awareness of its benefits and lack of access to insulation services.

Insulation of hot water cylinders will require labour for installation of the insulation. Non-greenhouse gas emissions in energy supply will be reduced.

6.5.8 Heat pumps for hot water

Meyer et al (1997) propose the installation of small centralised heat pump and hot water storage systems which then pipe hot water to houses nearby. The energy conservation potential per house is 30 to 60 percent. They believe such systems are financially viable for medium and high density dwellings. A financial analysis was conducted on 14 different types of dwellings for new dwellings and retrofits. It was found that centralised heat pump retrofits were not financially viable, but that they were financially viable for most new types of dwellings. Only high density formal dwellings were considered for this mitigation option, and this includes high density houses, flats, hostels and townhouses. Table 3 shows the incremental costs of a heat pump system over the standard resistance heater.

Table 3. Comparative costs of a heat pump system
(Meyer et al 1998)

	Electric geyser cost (Rand/unit)	*Heat pump district heating (Rand/unit)*	*% of housing stock*
House	2 237	3 876	22.3%
Flat	2 237	1 931	4.0%
Hostel	2 166	1 051	3.5%
Townhouse	2 237	2 117	2.7%
Total/average	2 229	3 186	32.5%

No implementation costs are given, and so these are estimated to be 5% of the installation cost. Maintenance and running costs are not considered by Meyer et al (1997), but it is assumed that they are 3% of the installation cost and the life of a heat pump is assumed to be 20 years. It is assumed that 10% of the potential market is penetrated over the next 15 years.

The main barriers to heat pumps are the high cost of conversion and the high level of institutional involvement required.

Heat pump systems will increase demand for labour through the installation of such systems, but they will reduce demand for labour in the electric geyser sector. Non-greenhouse gas emissions in energy supply will be reduced.They could have a negative impact on the trade balance as certain components may be imported. Centralised heat pump systems have not yet been demonstrated, and they require a high degree of technical expertise.

6.5.9 Efficient use of hot water

Efficient use of hot water involves measures such as use of efficient shower heads, showering instead of bathing, using less hot water in a bath, using the cold water tap, and setting the thermostat to 55 degrees centigrade. It is estimated that the efficient use of hot water can reduce water heating energy consumption by 13% (Lane 1996). Holm and Lane (1998) estimate that the technical potential reduction in hot water energy use is 10% for low flow showerheads, but the realistic potential is 3.4% for existing houses and 6.2% for new houses. It is assumed in this study that an intense promotional programme could reduce current electric geyser energy consumption by 8% over the next 10 years. Such a campaign is estimated to cost R1 million per year.

The main barrier is lack of awareness by hot water users.

Efficient use of hot water will help conserve water and it will reduce energy expenditure and help alleviate poverty. Non-greenhouse gas emissions in energy supply will be reduced.

6.5.10 Thermally efficient housing

Measures that can be taken to improve thermal efficiency include correct choice of exterior colour, correct building orientation, ventilation control, optimal window size for different facing walls, provision of a ceiling and provision of adequate wall insulation.

Steenkamp (1995) has calculated the percentage reduction in space heating energy in order to keep a typical low cost house at 20 degrees centigrade from 18:00 to 22:00 for Cape Town Johannesburg (Durban's space heating requirements are very low). Table 4 shows the costs and percent energy saving for different thermal efficiency measures.

Table 4. Costs and savings of thermal improvements
(Steenkamp 1995)

	Measure	*Cost per house (Rand)*	*Energy saving (%)*	
			Cape Town	*Johannesburg*
A	North window 100% larger	760	4	4
B	Ceiling	2 582	27	24
C	Ceiling + 50 mm insulation	3 195	44	39
D	220 mm brick exterior wall	1 747	23	25
E	220 +100 interior brick walls	2 099	25	27
F	A + B	3 342	30	27
G	A + C	3 955	47	43
H	A + C + D	5 638	81	79
I	A +C + E	5 990	82	80

Table 4 illustrates that there is a cost savings curve and it is only relevant to talk about savings if the related cost is provided. Provision of a ceiling appears to be the single most cost effective means of improving the thermal efficiency of houses. Simmonds (1997) estimates that provision of ceiling can reduce annual space heating energy consumption by 20% and the cost of a ceiling for a low-cost house to be R450. Holm and Lane (1998) estimate that thermal efficiency retrofits can save 15% of heating energy, but the realistic potential is 11.1%. They also estimate that new houses can be built to reduce heating energy by 30%, but the realistic potential is 12.9%. Mathews et al (1998) estimate that thermally retrofitting existing houses can save 4.72 million MWh per year with a total investment of R6.84 million (average simple payback of 7.4 years). Mathews et al (1998) estimates that the cost of promotion and energy audits would be R1.3 million start-up and R16.6 million annual cost, but they include hot water insulation in the estimate. They believe that, even with such a programme, most of the potential savings would not be realised, and that interest free loans and minimum standards would also be required. Guy and Price (1998) presented the ECO homes concept, which has been successfully applied in Kimberly by Peer Africa (Pty) Ltd. An ECO home incorporates thermally efficient design components including optimised orientation, window overhangs, optimised size and positioning of windows, materials usage for adequate thermal mass, insulation of walls and ceiling, and sealing and weather-stripping. For a 45 square metre house, an ECO home will cost R2 800 more than the standard low-cost house. They estimate that in Cape Town an ECO home will reduce fuel consumption by 70%.

For this study it is assumed that the ECO home options are implemented at a cost of R2 800 per house, and that heating energy consumption will be reduced by 70%. It is assumed that an average of 200 000 low-income houses will be built each year between 2001 and 2015 and that 50% of these will realise the above savings. The implementation cost is assumed to be R1.3 million in the first year and R16.6 million/year (Mathews 1998). Proportionately more electricity will be used by low-income households as time goes by, but to simplify calculations an average fuel mix was assumed for the mitigation calculations. Table 5 shows average weighted energy consumption per low-income household for space heating (Spalding-Fecher et al 1999).

Table 5. Weighted average space heating energy consumption
(Spalding-Fecher et al 1999)

	GJ/annum/hh
Electricity	0.02
Paraffin	0.52
Gas	0.00
Coal	2.37
Wood	0.86
Dung	0.00

Barriers to efficient housing include:

- lack of access to capital to finance energy efficiency and a strong emphasis on minimising investment costs;
- split incentives i.e. separation of responsibilities of the decision-maker for capital investment (developer) and the payer of operating costs (house owner);
- lack of information by all stakeholders;
- complicated institutional issues that cut across many government departments.

Thermally efficient housing will reduce the need for heating with fuels and therefore reduce emissions of harmful local pollutants. Non-greenhouse gas emissions in energy supply will be reduced. Depending on the type and cost of measures implemented it could have a net positive effect on expenditure by low-income households thus helping to alleviate poverty. It would have a positive effect on the demand for labour in the building sector. Local labour could be used for the incremental building labour requirements.

6.5.11 Electricity to gas space heating

Total greenhouse gas emissions for gas are about half of that for electricity. The cost of an electrical heater is R179 with a 5.5 year life and the cost of a gas heater is R431 with a life of 4.8 years (Thorne 1996). It is assumed that gas heaters can replace 50% of electrical heaters by 2015. It is estimated that implementation costs are R1 million per year.

The main barriers to gas heating are inconvenience of obtaining LPG, non-availability of LPG in some areas and the initial cost of switching.

Switching from electricity to gas will result in non-greenhouse gas emissions in energy supply being reduced.

6.5.12 Appliance standards and labelling

Although standards and labelling can be implemented separately, their synergies justify examination of standards and labelling as one mitigation option. South Africa could benefit substantially due to its vulnerability to illegal imports and dumping of sub-standard appliances. Refrigerator and freezers have received most attention, although geysers and lighting equipment can also benefit. This mitigation option only considers the benefit to refrigerators and freezers, as other appliances are dealt with by other mitigation options. Appliance standards and labelling can be voluntary or mandatory and are mandatory in North America, the European Union and Australia. Marbek Resource Consultants (1997) estimate that an average unit efficiency improvement of 30% could be achieved, but do not estimate likely market penetration. They assume that that the average retail price increase would be 15%. They estimate that implementation costs for a mandatory programme would be R0.90 per unit sold. It is assumed that 50% of the market would benefit from a labelling and standards programme and that the average cost of a standard refrigerator/freezer is R2 400 (Marbek Resource Consultants (1997). Annual unit sales in South Africa in 1996 were given to be 342 000 refrigerators and 181 000 for freezers and it is assumed that sales grow by 3% per year.

Barriers to mandatory standards and labelling include the high level of government planning and involvement required, and the lack of capacity and finance that exists in government to implement such a programme. There may also be resistance from manufacturers and retailers.

Appliance labelling and standards will help reduce expenditure on energy services. Non-greenhouse gas emissions in energy supply will be reduced. They could have a negative effect on employment in the electricity supply sector as electricity sales will decline. Institutional capacity exists to administer such a programme.

6.5.13 Solar home systems

A solar home system, defined in this study, consists of a 50 Wp solar panel, battery storage, a compact fluorescent light and at least one electricity socket. It is assumed for the solar home system that 50% of electricity is used for lighting, and 50% for radio, television, and sewing. The main greenhouse gas benefits of the solar home system will be:

- the replacement of paraffin and gas with ‘clean’ electricity for lighting;
- the replacement of battery charging from grid electricity with solar powered electricity;
- the replacement of a potential grid connection with a clean source of electricity.

The middle scenario for solar home system penetration (20% of non-electrified houses within 15 years) given by Cowan et al (1996) was selected as the market size for this mitigation option. This means that 368 000 systems would be installed by 2015. It is likely that all solar home systems would be installed for houses that are very expensive to grid electrify, and therefore the replacement of grid electricity with solar electricity is not considered as a mitigation option.

The initial costs components of a 50 Wp solar home system are (Cowan et al 1996):

Equipment	R 2 174
Installation	R 400
Retail margin	R 435
Total	R 3 009

In addition fixed implementation costs would be R975 000 escalating at 2% (real) per year, and a variable cost of R250 per system (Cowan et al 1996). Maintenance and replacement costs would be R 192 per year (Cowan et al 1996).

It is estimated that the most likely households to switch to the soalr home system are those that spend a significant amount on energy services – that is, it is assumed that 75% of households selecting the solar home system use paraffin for lighting and 75% use car batteries. It is assumed that the solar home system displaces 80% of the energy of these (Cowan et al 1996). It is estimated that paraffin users use 6l per month of paraffin for lighting and that a car battery consumes 1.2 kWh per charge. A paraffin wick lamp costs R11 and lasts about three years (Thorne 1996). A car battery costs about R130 and lasts about 1.5 years. Based on a number of case studies included in Cowan et al (1996) a car battery is charged about once every 14 days and each charge costs about R5 and transport costs are R13 per charge (but only half of this is attributed to battery charging). In addition the solar home system will displace dry cell batteries (60% displacement) and candles (80% displacement). It is estimated that average monthly household expenditure will be R6.40 on candles and R10.60 on dry cell batteries (Cowan et al 1996).

Barriers to the solar home system are:

- the high up-front cost and lack of financing;

- negative perceptions about solar electricity versus grid electricity;
- security of the solar home system;
- limitations of SHS, e.g. cannot power major appliances or tools;
- the high amount of institutional involvement required.

The solar home system will reduce the need for paraffin, which carries the risk of poisoning and fires in low income homes – same for candles, in many households. It will also eliminate the need to waste time travelling to have a car battery charged every two weeks. It will provide low-income households will a good source of light. It will increase the demand for labour through the manufacture and installation of solar systems. The solar home system could become an export service of South Africa.

6.5.14 Distributed wind generation

Distributed wind generation refers to all wind electricity generation that is not connected to the electricity grid. Wind generation systems will be of different sizes and each system will supply communities. It is therefore more useful to examine costs in terms of per kWh and estimated the average number of KWhs consumed by each household. The most important factor for wind generation is wind speed. It is estimated that distributed wind generation is only feasible in areas that have average wind speeds in excess of 5 m/s (Cowan 1999). At such wind speeds the cost of wind generation with battery backup is about R5.00/kWh (EDRC 1992). It is estimated that each household using wind energy would consume an average of 50W for four hours each day.

Distributed wind generation is assumed to replace the same fuel use patterns as the solar home system, and the same implementation costs are assumed.

Only a few areas in South Africa have wind speeds in excess of 5 m/s, and only a fraction of these are located a significant distance from the grid. Some communities in the south-eastern Cape may be able to make use of wind generation. No previous estimated has been made of the potential use of distributed wind generation. It is estimated that over the next 15 years 5 000 households could be connected each year.

Barriers to distributed wind generation systems are:

- the high capital costs of the system;
- the high cost of stand-alone wind systems;
- the high amount of co-ordination required;
- the perception that non-grid electricity is inferior to grid-electricity.

Distributed wind generation will reduce the need for paraffin, which carries the risk of poisoning and fires in low income homes – same for candles, in many households. It will also eliminate the need to waste time travelling to have a car battery charged every two weeks. It will provide low-income households will a good source of light. It will increase the demand for labour through the manufacture and installation of the wind systems.

6.5.15 Paraffin to gas cooking

Gas cooking is more efficient than paraffin cooking, and gas is also a safer fuel. The average cost of a paraffin wick stove is R122 with a life of 3 years and the average costs of a gas ring is R40 with a life of 4.8 years (Thorne 1996). The average efficiency of a paraffin wick stove is 42.5% and the average efficiency of a gas ring stove is 50% (Thorne 1996). It is assumed that gas ring stoves could replace 25 000 paraffin wick stoves each year for 15 years.

Barriers to converting from paraffin to gas are:

- ingrained cultural habits that have developed around paraffin;
- initial costs of obtaining a gas bottle;
- lack of access to LPG in certain areas.

Replacement of paraffin will reduce the incidence of paraffin poisoning, and also reduce non-greenhouse gas emissions.

6.6 Financial analysis of mitigation options

A financial analysis was carried out for each mitigation option for one unit of replacement (per stove, heater, geyser, etc). All monetary values are expressed in 1997 Rands. Key outputs of the financial analysis are:

1. Incremental life cycle costs (LCC) per unit, calculated by discounting all cash flows (including unitised investment costs) and subtracting the baseline technology LCC from the mitigation technology LCC.
2. Incremental levelised costs (LC) per unit, calculated by dividing incremental LCC by a 30-year levelised cost factor (function of discount rate).
3. Cumulative direct and indirect carbon dioxide equivalent reduction per unit, evaluated over 30 years.
4. Rand per ton of carbon dioxide equivalent, calculated by dividing LCC/unit by cumulative carbon dioxide equivalent reduction.
5. Kg cumulative carbon dioxide equivalent reduction per rand of incremental investment, calculated by dividing cumulative carbon dioxide equivalent per unit by incremental investment cost per unit.
6. Total LCC, calculated by multiplying LCC/unit by the number of replacements each year and then discounting each year's total LCC back to the first year.
7. Cumulative total carbon dioxide equivalent reduction, calculated by determining the change in energy consumption each year until 2030 and then multiplying each energy type by total (direct and indirect) greenhouse gas emission coefficients.

Appendix J shows the number of annual unit replacements for each mitigation option. The financial analysis was carried out with discount rates of 3%, 6% and 12%. Appendix K summarises financial results for each mitigation option and discount rate. The 6% discount rate was used for all further analysis in this study.

6.7 Greenhouse gas emissions for mitigation options

Appendix L shows projections of direct greenhouse emissions for each mitigation option.

6.8 Evaluation of mitigation options

Table 6 shows shows an evaluation of mitigation options. Each mitigation option was either quantified or assessed as having a positive, negative, or zero influence on each evaluation criteria. The effect of mitigation options on GDP and inflation is unknown.

Table 6. Evaluation of mitigation options

	Reduction in GHG emissions (mill. tons)	**Local environmental impact**				**Cost-effectiveness (R/ton)**	**Macro-economic impact**					**Social impacts**		**Institutional and admin. capacity**	**Technological feasibility**
		soil conservation & biodiversity	water resources & biodiversity	Air quality non GHG emissions	leakage		impact on trade balance	impact on GDP	impact on inflation	return on initial investment (Kg/R)	impact on international competitiveness	social equity & poverty alleviation	job creation		
Replace incandescents	11	Zero	Zero	+	Zero	-119	-	?	?	79	Zero	+	Zero	-	+
Efficient lighting practices	18	Zero	Zero	+	Zero	-120	Zero	?	?	infinite	Zero	+	Zero	-	+
Efficient wood/coal stove	5	Zero	Zero	+	Zero	-15	Zero	?	?	32	Zero	+	Zero	-	+
Hot plate to gas cooking	5	Zero	Zero	-	Zero	-24	-	?	?	-153	Zero	Zero	Zero	-	+
Hybrid solar water heaters	88	Zero	Zero	+	Zero	84	Zero	?	?	14	Zero	Zero	+	-	+
Solar water heaters	2	Zero	Zero	+	Zero	198	Zero	?	?	14	Zero	+	+	-	+
Heat pumps for hot water	19	Zero	Zero	+	Zero	-104	Zero	?	?	148	+	+	+	-	-
Insulation of geysers	25	Zero	Zero	+	Zero	13	Zero	?	?	43	Zero	Zero	+	-	+
Efficient use of hot water	22	Zero	+	+	Zero	-121	Zero	?	?	infinite	Zero	+	Zero	-	+
Thermally efficient housing	9	Zero	Zero	+	Zero	723	Zero	?	?	3	Zero	+	+	-	+
Elec to gas space heating	25	Zero	Zero	-	Zero	129	-	?	?	43	Zero	Zero	Zero	-	+
Appliance labelling & standards	25	Zero	Zero	+	Zero	-15	Zero	?	?	19	Zero	+	Zero	-	+
Solar home system	2	Zero	Zero	+	Zero	351	Zero	?	?	3	+	+	+	-	+
Distributed wind generation	0	Zero	Zero	+	Zero	222	-	?	?	-79	+	+	+	-	+
Paraffin to gas cooking	2	Zero	Zero	Zero	Zero	-16	Zero	?	?	-48	Zero	Zero	Zero	-	+

7. Mitigation marginal cost curve

Figure 1 shows a marginal cost curve for the mitigation options considered. It should be noted that mitigation options are not mutually exclusive and therefore the actual cumulative savings will be considerably less than the 252 indicated in Figure 1.

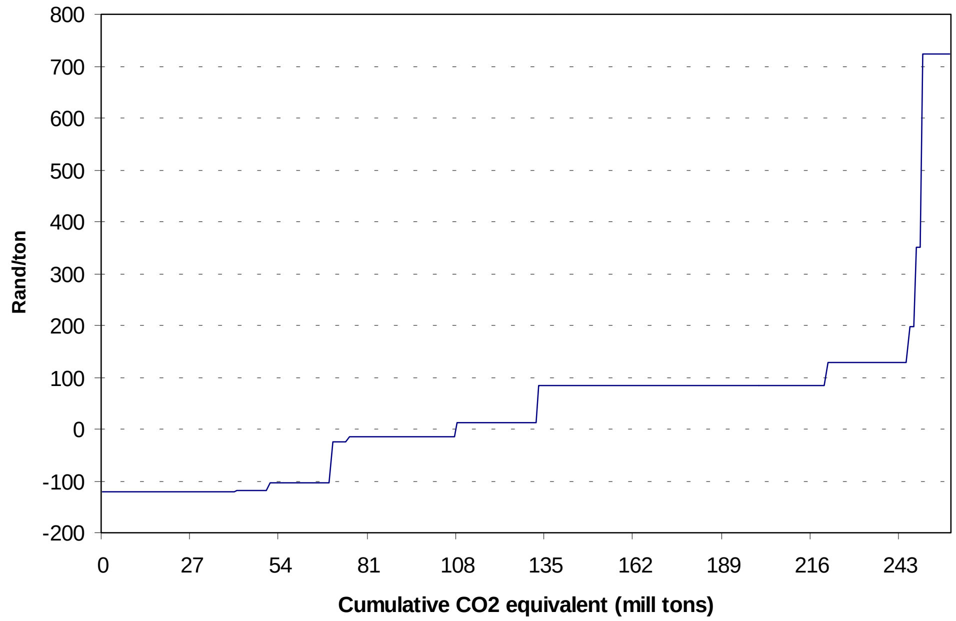

Figure 1. Mitigation marginal cost curve

8. Conclusions

A number of cost-effective mitigation options exist for the residential sector. Social equity, poverty alleviation and local air pollution are important considerations for the residential sector. The greatest cumulative greenhouse gas reduction is possible through hybrid solar water heaters, but they have a high Rand/ton savings costs. The most cost-effective residential sector mitigation option is the promotion of efficient use of hot water.

9. Recommendations

Recommendations can only be made for the residential sector when it is evaluated against other sector results.

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Appendices

Appendix A: Stakeholders consulted

Appendix B: Projections of number of households

Appendix C: Projections of households using each appliance

Appendix D: Projections of annual appliance energy consumption per household

Appendix E: Assumptions for 1990 appliance energy consumption per household

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Appendix H: Projections of direct greenhouse gas emissions

Appendix I: Projections of residential energy prices

Appendix J: Market penetration for mitigation options

Appendix K: Financial analysis for mitigation options

Appendix L: Greenhouse gas projections for each mitigation option

Appendix A: Stakeholders consulted

Department of Minerals & Energy, Electrification, Dr Izak Kotze

Department of Minerals & Energy, SEED Project, Ms Kosi Lisa

Department of Minerals & Energy, Mr Tony Golding

Department of Minerals & energy, Mr Robert Maake

Minerals and Energy Policy Centre, Dr Frank Hochmuth

LPG Association, Mr Colin Bain

Eskom, Residential Demand Side Management, Mr Piet Naude

Solar Energy Society of South Africa, Mr Marius Willemse

Energy Efficiency Enterprises, Prof Ian Lane

International Institute for Energy Conservation, Bob Price

Eskom, Efficient Lighting Initiative, Mr Barry Bredenkamp

Department of Trade and Industry, Appliance Labelling Initiative, Mr Ian Grant

Department of Housing, Ms Sharon Lewis

National Electricity Regulator, Ms Bathi Mlalazi

Palmer Development Group, Richard Palmer

Appendix B: Projections of number of households (million)

	hh estab. Electrified	*hh newly electrified*	*hh non-grid electrified*	*hh not electrified*	*Total*
1990	2.38	0.63	0.03	4.89	7.93
1994	2.56	1.53	0.03	4.53	8.65
1998	2.76	3.18	0.03	3.47	9.44
2000	2.85	3.89	0.03	3.03	9.80
2005	3.07	5.12	0.03	2.46	10.68
2010	4.85	4.34	0.03	2.32	11.54
2015	7.23	2.70	0.03	2.40	12.37
2020	8.87	1.81	0.03	2.41	13.13
2025	10.04	1.40	0.03	2.33	13.80
2030	10.96	1.23	0.03	2.26	14.48

Appendix C: Projections of percent households using each appliance

	Incand. light	Fluor. tube	CFL	Secur-ity light	Paraffin wick	Paraffin press.	Gas pres.	Hot plate	Micro-wave oven	Electric stove	Paraffin primus	Paraffin wick	Gas ring	Coal stove	Coal brazier	Wood stove	Wood open fire	Dung open fire	Electric geyser	Gas geyser	Solar water heater	Electric heater	Gas heater	Paraffin heater	Anthr. heater	Air cond-itioner	Electric fridge	Electric freezer	Paraffin fridge	Gas fridge	Other
1990	38.1%	33.3%	0.2%	3.1%	12.4%	3.1%	0.6%	4.0%	15.5%	31.3%	25.3%	25.3%	11.9%	9.4%	5.2%	9.4%	21.7%	1.5%	29.0%	0.3%	0.5%	23.4%	2.5%	7.8%	0.9%	0.3%	34.1%	18.1%	2.0%	4.0%	38.1%
1994	47.5%	36.8%	0.4%	3.1%	10.5%	2.6%	0.5%	8.9%	15.7%	33.0%	24.8%	24.8%	11.2%	9.5%	4.7%	9.5%	18.4%	1.3%	29.1%	0.4%	0.4%	24.1%	2.1%	7.2%	0.9%	0.3%	38.6%	17.8%	1.9%	3.9%	47.5%
1998	63.1%	42.8%	0.7%	3.1%	7.4%	1.8%	0.4%	16.9%	16.3%	36.2%	23.8%	23.8%	10.0%	9.5%	4.0%	9.5%	12.9%	0.9%	29.5%	0.4%	0.3%	25.4%	1.5%	6.1%	0.9%	0.3%	46.2%	17.6%	1.8%	3.6%	63.1%
2000	69.0%	45.1%	0.9%	3.1%	6.2%	1.5%	0.3%	19.9%	16.6%	37.3%	23.4%	23.4%	9.6%	9.6%	3.7%	9.6%	10.8%	0.8%	29.7%	0.4%	0.3%	25.9%	1.2%	5.7%	0.9%	0.3%	49.1%	17.5%	1.7%	3.5%	69.0%
2005	76.9%	48.0%	2.0%	3.1%	4.6%	1.2%	0.2%	24.0%	16.8%	38.8%	23.0%	23.0%	9.0%	9.6%	3.3%	9.6%	8.1%	0.6%	29.8%	0.4%	0.3%	26.4%	0.9%	5.2%	0.9%	0.3%	52.8%	17.3%	1.7%	3.3%	76.9%
2010	79.8%	57.2%	3.3%	4.4%	4.0%	1.0%	0.2%	18.9%	22.9%	49.6%	18.8%	18.8%	7.4%	7.8%	2.7%	7.8%	7.1%	0.5%	41.9%	0.3%	0.3%	35.3%	0.8%	4.3%	1.3%	0.4%	61.0%	25.3%	1.4%	2.7%	79.8%
2015	80.6%	67.4%	4.5%	6.0%	3.9%	1.0%	0.2%	11.0%	30.4%	62.3%	13.8%	13.8%	5.7%	5.6%	2.2%	5.6%	6.8%	0.5%	56.8%	0.2%	0.4%	46.2%	0.8%	3.4%	1.8%	0.5%	69.6%	35.2%	1.0%	2.0%	80.6%
2020	81.6%	73.3%	5.8%	6.8%	3.7%	0.9%	0.2%	6.9%	34.6%	69.4%	11.0%	11.0%	4.7%	4.4%	1.9%	4.4%	6.4%	0.5%	65.0%	0.2%	0.4%	52.2%	0.7%	2.9%	2.0%	0.6%	74.7%	40.6%	0.8%	1.7%	81.6%
2025	83.1%	77.0%	7.0%	7.3%	3.4%	0.8%	0.2%	5.1%	37.0%	73.7%	9.3%	9.3%	4.1%	3.7%	1.7%	3.7%	5.9%	0.4%	69.8%	0.1%	0.4%	55.7%	0.7%	2.5%	2.2%	0.7%	78.0%	43.8%	0.7%	1.4%	83.1%
2030	84.4%	79.3%	8.3%	7.6%	3.1%	0.8%	0.2%	4.3%	38.4%	76.2%	8.3%	8.3%	3.7%	3.3%	1.5%	3.3%	5.5%	0.4%	72.5%	0.1%	0.5%	57.8%	0.6%	2.3%	2.3%	0.7%	80.1%	45.5%	0.6%	1.3%	84.4%

Appendix D:
Projections of annual appliance energy consumption per household (GJ/hh/year)

	Incand. light	Fluor. tube	CFL	Secur-ity light	Paraffin wick	Paraffin press.	Gas pres.	Hot plate	Micro-wave oven	Electric stove	Paraffin primus	Paraffin wick	Gas ring	Coal stove	Coal brazier	Wood stove	Wood open fire	Dung open fire	Electric geyser	Gas geyser	Solar water heater	Electric heater	Gas heater	Paraffin heater	Anthr. heater	Air cond-itioner	Electric fridge	Electric freezer	Paraffin fridge	Gas fridge	Other
1990	2.72	0.31	0.12	9.33	1.73	6.91	0.97	3.89	0.39	4.15	4.32	5.18	1.94	31.20	74.88	16.32	44.88	40.80	11.34	6.48	6.48	3.89	3.24	3.46	24.96	15.55	3.24	2.49	6.48	4.86	1.30
1994	2.41	0.28	0.12	8.26	1.73	6.91	0.97	3.89	0.39	4.15	4.32	5.18	1.94	31.20	74.88	16.32	44.88	40.80	10.46	6.48	6.48	3.89	3.24	3.46	24.96	14.94	3.24	2.49	6.48	4.86	1.35
1998	2.13	0.24	0.12	7.31	1.73	6.91	0.97	3.89	0.39	4.15	4.32	5.18	1.94	31.20	74.88	16.32	44.88	40.80	9.65	6.48	6.48	3.89	3.24	3.46	24.96	14.35	3.24	2.49	6.48	4.86	1.40
2000	2.01	0.23	0.12	6.88	1.73	6.91	0.97	3.89	0.39	4.15	4.32	5.18	1.94	31.20	74.88	16.32	44.88	40.80	9.45	6.48	6.48	3.89	3.24	3.46	24.96	14.06	3.24	2.49	6.48	4.86	1.43
2005	2.03	0.20	0.12	6.95	1.73	6.91	0.97	3.89	0.39	4.15	4.32	5.18	1.94	31.20	74.88	16.32	44.88	40.80	9.55	6.48	6.48	3.89	3.24	3.46	24.96	13.38	3.16	2.43	6.32	4.74	1.50
2010	2.13	0.21	0.14	7.30	1.73	6.91	0.97	3.89	0.39	4.15	4.32	5.18	1.94	31.20	74.88	16.32	44.88	40.80	10.04	6.48	6.48	3.89	3.24	3.46	24.96	12.72	3.08	2.37	6.16	4.62	1.58
2015	2.24	0.22	0.16	7.68	1.73	6.91	0.97	3.89	0.39	4.15	4.32	5.18	1.94	31.20	74.88	16.32	44.88	40.80	10.55	6.48	6.48	3.89	3.24	3.46	24.96	12.10	3.01	2.31	6.01	4.51	1.66
2020	2.35	0.23	0.19	8.07	1.73	6.91	0.97	3.89	0.39	4.15	4.32	5.18	1.94	31.20	74.88	16.32	44.88	40.80	11.09	6.48	6.48	3.89	3.24	3.46	24.96	11.50	2.93	2.25	5.86	4.40	1.75
2025	2.47	0.24	0.22	8.48	1.73	6.91	0.97	3.89	0.39	4.15	4.32	5.18	1.94	31.20	74.88	16.32	44.88	40.80	11.65	6.48	6.48	3.89	3.24	3.46	24.96	10.94	2.86	2.20	5.72	4.29	1.84
2030	2.60	0.25	0.25	8.91	1.73	6.91	0.97	3.89	0.39	4.15	4.32	5.18	1.94	31.20	74.88	16.32	44.88	40.80	12.25	6.48	6.48	3.89	3.24	3.46	24.96	10.40	2.79	2.14	5.58	4.18	1.93

Appendix E:
Assumptions for 1990 appliance energy consumption per household

	Incand. light	Fluor. tube	CFL	Secur-ity light	Paraffin wick	Paraffin press.	Gas pres.	Hot plate	Micro-wave oven	Electric stove	Paraffin primus	Paraffin wick	Gas ring	Coal stove	Coal brazier	Wood stove	Wood open fire	Dung open fire	Electric geyser	Gas geyser	Solar water heater	Electric heater	Gas heater	Paraffin heater	Anthr. heater	Air cond-itioner	Electric fridge	Electric freezer	Paraffin fridge	Gas fridge	Other
No/hh	7	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ave. W	75	30	15	300	0	0	0	1000	600	1600	0	0	0	0	0	0	0	0	2500	0	1000	2000	0	0	0	1000	500	80	0	0	200
hr/day	4	4	6	12	0	0	0	3	0.5	2	0	0	0	0	0	0	0	0	3.5	0	5	1.5	0	0	0	12	5	24	0	0	5
Units/month	0	0	0	0	4	16	3	0	0	0	10	12	6	100	240	80	220	200	0	20	0	0	10	8	80	0	0	0	15	15	0
MJ/unit	0	0	0	0	36	36	27	0	0	0	36	36	27	26	26	17	17	17	0	27	0	0	27	36	26	0	0	0	36	27	0
MJ/month	227	26	10	778	144	576	81	324	32	346	360	432	162	2600	6240	1360	3740	3400	945	540	540	324	270	288	2080	1296	270	207	540	405	108
GJ/yr	2.72	0.31	0.12	9.33	1.73	6.91	0.97	3.89	0.39	4.15	4.32	5.18	1.94	31.20	74.88	16.32	44.88	40.80	11.34	6.48	6.48	3.89	3.24	3.46	24.96	15.55	3.24	2.49	6.48	4.86	1.30

UNITS	
paraffin	litres
coal	kg
gas	litres
wood	kg
dung	kg

Appendix F:
Projections of energy consumption (PJ)

	Incand. light	Fluor. tube	CFL	Secur-ity light	Paraffin wick	Paraffin press.	Gas pres.	Hot plate	Micro-wave oven	Electric stove	Paraffin primus	Paraffin wick	Gas ring	Coal stove	Coal brazier	Wood stove	Wood open fire	Dung open fire	Electric geyser	Gas geyser	Solar water heater	Electric heater	Gas heater	Paraffin heater	Anthr. heater	Air cond-itioner	Electric fridge	Electric freezer	Paraffin fridge	Gas fridge	Other
1990	8.19	0.82	0.00	2.25	1.69	1.69	0.05	1.22	0.48	10.25	8.63	10.36	1.83	23.25	30.72	12.16	76.87	4.99	26.01	0.18	0.24	7.19	0.63	2.14	1.78	0.33	8.73	3.56	1.03	1.55	3.90
1994	9.86	0.87	0.00	2.18	1.57	1.57	0.04	2.97	0.53	11.81	9.23	11.07	1.88	25.53	30.58	13.35	71.17	4.62	26.26	0.20	0.23	8.07	0.59	2.14	1.92	0.34	10.78	3.82	1.08	1.62	5.52
1998	12.66	0.98	0.01	2.13	1.20	1.20	0.03	6.18	0.60	14.11	9.66	11.60	1.83	28.00	27.91	14.65	54.46	3.54	26.80	0.22	0.20	9.28	0.45	1.99	2.06	0.36	14.08	4.12	1.09	1.63	8.33
2000	13.52	1.01	0.01	2.09	1.05	1.05	0.03	7.56	0.63	15.12	9.88	11.85	1.82	29.13	26.87	15.24	47.53	3.09	27.41	0.22	0.19	9.81	0.39	1.93	2.13	0.36	15.53	4.25	1.09	1.64	9.64
2005	16.60	1.01	0.03	2.31	0.85	0.85	0.02	9.95	0.70	17.14	10.57	12.68	1.86	31.93	26.25	16.70	38.69	2.51	30.28	0.25	0.18	10.94	0.32	1.91	2.30	0.37	17.78	4.47	1.11	1.67	12.32
2010	19.57	1.36	0.05	3.70	0.80	0.80	0.02	8.44	1.03	23.66	9.34	11.21	1.66	28.08	23.68	14.69	36.51	2.37	48.38	0.22	0.23	15.82	0.30	1.71	3.63	0.55	21.62	6.88	0.96	1.45	14.53
2015	22.25	1.81	0.09	5.66	0.83	0.83	0.02	5.26	1.46	31.86	7.34	8.81	1.37	21.50	20.45	11.25	37.69	2.45	73.90	0.17	0.31	22.14	0.31	1.46	5.42	0.79	25.80	10.02	0.76	1.14	16.52
2020	25.15	2.19	0.14	7.23	0.83	0.83	0.02	3.53	1.76	37.72	6.21	7.45	1.20	17.80	18.53	9.31	37.90	2.46	94.46	0.14	0.37	26.58	0.31	1.31	6.64	0.92	28.66	11.98	0.64	0.96	18.67
2025	28.29	2.54	0.21	8.57	0.81	0.81	0.02	2.72	1.98	42.08	5.54	6.65	1.09	15.71	17.11	8.22	36.64	2.38	111.95	0.12	0.40	29.82	0.30	1.21	7.52	0.99	30.70	13.22	0.56	0.84	21.00
2030	31.68	2.89	0.30	9.82	0.78	0.78	0.02	2.39	2.15	45.66	5.20	6.24	1.03	14.68	16.27	7.68	35.44	2.30	128.25	0.11	0.43	32.43	0.29	1.15	8.21	1.03	32.26	14.08	0.51	0.77	23.52

Appendix G:
Projections of emission coefficients (kg/GJ)

	Incand. light	Fluor. tube	CFL	Secur-ity light	Paraffin wick	Paraffin press.	Gas pres.	Hot plate	Micro-wave oven	Electric stove	Paraffin primus	Paraffin wick	Gas ring	Coal stove	Coal brazier	Wood stove	Wood open fire	Dung open fire	Electric geyser	Gas geyser	Solar water heater	Electric heater	Gas heater	Paraffin heater	Anthr. heater	Air cond-itioner	Electric fridge	Electric freezer	Paraffin fridge	Gas fridge	Other
Direct																															
CO2	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.1E+01	7.1E+01	6.2E+01	0.0E+00	0.0E+00	0.0E+00	7.1E+01	7.1E+01	6.2E+01	9.0E+01	9.0E+01	1.8E+01	1.8E+01	1.8E+01	0.0E+00	6.2E+01	0.0E+00	0.0E+00	6.2E+01	7.1E+01	9.2E+01	0.0E+00	0.0E+00	0.0E+00	7.1E+01	6.2E+01	0.0E+00
CH4	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-01	1.3E-01	2.4E-02	0.0E+00	0.0E+00	0.0E+00	1.3E-01	1.3E-01	2.4E-02	7.0E-01	7.0E-01	1.6E-01	1.6E-01	1.6E-01	0.0E+00	2.4E-02	0.0E+00	0.0E+00	2.4E-02	1.3E-01	7.0E-01	0.0E+00	0.0E+00	0.0E+00	1.3E-01	2.4E-02	0.0E+00
N2O	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.9E-04	5.9E-04	6.0E-04	0.0E+00	0.0E+00	0.0E+00	5.9E-04	5.9E-04	6.0E-04	1.4E-03	1.4E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00	6.0E-04	0.0E+00	0.0E+00	6.0E-04	5.9E-04	1.4E-03	0.0E+00	0.0E+00	0.0E+00	5.9E-04	6.0E-04	0.0E+00
CO2 equiv	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.4E+01	7.4E+01	6.3E+01	0.0E+00	0.0E+00	0.0E+00	7.4E+01	7.4E+01	6.3E+01	1.1E+02	1.1E+02	2.1E+01	2.1E+01	2.1E+01	0.0E+00	6.3E+01	0.0E+00	0.0E+00	6.3E+01	7.4E+01	1.1E+02	0.0E+00	0.0E+00	0.0E+00	7.4E+01	6.3E+01	0.0E+00
Indirect																															
CO2	2.7E+02	2.7E+02	2.7E+02	2.7E+02	2.3E+01	2.3E+01	3.0E+01	2.7E+02	2.7E+02	2.7E+02	2.3E+01	2.3E+01	3.0E+01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.7E+02	3.0E+01	0.0E+00	2.7E+02	3.0E+01	2.3E+01	0.0E+00	2.7E+02	2.7E+02	2.7E+02	2.3E+01	3.0E+01	2.7E+02
CH4	2.9E-04	2.9E-04	2.9E-04	2.9E-04	2.7E+00	2.7E+00	2.5E+00	2.9E-04	2.9E-04	2.9E-04	2.7E+00	2.7E+00	2.5E+00	8.0E-02	8.0E-02	0.0E+00	0.0E+00	0.0E+00	2.9E-04	2.5E+00	0.0E+00	2.9E-04	2.5E+00	2.7E+00	0.0E+00	2.9E-04	2.9E-04	2.9E-04	2.7E+00	2.5E+00	2.9E-04
N2O	3.4E-03	3.4E-03	3.4E-03	3.4E-03	2.9E-05	2.9E-05	2.7E-05	3.4E-03	3.4E-03	3.4E-03	2.9E-05	2.9E-05	2.7E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.4E-03	2.7E-05	0.0E+00	3.4E-03	2.7E-05	2.9E-05	0.0E+00	3.4E-03	3.4E-03	3.4E-03	2.9E-05	2.7E-05	3.4E-03
CO2 equiv	2.7E+02	2.7E+02	2.7E+02	2.7E+02	8.0E+01	8.0E+01	8.2E+01	2.7E+02	2.7E+02	2.7E+02	8.0E+01	8.0E+01	8.2E+01	1.7E+00	1.7E+00	0.0E+00	0.0E+00	0.0E+00	2.7E+02	8.2E+01	0.0E+00	2.7E+02	8.2E+01	8.0E+01	0.0E+00	2.7E+02	2.7E+02	2.7E+02	8.0E+01	8.2E+01	2.7E+02
Total																															
CO2	2.7E+02	2.7E+02	2.7E+02	2.7E+02	9.4E+01	9.4E+01	9.2E+01	2.7E+02	2.7E+02	2.7E+02	9.4E+01	9.4E+01	9.2E+01	9.0E+01	9.0E+01	1.8E+01	1.8E+01	1.8E+01	2.7E+02	9.2E+01	0.0E+00	2.7E+02	9.2E+01	9.4E+01	9.2E+01	2.7E+02	2.7E+02	2.7E+02	9.4E+01	9.2E+01	2.7E+02
CH4	2.9E-04	2.9E-04	2.9E-04	2.9E-04	2.9E+00	2.9E+00	2.5E+00	2.9E-04	2.9E-04	2.9E-04	2.9E+00	2.9E+00	2.5E+00	7.7E-01	7.7E-01	1.6E-01	1.6E-01	1.6E-01	2.9E-04	2.5E+00	0.0E+00	2.9E-04	2.5E+00	2.9E+00	7.0E-01	2.9E-04	2.9E-04	2.9E-04	2.9E+00	2.5E+00	2.9E-04
N2O	3.4E-03	3.4E-03	3.4E-03	3.4E-03	6.2E-04	6.2E-04	6.3E-04	3.4E-03	3.4E-03	3.4E-03	6.2E-04	6.2E-04	6.3E-04	1.4E-03	1.4E-03	0.0E+00	0.0E+00	0.0E+00	3.4E-03	6.3E-04	0.0E+00	3.4E-03	6.3E-04	6.2E-04	1.4E-03	3.4E-03	3.4E-03	3.4E-03	6.2E-04	6.3E-04	3.4E-03
CO2 equiv	2.7E+02	2.7E+02	2.7E+02	2.7E+02	1.5E+02	1.5E+02	1.4E+02	2.7E+02	2.7E+02	2.7E+02	1.5E+02	1.5E+02	1.4E+02	1.1E+02	1.1E+02	2.1E+01	2.1E+01	2.1E+01	2.7E+02	1.4E+02	0.0E+00	2.7E+02	1.4E+02	1.5E+02	1.1E+02	2.7E+02	2.7E+02	2.7E+02	1.5E+02	1.4E+02	2.7E+02

Appendix H: Projections of direct greenhouse gas emissions - Baseline scenario

YEAR: 1990

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.79E+03	0.00E+00	5.75E+01	0.00E+00	9.74E-02	0.00E+00	1.00E+04	0.00E+00			

YEAR: 1994

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.99E+03	0.00E+00	5.84E+01	0.00E+00	1.01E-01	0.00E+00	1.02E+04	0.00E+00			

YEAR: 1998

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.69E+03	0.00E+00	5.57E+01	0.00E+00	1.01E-01	0.00E+00	9.89E+03	0.00E+00			

YEAR: 2000

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.58E+03	0.00E+00	5.47E+01	0.00E+00	1.01E-01	0.00E+00	9.76E+03	0.00E+00			

YEAR: 2005

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.73E+03	0.00E+00	5.52E+01	0.00E+00	1.05E-01	0.00E+00	9.92E+03	0.00E+00			

YEAR: 2010

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	7.95E+03	0.00E+00	5.05E+01	0.00E+00	9.60E-02	0.00E+00	9.04E+03	0.00E+00			

YEAR: 2015

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	6.65E+03	0.00E+00	4.40E+01	0.00E+00	8.13E-02	0.00E+00	7.75E+03	0.00E+00			

YEAR: 2020

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	6.16E+03	0.00E+00	4.03E+01	0.00E+00	7.32E-02	0.00E+00	7.03E+03	0.00E+00			

YEAR: 2025

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	5.75E+03	0.00E+00	3.78E+01	0.00E+00	6.83E-02	0.00E+00	6.56E+03	0.00E+00			

YEAR: 2030

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	5.54E+03	0.00E+00	3.66E+01	0.00E+00	6.60E-02	0.00E+00	6.32E+03	0.00E+00			

Appendix I: Projections of residential energy prices (R/GJ)

	1990	1994	1998	2000	2005	2010	2015	2020	2025	2030
Electricity	90.23	78.10	68.75	65.98	65.32	65.32	65.32	65.32	65.32	65.32
Coal	9.63	9.63	9.63	9.63	9.63	9.63	9.63	9.63	9.63	9.63
Paraffin	34.70	26.81	27.75	28.22	29.38	30.53	31.69	32.85	34.01	35.17
LPG	59.50	40.90	48.07	48.87	50.88	52.88	54.89	56.90	58.90	60.91
Wood	28.24	28.24	28.24	28.24	28.24	28.24	28.24	28.24	28.24	28.24
Dung	28.24	28.24	28.24	28.24	28.24	28.24	28.24	28.24	28.24	28.24

Appendix J:
Market penetration for mitigation options (units/year)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Replace incandescents	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	7,500,000
Efficient lighting practices	1,637,400	1,637,400	1,637,400	1,637,400	1,637,400	0	0	0	0	0	0	0	0	0	0	8,187,000
Efficient wood/coal stove	38,095	38,095	38,095	38,095	38,095	38,095	38,095	38,095	38,095	38,095	0	0	0	0	0	380,954
Hot plate to gas cooking	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	750,000
Hybrid solar water heaters	93,410	93,410	93,410	93,410	93,410	93,410	93,410	93,410	93,410	93,410	93,410	93,410	93,410	93,410	93,410	1,401,149
Stand-alone solar water heaters	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	375,000
Insulation of geysers	163,215	163,215	163,215	163,215	163,215	163,215	163,215	163,215	163,215	163,215	0	0	0	0	0	1,632,154
Heat pumps for hot water	53,458	53,458	53,458	53,458	53,458	53,458	53,458	53,458	53,458	53,458	53,458	53,458	53,458	53,458	53,458	801,866
Efficient use of hot water	634,195	634,195	634,195	634,195	634,195	0	0	0	0	0	0	0	0	0	0	3,170,975
Thermally efficient housing	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	1,500,000
Elec to gas space heating	189,819	189,819	189,819	189,819	189,819	189,819	189,819	189,819	189,819	189,819	189,819	189,819	189,819	189,819	189,819	2,847,285
Appliance labelling & standards	261,500	269,345	277,425	285,748	294,321	303,150	312,245	321,612	331,260	341,198	351,434	361,977	372,836	384,022	395,542	4,863,616
Solar home system	2,000	3,000	4,000	9,000	12,000	20,000	30,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	368,000
Distributed wind generation	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	75,000
Paraffin to gas cooking	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	750,000

Appendix K: Financial analysis for mitigation options

Discount rate: 6%

	Replace incand-escents	Efficient lighting practices	Efficient wood/coal stove	Hot plate to gas cooking	Hybrid solar water heaters	Stand-alone solar water heaters	Insulation of geysers	Heat pumps for hot water	Efficient use of hot water	Thermally efficient housing	Elec to gas space heating	Appliance labelling & standards	Solar home system	Distributed wind generation	Paraffin to gas cooking
Unit	bulb	house	stove	hot plate	SWH	SWH	geyser	house	house	house	heater	appliance	house	house	house
Incremental LCC (R/unit)	-109	-136	-122	-108	3,325	692	-689	249	-427	2,638	717	-52	1,318	834	-32
Incremental LC (R/unit/year)	-7	-9	-8	-7	228	47	-47	17	-29	181	49	-4	90	57	-2
CO2 equiv. Reduction/unit (kg)	1,887	2,323	16,754	9,169	81,768	7,182	13,628	40,884	7,268	7,501	11,389	6,874	7,720	7,720	3,973
R per ton CO2 equiv.	-119	-120	-15	-24	84	198	-104	13	-121	723	129	-15	351	222	-16
Kg CO2 equiv./R incr. invest.	79	#DIV/0!	32	-153	14	14	148	43	#DIV/0!	3	43	19	3	-79	-48
Total incremental LCC (Rm)	-530	-936	-34	-52	3,017	168	-828	129	-1,140	2,562	1,321	-157	273	40	-15
CO2 equiv. reduction (mill. tons)	11	18	5	5	88	2	19	25	22	9	25	25	2	0	2

Discount rate: 3%

	Replace incand-escents	Efficient lighting practices	Efficient wood/coal stove	Hot plate to gas cooking	Hybrid solar water heaters	Stand-alone solar water heaters	Insulation of geysers	Heat pumps for hot water	Efficient use of hot water	Thermally efficient housing	Elec to gas space heating	Appliance labelling & standards	Solar home system	Distributed wind generation	Paraffin to gas cooking
Unit	bulb	house	stove	hot plate	SWH	SWH	geyser	house	house	house	heater	appliance	house	house	house
Incremental LCC (R/unit)	-136	-158	-162	-175	3,751	916	-808	506	-496	2,586	975	-117	650	1,133	-135
Incremental LC (R/unit/year)	-7	-8	-8	-9	186	45	-40	25	-25	128	48	-6	32	56	-7
CO2 equiv. Reduction/unit (kg)	1,887	2,323	16,754	9,169	81,768	7,182	13,628	40,884	7,268	7,501	11,389	6,874	7,720	7,720	3,973
R per ton CO2 equiv.	-107	-101	-14	-28	68	189	-88	18	-101	512	127	-25	125	218	-51
Kg CO2 equiv./R incr. invest.	79	#DIV/0!	32	-153	14	14	148	43	#DIV/0!	3	43	19	3	-79	-48
Total incremental LCC (Rm)	-814	-1,184	-53	-104	4,183	273	-1,125	323	-1,441	3,087	2,209	-446	178	68	-81
CO2 equiv. reduction (mill. tons)	11	18	5	5	88	2	19	25	22	9	25	25	2	0	2

Discount rate: 12%

	Replace incand-escents	Efficient lighting practices	Efficient wood/coal stove	Hot plate to gas cooking	Hybrid solar water heaters	Stand-alone solar water heaters	Insulation of geysers	Heat pumps for hot water	Efficient use of hot water	Thermally efficient housing	Elec to gas space heating	Appliance labelling & standards	Solar home system	Distributed wind generation	Paraffin to gas cooking
Unit	bulb	house	stove	hot plate	SWH	SWH	geyser	house	house	house	heater	appliance	house	house	house
Incremental LCC (R/unit)	-74	-103	-25	-43	3,206	499	-510	170	-325	2,715	476	44	2,012	564	40
Incremental LC (R/unit/year)	-8	-11	-3	-5	355	55	-57	19	-36	301	53	5	223	63	4
CO2 equiv. Reduction/unit (kg)	1,887	2,323	16,754	9,169	81,768	7,182	13,628	40,884	7,268	7,501	11,389	6,874	7,720	7,720	3,973
R per ton CO2 equiv.	-131	-148	-5	-16	130	231	-124	14	-149	1203	139	21	867	243	34
Kg CO2 equiv./R incr. invest.	79	#DIV/0!	32	-153	14	14	148	43	#DIV/0!	3	43	19	3	-79	-48
Total incremental LCC (Rm)	-252	-610	-5	-15	2,040	85	-471	62	-744	1,849	616	92	250	19	14
CO2 equiv. reduction (mill. tons)	11	18	5	5	88	2	19	25	22	9	25	25	2	0	2

Appendix L:
Direct greenhouse gas emissions for mitigation options

Replace incandescents

YEAR: 1990

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.79E+03	0.00E+00	5.75E+01	0.00E+00	9.74E-02	0.00E+00	1.00E+04	0.00E+00			

YEAR: 1994

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.99E+03	0.00E+00	5.84E+01	0.00E+00	1.01E-01	0.00E+00	1.02E+04	0.00E+00			

YEAR: 1998

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.69E+03	0.00E+00	5.57E+01	0.00E+00	1.01E-01	0.00E+00	9.89E+03	0.00E+00			

YEAR: 2000

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.58E+03	0.00E+00	5.47E+01	0.00E+00	1.01E-01	0.00E+00	9.76E+03	0.00E+00			

YEAR: 2005

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.73E+03	0.00E+00	5.52E+01	0.00E+00	1.05E-01	0.00E+00	9.92E+03	0.00E+00			

YEAR: 2010

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	7.95E+03	0.00E+00	5.05E+01	0.00E+00	9.60E-02	0.00E+00	9.04E+03	0.00E+00			

YEAR: 2015

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	6.65E+03	0.00E+00	4.40E+01	0.00E+00	8.13E-02	0.00E+00	7.75E+03	0.00E+00			

YEAR: 2020

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	6.16E+03	0.00E+00	4.03E+01	0.00E+00	7.32E-02	0.00E+00	7.03E+03	0.00E+00			

YEAR: 2025

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	5.75E+03	0.00E+00	3.78E+01	0.00E+00	6.83E-02	0.00E+00	6.56E+03	0.00E+00			

YEAR: 2030

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	5.54E+03	0.00E+00	3.66E+01	0.00E+00	6.60E-02	0.00E+00	6.32E+03	0.00E+00			

Efficient lighting practices

YEAR: 1990

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.79E+03	0.00E+00	5.75E+01	0.00E+00	9.74E-02	0.00E+00	1.00E+04	0.00E+00			

YEAR: 1994

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.99E+03	0.00E+00	5.84E+01	0.00E+00	1.01E-01	0.00E+00	1.02E+04	0.00E+00			

YEAR: 1998

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.69E+03	0.00E+00	5.57E+01	0.00E+00	1.01E-01	0.00E+00	9.89E+03	0.00E+00			

YEAR: 2000

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.58E+03	0.00E+00	5.47E+01	0.00E+00	1.01E-01	0.00E+00	9.76E+03	0.00E+00			

YEAR: 2005

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.73E+03	0.00E+00	5.52E+01	0.00E+00	1.05E-01	0.00E+00	9.92E+03	0.00E+00			

YEAR: 2010

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	7.95E+03	0.00E+00	5.05E+01	0.00E+00	9.60E-02	0.00E+00	9.04E+03	0.00E+00			

YEAR: 2015

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	6.65E+03	0.00E+00	4.40E+01	0.00E+00	8.13E-02	0.00E+00	7.75E+03	0.00E+00			

YEAR: 2020

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	6.16E+03	0.00E+00	4.03E+01	0.00E+00	7.32E-02	0.00E+00	7.03E+03	0.00E+00			

YEAR: 2025

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	5.75E+03	0.00E+00	3.78E+01	0.00E+00	6.83E-02	0.00E+00	6.56E+03	0.00E+00			

YEAR: 2030

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	5.54E+03	0.00E+00	3.66E+01	0.00E+00	6.60E-02	0.00E+00	6.32E+03	0.00E+00			

Efficient wood/coal stove

YEAR: 1990

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.79E+03	0.00E+00	5.75E+01	0.00E+00	9.74E-02	0.00E+00	1.00E+04	0.00E+00			

YEAR: 1994

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.99E+03	0.00E+00	5.84E+01	0.00E+00	1.01E-01	0.00E+00	1.02E+04	0.00E+00			

YEAR: 1998

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.69E+03	0.00E+00	5.57E+01	0.00E+00	1.01E-01	0.00E+00	9.89E+03	0.00E+00			

YEAR: 2000

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.58E+03	0.00E+00	5.47E+01	0.00E+00	1.01E-01	0.00E+00	9.76E+03	0.00E+00			

YEAR: 2005

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.64E+03	0.00E+00	5.45E+01	0.00E+00	1.04E-01	0.00E+00	9.82E+03	0.00E+00			

YEAR: 2010

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	7.77E+03	0.00E+00	4.91E+01	0.00E+00	9.35E-02	0.00E+00	8.83E+03	0.00E+00			

YEAR: 2015

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	6.47E+03	0.00E+00	4.26E+01	0.00E+00	7.88E-02	0.00E+00	7.55E+03	0.00E+00			

YEAR: 2020

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	5.99E+03	0.00E+00	3.89E+01	0.00E+00	7.06E-02	0.00E+00	6.82E+03	0.00E+00			

YEAR: 2025

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	5.57E+03	0.00E+00	3.64E+01	0.00E+00	6.57E-02	0.00E+00	6.35E+03	0.00E+00			

YEAR: 2030

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	5.36E+03	0.00E+00	3.52E+01	0.00E+00	6.34E-02	0.00E+00	6.11E+03	0.00E+00			

Hot plate to gas cooking

YEAR: 1990

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.79E+03	0.00E+00	5.75E+01	0.00E+00	9.74E-02	0.00E+00	1.00E+04	0.00E+00			

YEAR: 1994

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.99E+03	0.00E+00	5.84E+01	0.00E+00	1.01E-01	0.00E+00	1.02E+04	0.00E+00			

YEAR: 1998

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.69E+03	0.00E+00	5.57E+01	0.00E+00	1.01E-01	0.00E+00	9.89E+03	0.00E+00			

YEAR: 2000

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.58E+03	0.00E+00	5.47E+01	0.00E+00	1.01E-01	0.00E+00	9.76E+03	0.00E+00			

YEAR: 2005

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.81E+03	0.00E+00	5.52E+01	0.00E+00	1.06E-01	0.00E+00	1.00E+04	0.00E+00			

YEAR: 2010

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.10E+03	0.00E+00	5.06E+01	0.00E+00	9.76E-02	0.00E+00	9.19E+03	0.00E+00			

YEAR: 2015

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	6.89E+03	0.00E+00	4.40E+01	0.00E+00	8.36E-02	0.00E+00	7.99E+03	0.00E+00			

YEAR: 2020

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	6.40E+03	0.00E+00	4.03E+01	0.00E+00	7.55E-02	0.00E+00	7.27E+03	0.00E+00			

YEAR: 2025

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	5.98E+03	0.00E+00	3.79E+01	0.00E+00	7.06E-02	0.00E+00	6.80E+03	0.00E+00			

YEAR: 2030

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	5.77E+03	0.00E+00	3.66E+01	0.00E+00	6.83E-02	0.00E+00	6.56E+03	0.00E+00			

Hybrid solar water heaters

YEAR: 1990

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.79E+03	0.00E+00	5.75E+01	0.00E+00	9.74E-02	0.00E+00	1.00E+04	0.00E+00			

YEAR: 1994

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.99E+03	0.00E+00	5.84E+01	0.00E+00	1.01E-01	0.00E+00	1.02E+04	0.00E+00			

YEAR: 1998

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.69E+03	0.00E+00	5.57E+01	0.00E+00	1.01E-01	0.00E+00	9.89E+03	0.00E+00			

YEAR: 2000

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.58E+03	0.00E+00	5.47E+01	0.00E+00	1.01E-01	0.00E+00	9.76E+03	0.00E+00			

YEAR: 2005

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.73E+03	0.00E+00	5.52E+01	0.00E+00	1.05E-01	0.00E+00	9.92E+03	0.00E+00			

YEAR: 2010

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	7.95E+03	0.00E+00	5.05E+01	0.00E+00	9.60E-02	0.00E+00	9.04E+03	0.00E+00			

YEAR: 2015

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	6.65E+03	0.00E+00	4.40E+01	0.00E+00	8.13E-02	0.00E+00	7.75E+03	0.00E+00			

YEAR: 2020

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	6.16E+03	0.00E+00	4.03E+01	0.00E+00	7.32E-02	0.00E+00	7.03E+03	0.00E+00			

YEAR: 2025

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	5.75E+03	0.00E+00	3.78E+01	0.00E+00	6.83E-02	0.00E+00	6.56E+03	0.00E+00			

YEAR: 2030

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	5.54E+03	0.00E+00	3.66E+01	0.00E+00	6.60E-02	0.00E+00	6.32E+03	0.00E+00			

Stand-alone solar water heaters

YEAR: 1990

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.79E+03	0.00E+00	5.75E+01	0.00E+00	9.74E-02	0.00E+00	1.00E+04	0.00E+00			

YEAR: 1994

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.99E+03	0.00E+00	5.84E+01	0.00E+00	1.01E-01	0.00E+00	1.02E+04	0.00E+00			

YEAR: 1998

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.69E+03	0.00E+00	5.57E+01	0.00E+00	1.01E-01	0.00E+00	9.89E+03	0.00E+00			

YEAR: 2000

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.58E+03	0.00E+00	5.47E+01	0.00E+00	1.01E-01	0.00E+00	9.76E+03	0.00E+00			

YEAR: 2005

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.71E+03	0.00E+00	5.51E+01	0.00E+00	1.05E-01	0.00E+00	9.90E+03	0.00E+00			

YEAR: 2010

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	7.90E+03	0.00E+00	5.03E+01	0.00E+00	9.56E-02	0.00E+00	8.99E+03	0.00E+00			

YEAR: 2015

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	6.59E+03	0.00E+00	4.35E+01	0.00E+00	8.06E-02	0.00E+00	7.68E+03	0.00E+00			

YEAR: 2020

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	6.10E+03	0.00E+00	3.98E+01	0.00E+00	7.25E-02	0.00E+00	6.96E+03	0.00E+00			

YEAR: 2025

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	5.68E+03	0.00E+00	3.74E+01	0.00E+00	6.76E-02	0.00E+00	6.49E+03	0.00E+00			

YEAR: 2030

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	5.47E+03	0.00E+00	3.61E+01	0.00E+00	6.53E-02	0.00E+00	6.25E+03	0.00E+00			

Insulation of geysers

YEAR: 1990

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.79E+03	0.00E+00	5.75E+01	0.00E+00	9.74E-02	0.00E+00	1.00E+04	0.00E+00			

YEAR: 1994

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.99E+03	0.00E+00	5.84E+01	0.00E+00	1.01E-01	0.00E+00	1.02E+04	0.00E+00			

YEAR: 1998

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.69E+03	0.00E+00	5.57E+01	0.00E+00	1.01E-01	0.00E+00	9.89E+03	0.00E+00			

YEAR: 2000

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.58E+03	0.00E+00	5.47E+01	0.00E+00	1.01E-01	0.00E+00	9.76E+03	0.00E+00			

YEAR: 2005

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.73E+03	0.00E+00	5.52E+01	0.00E+00	1.05E-01	0.00E+00	9.92E+03	0.00E+00			

YEAR: 2010

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	7.95E+03	0.00E+00	5.05E+01	0.00E+00	9.60E-02	0.00E+00	9.04E+03	0.00E+00			

YEAR: 2015

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	6.65E+03	0.00E+00	4.40E+01	0.00E+00	8.13E-02	0.00E+00	7.75E+03	0.00E+00			

YEAR: 2020

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	6.16E+03	0.00E+00	4.03E+01	0.00E+00	7.32E-02	0.00E+00	7.03E+03	0.00E+00			

YEAR: 2025

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	5.75E+03	0.00E+00	3.78E+01	0.00E+00	6.83E-02	0.00E+00	6.56E+03	0.00E+00			

YEAR: 2030

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	5.54E+03	0.00E+00	3.66E+01	0.00E+00	6.60E-02	0.00E+00	6.32E+03	0.00E+00			

Heat pumps for hot water

YEAR: 1990

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.79E+03	0.00E+00	5.75E+01	0.00E+00	9.74E-02	0.00E+00	1.00E+04	0.00E+00			

YEAR: 1994

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.99E+03	0.00E+00	5.84E+01	0.00E+00	1.01E-01	0.00E+00	1.02E+04	0.00E+00			

YEAR: 1998

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.69E+03	0.00E+00	5.57E+01	0.00E+00	1.01E-01	0.00E+00	9.89E+03	0.00E+00			

YEAR: 2000

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.58E+03	0.00E+00	5.47E+01	0.00E+00	1.01E-01	0.00E+00	9.76E+03	0.00E+00			

YEAR: 2005

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.73E+03	0.00E+00	5.52E+01	0.00E+00	1.05E-01	0.00E+00	9.92E+03	0.00E+00			

YEAR: 2010

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	7.95E+03	0.00E+00	5.05E+01	0.00E+00	9.60E-02	0.00E+00	9.04E+03	0.00E+00			

YEAR: 2015

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	6.65E+03	0.00E+00	4.40E+01	0.00E+00	8.13E-02	0.00E+00	7.75E+03	0.00E+00			

YEAR: 2020

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	6.16E+03	0.00E+00	4.03E+01	0.00E+00	7.32E-02	0.00E+00	7.03E+03	0.00E+00			

YEAR: 2025

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	5.75E+03	0.00E+00	3.78E+01	0.00E+00	6.83E-02	0.00E+00	6.56E+03	0.00E+00			

YEAR: 2030

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	5.54E+03	0.00E+00	3.66E+01	0.00E+00	6.60E-02	0.00E+00	6.32E+03	0.00E+00			

Efficient use of hot water

YEAR: 1990

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.79E+03	0.00E+00	5.75E+01	0.00E+00	9.74E-02	0.00E+00	1.00E+04	0.00E+00			

YEAR: 1994

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.99E+03	0.00E+00	5.84E+01	0.00E+00	1.01E-01	0.00E+00	1.02E+04	0.00E+00			

YEAR: 1998

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.69E+03	0.00E+00	5.57E+01	0.00E+00	1.01E-01	0.00E+00	9.89E+03	0.00E+00			

YEAR: 2000

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.58E+03	0.00E+00	5.47E+01	0.00E+00	1.01E-01	0.00E+00	9.76E+03	0.00E+00			

YEAR: 2005

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.73E+03	0.00E+00	5.52E+01	0.00E+00	1.05E-01	0.00E+00	9.92E+03	0.00E+00			

YEAR: 2010

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	7.95E+03	0.00E+00	5.05E+01	0.00E+00	9.60E-02	0.00E+00	9.04E+03	0.00E+00			

YEAR: 2015

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	6.65E+03	0.00E+00	4.40E+01	0.00E+00	8.13E-02	0.00E+00	7.75E+03	0.00E+00			

YEAR: 2020

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	6.16E+03	0.00E+00	4.03E+01	0.00E+00	7.32E-02	0.00E+00	7.03E+03	0.00E+00			

YEAR: 2025

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	5.75E+03	0.00E+00	3.78E+01	0.00E+00	6.83E-02	0.00E+00	6.56E+03	0.00E+00			

YEAR: 2030

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	5.54E+03	0.00E+00	3.66E+01	0.00E+00	6.60E-02	0.00E+00	6.32E+03	0.00E+00			

Thermally efficient housing

YEAR: 1990

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.79E+03	0.00E+00	5.75E+01	0.00E+00	9.74E-02	0.00E+00	1.00E+04	0.00E+00			

YEAR: 1994

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.99E+03	0.00E+00	5.84E+01	0.00E+00	1.01E-01	0.00E+00	1.02E+04	0.00E+00			

YEAR: 1998

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.69E+03	0.00E+00	5.57E+01	0.00E+00	1.01E-01	0.00E+00	9.89E+03	0.00E+00			

YEAR: 2000

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.58E+03	0.00E+00	5.47E+01	0.00E+00	1.01E-01	0.00E+00	9.76E+03	0.00E+00			

YEAR: 2005

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.64E+03	0.00E+00	5.46E+01	0.00E+00	1.04E-01	0.00E+00	9.82E+03	0.00E+00			

YEAR: 2010

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	7.76E+03	0.00E+00	4.92E+01	0.00E+00	9.35E-02	0.00E+00	8.82E+03	0.00E+00			

YEAR: 2015

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	6.37E+03	0.00E+00	4.20E+01	0.00E+00	7.75E-02	0.00E+00	7.43E+03	0.00E+00			

YEAR: 2020

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	5.89E+03	0.00E+00	3.83E+01	0.00E+00	6.94E-02	0.00E+00	6.71E+03	0.00E+00			

YEAR: 2025

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	5.47E+03	0.00E+00	3.58E+01	0.00E+00	6.44E-02	0.00E+00	6.24E+03	0.00E+00			

YEAR: 2030

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	5.26E+03	0.00E+00	3.46E+01	0.00E+00	6.21E-02	0.00E+00	6.00E+03	0.00E+00			

Elec to gas space heating

YEAR: 1990

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.79E+03	0.00E+00	5.75E+01	0.00E+00	9.74E-02	0.00E+00	1.00E+04	0.00E+00			

YEAR: 1994

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.99E+03	0.00E+00	5.84E+01	0.00E+00	1.01E-01	0.00E+00	1.02E+04	0.00E+00			

YEAR: 1998

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.69E+03	0.00E+00	5.57E+01	0.00E+00	1.01E-01	0.00E+00	9.89E+03	0.00E+00			

YEAR: 2000

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.58E+03	0.00E+00	5.47E+01	0.00E+00	1.01E-01	0.00E+00	9.76E+03	0.00E+00			

YEAR: 2005

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.91E+03	0.00E+00	5.53E+01	0.00E+00	1.07E-01	0.00E+00	1.01E+04	0.00E+00			

YEAR: 2010

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.31E+03	0.00E+00	5.07E+01	0.00E+00	9.96E-02	0.00E+00	9.41E+03	0.00E+00			

YEAR: 2015

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	7.20E+03	0.00E+00	4.42E+01	0.00E+00	8.67E-02	0.00E+00	8.31E+03	0.00E+00			

YEAR: 2020

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	6.71E+03	0.00E+00	4.05E+01	0.00E+00	7.85E-02	0.00E+00	7.59E+03	0.00E+00			

YEAR: 2025

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	6.30E+03	0.00E+00	3.80E+01	0.00E+00	7.36E-02	0.00E+00	7.12E+03	0.00E+00			

YEAR: 2030

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	6.09E+03	0.00E+00	3.68E+01	0.00E+00	7.13E-02	0.00E+00	6.88E+03	0.00E+00			

Appliance labelling & standards

YEAR: 1990

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.79E+03	0.00E+00	5.75E+01	0.00E+00	9.74E-02	0.00E+00	1.00E+04	0.00E+00			

YEAR: 1994

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.99E+03	0.00E+00	5.84E+01	0.00E+00	1.01E-01	0.00E+00	1.02E+04	0.00E+00			

YEAR: 1998

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.69E+03	0.00E+00	5.57E+01	0.00E+00	1.01E-01	0.00E+00	9.89E+03	0.00E+00			

YEAR: 2000

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.58E+03	0.00E+00	5.47E+01	0.00E+00	1.01E-01	0.00E+00	9.76E+03	0.00E+00			

YEAR: 2005

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.73E+03	0.00E+00	5.52E+01	0.00E+00	1.05E-01	0.00E+00	9.92E+03	0.00E+00			

YEAR: 2010

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	7.95E+03	0.00E+00	5.05E+01	0.00E+00	9.60E-02	0.00E+00	9.04E+03	0.00E+00			

YEAR: 2015

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	6.65E+03	0.00E+00	4.40E+01	0.00E+00	8.13E-02	0.00E+00	7.75E+03	0.00E+00			

YEAR: 2020

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	6.16E+03	0.00E+00	4.03E+01	0.00E+00	7.32E-02	0.00E+00	7.03E+03	0.00E+00			

YEAR: 2025

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	5.75E+03	0.00E+00	3.78E+01	0.00E+00	6.83E-02	0.00E+00	6.56E+03	0.00E+00			

YEAR: 2030

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO_2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	5.54E+03	0.00E+00	3.66E+01	0.00E+00	6.60E-02	0.00E+00	6.32E+03	0.00E+00			

Solar home system

YEAR: 1990

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.79E+03	0.00E+00	5.75E+01	0.00E+00	9.74E-02	0.00E+00	1.00E+04	0.00E+00			

YEAR: 1994

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.99E+03	0.00E+00	5.84E+01	0.00E+00	1.01E-01	0.00E+00	1.02E+04	0.00E+00			

YEAR: 1998

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.69E+03	0.00E+00	5.57E+01	0.00E+00	1.01E-01	0.00E+00	9.89E+03	0.00E+00			

YEAR: 2000

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.58E+03	0.00E+00	5.47E+01	0.00E+00	1.01E-01	0.00E+00	9.76E+03	0.00E+00			

YEAR: 2005

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	8.73E+03	0.00E+00	5.52E+01	0.00E+00	1.05E-01	0.00E+00	9.92E+03	0.00E+00			

YEAR: 2010

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	7.92E+03	0.00E+00	5.05E+01	0.00E+00	9.59E-02	0.00E+00	9.01E+03	0.00E+00			

YEAR: 2015

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	6.61E+03	0.00E+00	4.39E+01	0.00E+00	8.10E-02	0.00E+00	7.71E+03	0.00E+00			

YEAR: 2020

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	6.12E+03	0.00E+00	4.02E+01	0.00E+00	7.29E-02	0.00E+00	6.99E+03	0.00E+00			

YEAR: 2025

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	5.71E+03	0.00E+00	3.77E+01	0.00E+00	6.79E-02	0.00E+00	6.52E+03	0.00E+00			

YEAR: 2030

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO2 equiv/unit)
residential	5.50E+03	0.00E+00	3.65E+01	0.00E+00	6.56E-02	0.00E+00	6.28E+03	0.00E+00			

Distributed wind generation

YEAR: 1990

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.79E+03	0.00E+00	5.75E+01	0.00E+00	9.74E-02	0.00E+00	1.00E+04	0.00E+00			

YEAR: 1994

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.99E+03	0.00E+00	5.84E+01	0.00E+00	1.01E-01	0.00E+00	1.02E+04	0.00E+00			

YEAR: 1998

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.69E+03	0.00E+00	5.57E+01	0.00E+00	1.01E-01	0.00E+00	9.89E+03	0.00E+00			

YEAR: 2000

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.58E+03	0.00E+00	5.47E+01	0.00E+00	1.01E-01	0.00E+00	9.76E+03	0.00E+00			

YEAR: 2005

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	8.73E+03	0.00E+00	5.52E+01	0.00E+00	1.05E-01	0.00E+00	9.92E+03	0.00E+00			

YEAR: 2010

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	7.94E+03	0.00E+00	5.05E+01	0.00E+00	9.60E-02	0.00E+00	9.03E+03	0.00E+00			

YEAR: 2015

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	6.64E+03	0.00E+00	4.39E+01	0.00E+00	8.13E-02	0.00E+00	7.75E+03	0.00E+00			

YEAR: 2020

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	6.16E+03	0.00E+00	4.02E+01	0.00E+00	7.32E-02	0.00E+00	7.02E+03	0.00E+00			

YEAR: 2025

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	5.74E+03	0.00E+00	3.78E+01	0.00E+00	6.82E-02	0.00E+00	6.55E+03	0.00E+00			

YEAR: 2030

IPCC Category	CO2		CH4		N2O		CO2 equiv (Gg)	CO2 equiv (Gg)	Production Volume (units/a)	Production Value (R/a)	Emission factor (Gg CO2 equiv/unit)
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture			
residential	5.53E+03	0.00E+00	3.65E+01	0.00E+00	6.59E-02	0.00E+00	6.32E+03	0.00E+00			

Paraffin to gas cooking

YEAR: 1990

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO_2 equiv/unit)
residential	8.79E+03	0.00E+00	5.75E+01	0.00E+00	9.74E-02	0.00E+00	1.00E+04	0.00E+00			

YEAR: 1994

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO_2 equiv/unit)
residential	8.99E+03	0.00E+00	5.84E+01	0.00E+00	1.01E-01	0.00E+00	1.02E+04	0.00E+00			

YEAR: 1998

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO_2 equiv/unit)
residential	8.69E+03	0.00E+00	5.57E+01	0.00E+00	1.01E-01	0.00E+00	9.89E+03	0.00E+00			

YEAR: 2000

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO_2 equiv/unit)
residential	8.58E+03	0.00E+00	5.47E+01	0.00E+00	1.01E-01	0.00E+00	9.76E+03	0.00E+00			

YEAR: 2005

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO_2 equiv/unit)
residential	8.71E+03	0.00E+00	5.51E+01	0.00E+00	1.05E-01	0.00E+00	9.90E+03	0.00E+00			

YEAR: 2010

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO_2 equiv/unit)
residential	7.91E+03	0.00E+00	5.03E+01	0.00E+00	9.59E-02	0.00E+00	8.99E+03	0.00E+00			

YEAR: 2015

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO_2 equiv/unit)
residential	6.59E+03	0.00E+00	4.36E+01	0.00E+00	8.11E-02	0.00E+00	7.69E+03	0.00E+00			

YEAR: 2020

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO_2 equiv/unit)
residential	6.11E+03	0.00E+00	3.99E+01	0.00E+00	7.30E-02	0.00E+00	6.97E+03	0.00E+00			

YEAR: 2025

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO_2 equiv/unit)
residential	5.69E+03	0.00E+00	3.74E+01	0.00E+00	6.80E-02	0.00E+00	6.50E+03	0.00E+00			

YEAR: 2030

IPCC Category	CO_2		CH_4		N_2O		CO_2 equiv (Gg)	CO_2 equiv (Gg)	Production Volume	Production Value	Emission factor
	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	Energy	Manufacture	(units/a)	(R/a)	(Gg CO_2 equiv/unit)
residential	5.48E+03	0.00E+00	3.62E+01	0.00E+00	6.57E-02	0.00E+00	6.26E+03	0.00E+00			