S1 KCERT 2050 Calculation Summary

The general calculation flow for KCERT is as follows:

[1] Lever inputs translated into profiles.
[2] Priority order applied.
[3] Energy balance trajectories that represent energy consumption are calculated based on the activity level and energy intensity of the technology.
[4] Emissions calculated based on energy balance and technology activity.
[5] Capacity required to satisfy demand calculated.

S1.1 Example logic trees used to model KCERT 2050: Buildings and Transport Sectors

S1.1.1. Buildings Heat and Non-Heat Modules

The logic Trees for KCERT 2050 buildings heat module is illustrated in Figure S 1 and Figure S 2.

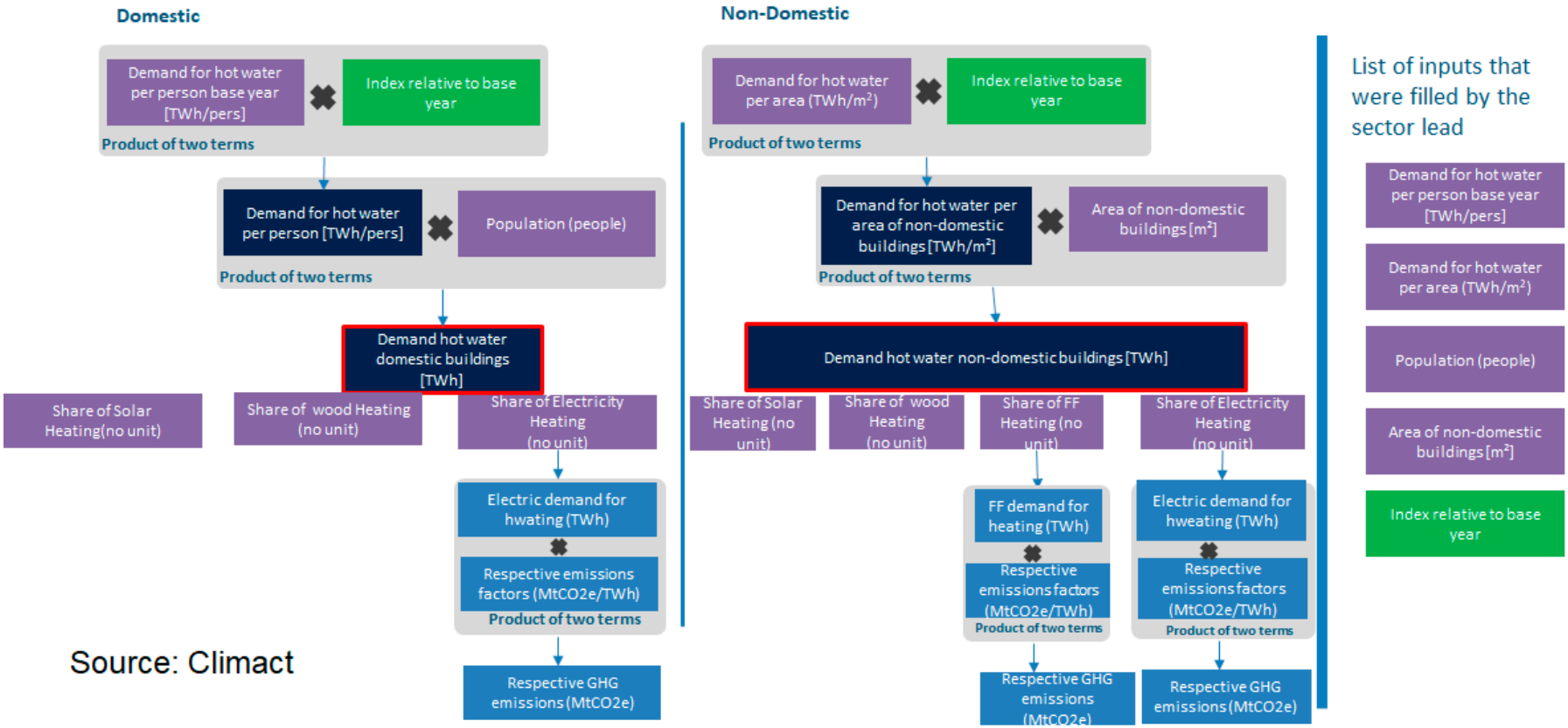


Figure S 1 KCERT 2050 Buildings Module logic tree showing the methodology for calculating demand for domestic and non-domestic buildings. Emission Factor CO2 bioenergy solid is zero. For hot water heating KCERT considered 4 major fuels that is wood, solar, electricity and fossil fuel boilers. Where electricity, wood and solar were used for domestic households, while for non-domestic buildings there was the addition of fossil fuels. For the levers, they are aimed at moving non-domestic and domestic households from using wood and fossil fuel-based means of water heating to cleaner fuels that is solar an electricity.

From the hot water demand calculation energy consumption and emissions are calculated as illustrated in Figure S 2.

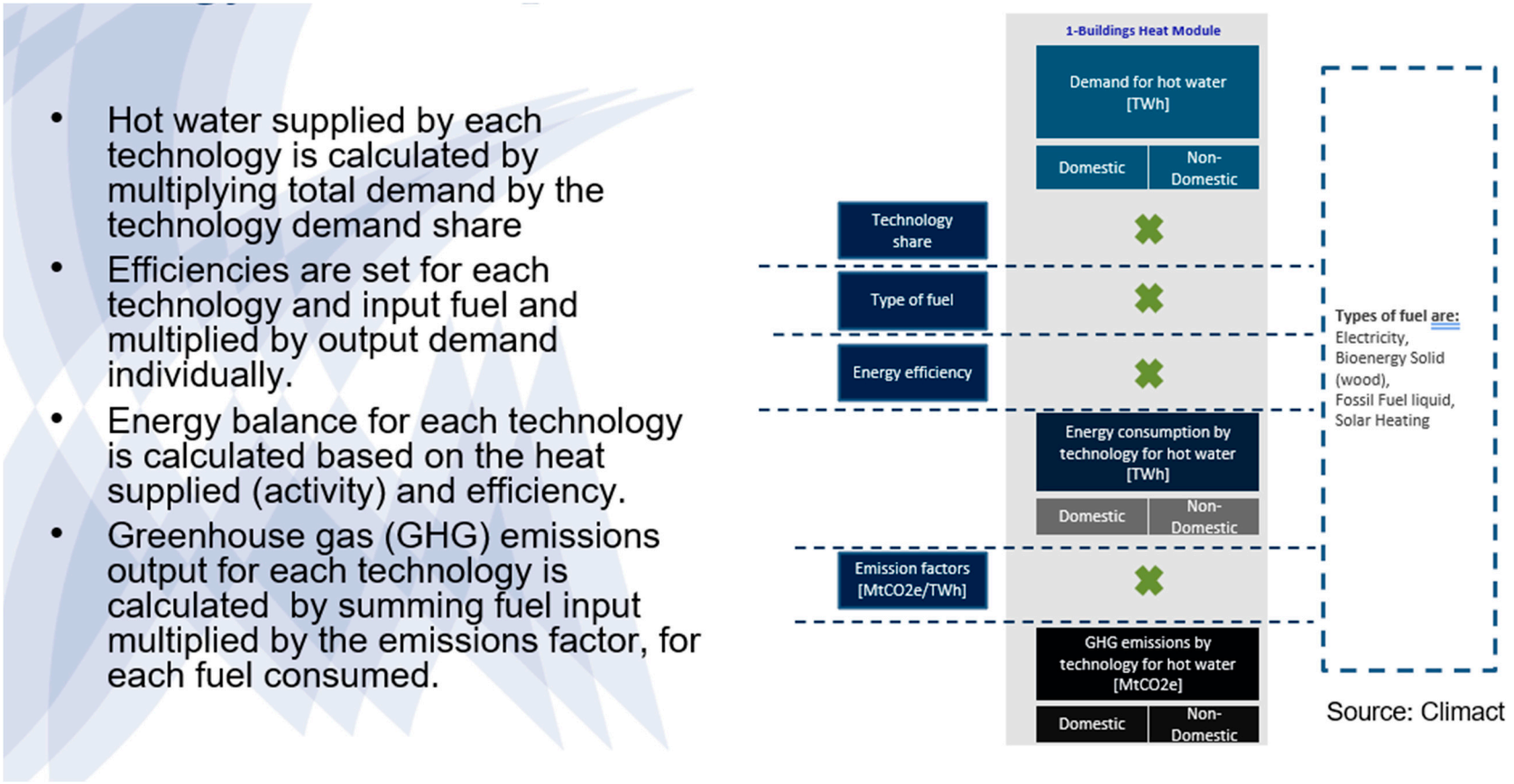
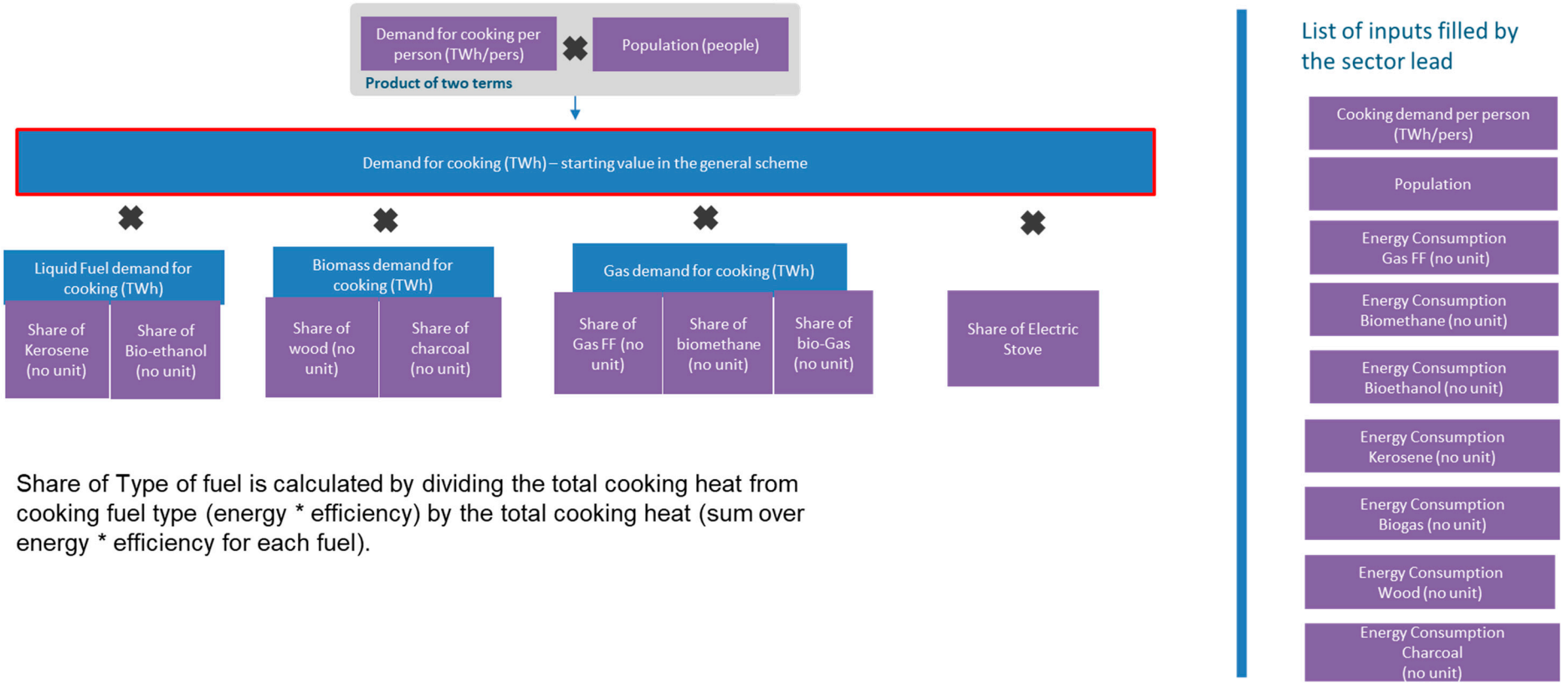


Figure S 2 Hot water supplied by each technology is calculated by multiplying total demand by the technology demand share. Efficiencies are set for each technology for each input fuel and output demand individually. Energy balance for each technology is calculated based on the heat supplied (activity) and efficiency.

The logic Trees for KCERT 2050 buildings non-heat module covering energy demand for cooking, lighting, appliances and cooling are summarised in Figure S 3, Figure S 4, Figure S 5, and Figure S 6.



Share of Type of fuel is calculated by dividing the total cooking heat from cooking fuel type (energy * efficiency) by the total cooking heat (sum over energy * efficiency for each fuel).

Figure S 3 Buildings non heat module - cooking fuel share. The cooking fuels considered were LPG, electricity, charcoal, kerosene, wood, bioethanol, biogas, and biomethane for institutions and domestic buildings. For non-domestic buildings, only LPG and electricity were considered. Cooking efficiency was deemed not to have significant room for improvement and therefore has no associated efficiency lever.

Cooking energy and emissions were calculated as follows:

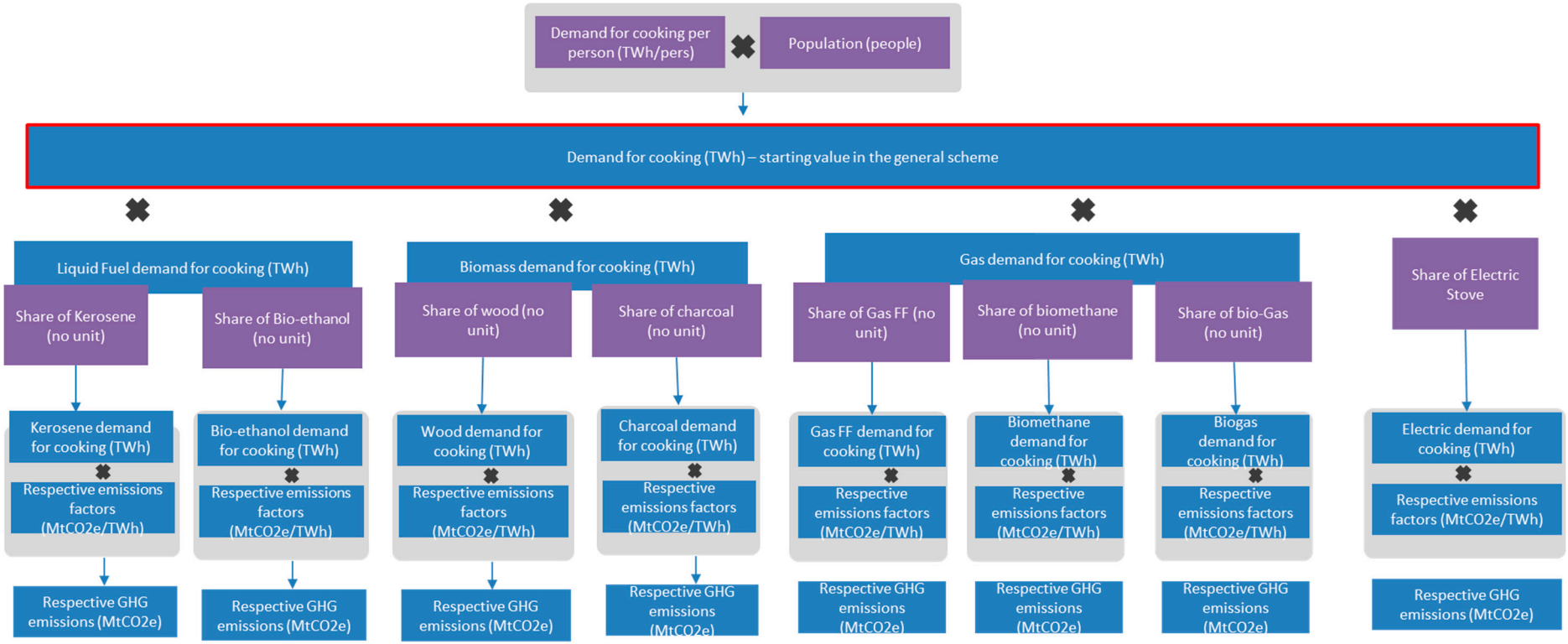
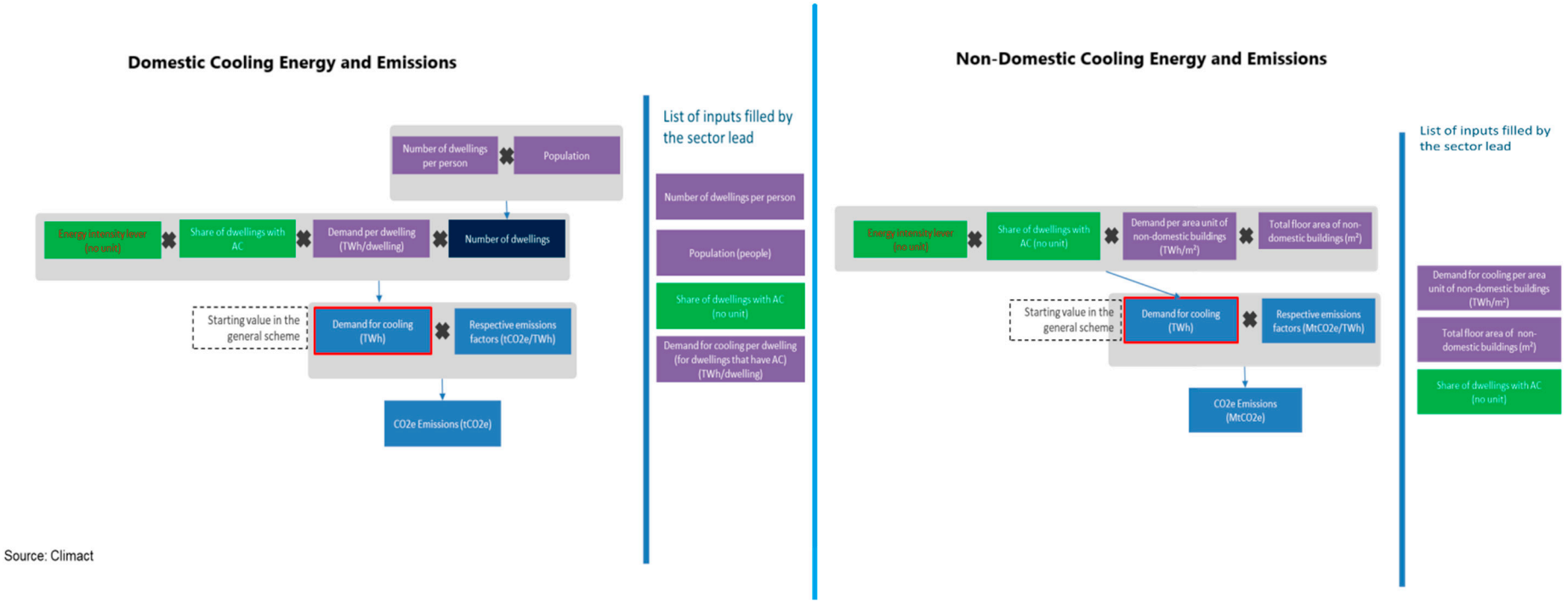


Figure S 4 Buildings non heat module - cooking energy and emissions

Domestic and non-domestic colling energy demand and emissions were calculated as illustrated below.



Source: Climact

Figure S 5 Buildings non heat module – non-domestic cooling energy and emissions

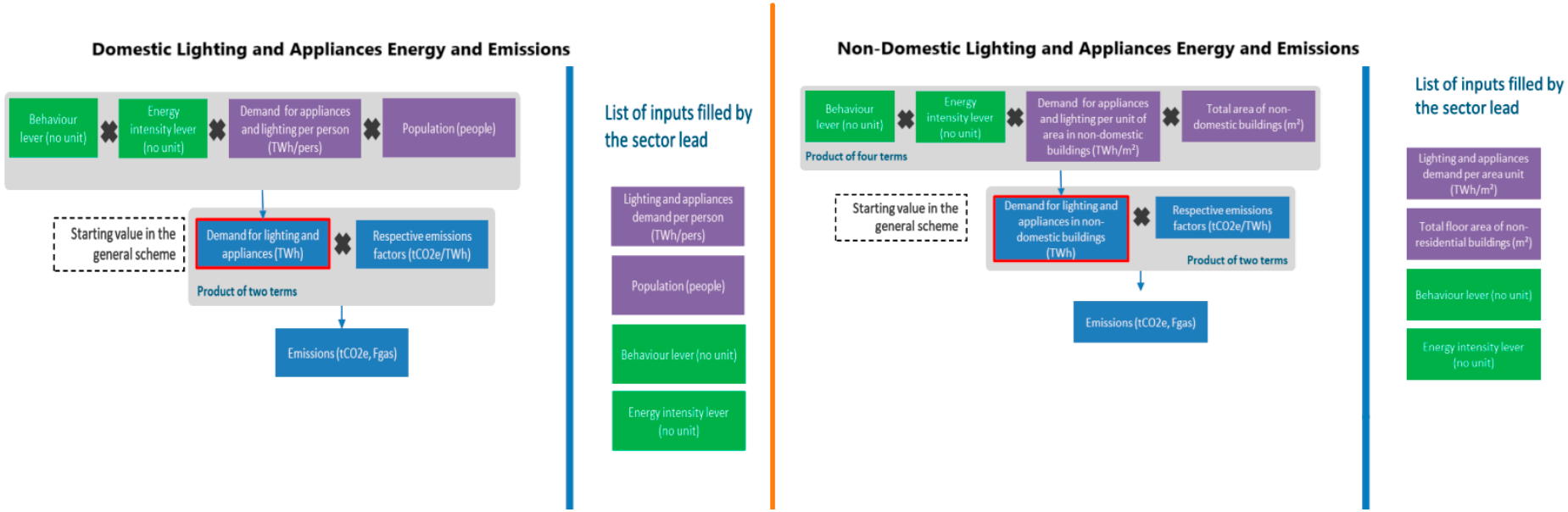


Figure S 6 Buildings non heat module – non-domestic lighting and appliances energy and emissions

S1.1.2 Transport Sector

The logic tree applied for transportation including aviation, maritime and vehicles.

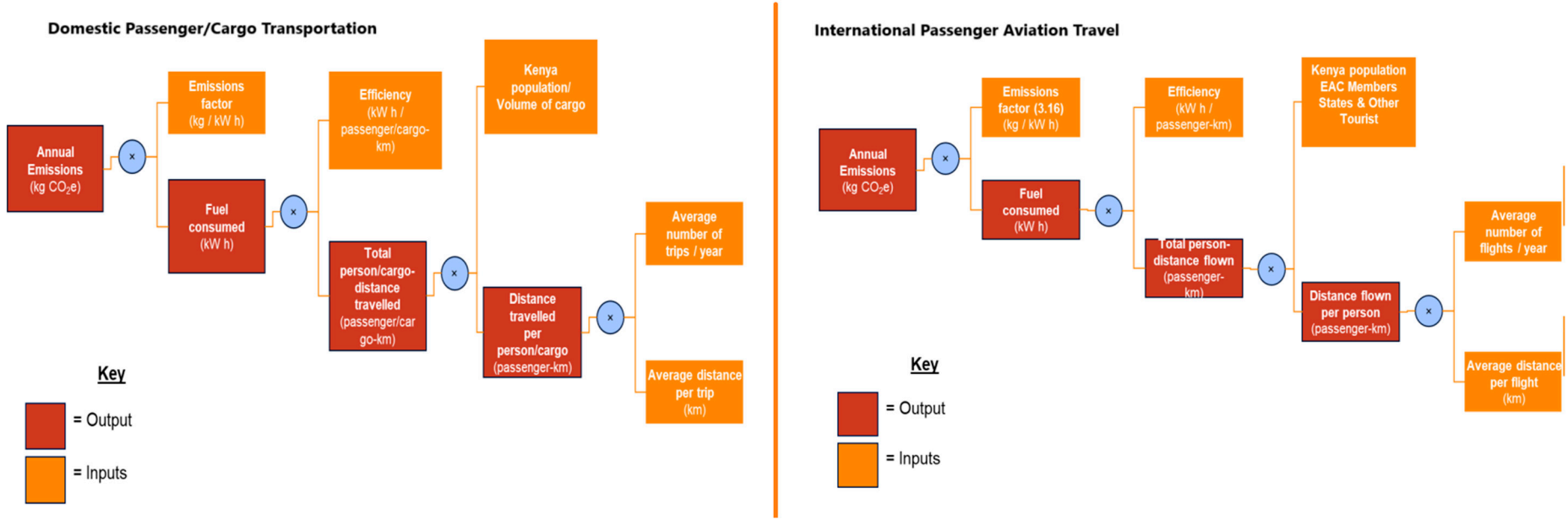


Figure S 7 Transport module fuel consumption and emissions calculation summary.

2 KCERT 2050 Levers and Sub-Levers

Table S1 summarises the levers and sub-levers considers in KCERT 2050 for the six sectors.

Table S1: Levers and Sub-Levers by Sector in KCERT 2050

Sector	Lever	Sub Lever
Transport	Kenya Transport Demand	Domestic passenger travel demand
		Walking share of passenger travel demand
		Cycling share of passenger travel demand
		Car share of passenger travel demand
		Bus and Matatu share of passenger travel demand
		Rail share of passenger travel demand
		Car Occupancy/sharing rates
		Car own or hire (average vehicle mileage)
	International Aviation	International passenger travel demand
	Light Vehicles - Electric	Car - Electric vehicle distance share
		LGV - Electric vehicle distance share
		HGV Rigid - Electric vehicle distance share
	Light Vehicles - Hydrogen	Car - Hydrogen vehicle distance share
		LGV - Hydrogen vehicle distance share
		HGV Rigid - Hydrogen vehicle distance share
	Light Vehicles - Hybrid	Car - Plug-in Hybrid Electric vehicle distance share
		LGV - Plug-in Hybrid Electric vehicle distance share
		HGV Rigid - Plug-in Hybrid Electric vehicle distance share
	Light Vehicles - Biofuel	Car - Biofuel share of liquid fuel
		LGV - Biofuel share of liquid fuel
		HGV Rigid - Biofuel share of liquid fuel
	Heavy Vehicles - Electric	HGV Articulated - Electric vehicle distance share
		Bus - Electric vehicle distance share
		Rail Passenger - Electric vehicle distance share
		Rail Freight - Electric vehicle distance share
	Heavy Vehicles - Hydrogen	HGV Articulated - Hydrogen vehicle distance share
		Bus - Hydrogen vehicle distance share

	Heavy Vehicles - Hybrid	HGV Articulated - Plug-in Hybrid Electric vehicle distance share
		Bus - Plug-in Hybrid Electric vehicle distance share
	Heavy Vehicles - Biofuel	HGV Articulated - Biofuel share of liquid fuel
		Bus - Biofuel share of liquid fuel
		Rail Passenger - Biofuel share of liquid fuel
		Rail Freight - Biofuel share of liquid fuel
		Non Road Mobile Machinery - Biofuel share of liquid fuel
		Shipping Domestic - Biofuel share of liquid fuel
		Shipping International - Biofuel share of liquid fuel
	Aviation Efficiency	Aviation Domestic - Energy Intensity Improvement
		Aviation International - Energy Intensity Improvement
		Aviation Domestic - Plug-in Hybrid Electric vehicle distance share
		Aviation International - Plug-in Hybrid Electric vehicle distance share
	Aviation Biofuel	Aviation Domestic - Biofuel share of liquid fuel
		Aviation International - Biofuel share of liquid fuel
Buildings	Buildings Hot Water and Temperature	Domestic hot water demand index
		Non-Domestic hot water demand index
		Domestic hot water solar heater share
		Domestic hot water electricity share
		Domestic hot water wood share
		Non-Domestic Solar Heater share
		Non-Domestic Electricity share
		Non-Domestic Fossil Fuel Boiler share
		Non-Domestic Wood share
	Domestic Dwelling Cooking	Domestic dwelling cooking gas share
		Domestic dwelling biogas share
		Domestic dwelling electricity share
		Domestic dwelling wood share
		Domestic dwelling charcoal share
		Domestic dwelling kerosene share
		Domestic dwelling bioethanol share
		Domestic dwelling biomethane share
		Institution cooking gas share

		Institution dwelling biogas share Institution dwelling electricity share Institution dwelling wood share Institution dwelling charcoal share Institution dwelling kerosene share Institution dwelling bioethanol share Institution dwelling biomethane share
	Lighting and Appliances	Share of dwellings with air conditioning Non-Domestic cooling demand Domestic lighting demand Non-Domestic lighting demand Domestic appliance demand Non-Domestic appliance demand Domestic lighting energy intensity Non-Domestic lighting energy intensity Domestic appliance energy intensity Non-Domestic appliance energy intensity Domestic air conditioning energy intensity Non-Domestic air conditioning energy intensity
Industry	Industrial Efficiency	Industrial Energy Intensity Index - Ferrous and non-ferrous metal production Industrial Energy Intensity Index - Cement, ceramics and glass Industrial Process Emissions Index - Ferrous and non-ferrous metal production Industrial Process Emissions Index - Cement, ceramics and glass Industrial Tea Industrial Sugar Industrial Process Emissions Index - Tea Industrial Process Emissions Index - Sugar
	Industry Electrification	Ind process heat share - Ferrous and non-ferrous metal production - Electricity Ind process heat share - Cement, ceramics and glass - Electricity Ind process heat share - Tea - Electricity

		Ind process heat share - Sugar - Electricity
	Industry Shift to Biomass	Ind process heat share - Ferrous and non-ferrous metal production - Biomass
		Ind process heat share - Cement, ceramics and glass - Biomass
		Ind process heat share - Tea - Biomass
		Ind process heat share - Sugar - Biomass
	Industry Shift to Gas	Ind process heat share - Ferrous and non-ferrous metal production - Gas
		Ind process heat share - Cement, ceramics and glass - Gas
		Ind process heat share - Tea - Gas
		Ind process heat share - Sugar - Gas
	Industry CCS	Ind CCS penetration - Ferrous and non-ferrous metal production
		Ind CCS penetration - Cement, ceramics and glass
		Ind CCS penetration - Tea
		Ind CCS penetration - Sugar
CO2 Removal & Gases	Hydrogen - Imports	Zero Carbon hydrogen imports
	Greenhouse Gas Removal	Carbon Captured - Direct Air Capture
		Carbon Captured - Enhanced Weathering
	Bioconversion with CCS	Share of conversions with CCS - Biomass Gasification
		Share of conversions with CCS - Bio liquid Production
		Share of conversions with CCS - Energy from Waste
	CCS Capture Rate	CCS Capture Rate - Ferrous and non-ferrous metal production
		CCS Capture Rate - Cement, ceramics and glass
		CCS Capture Rate - Biomass Gasification
		CCS Capture Rate - Bio liquid Production
		CCS Capture Rate - Energy from Waste
		CCS Capture Rate - H2 from Biomass Gasification
		CCS Capture Rate - H2 from SMR
		CCS Capture Rate - Electricity from Biomass
		CCS Capture Rate - Electricity from Gas
		CCS Capture Rate - Tea
		CCS Capture Rate - Sugar
Electricity	Seasonal Storage	Capacity Electricity - Seasonal Storage
	Hydo Electric Power	Capacity Electricity - Hydro

	Geothermal	Capacity Electricity - Geothermal
	Thermal - Mini Grid	Capacity Electricity - Thermal Mini Grid
	Natural Gas	Capacity Electricity - Natural Gas
	Power Imports	Capacity Electricity - Power Imports
	Nuclear	Capacity Electricity - Nuclear
	Onshore Wind	Capacity Electricity - Wind (onshore)
	Solar	Capacity Electricity - Solar PV
Land, Bioenergy & Waste	Farming Yield & Efficiency	Number of Livestock - Poultry
		Number of Livestock - Cattle
		Number of Livestock - Other
		Yield (output per unit area) - Land for Bioenergy
		Yield (output per unit area) - Land for food crops
		Yield (output per unit area) - Land for livestock
		Emissions intensity index - Livestock Enteric Fermentation
		Emissions intensity index - Livestock Manure Management
		Emissions intensity index - Arable land for food crops
		Emissions intensity index - Soil Management
		Agricultural Fuel Use - Biofuel share of liquid fuel
	Forestry	Land area dedicated to Woodland
	Land for Bioenergy	Land area dedicated to Growing Bioenergy
		Wood share for energy from Baseline Woodland
		Waste share collected for energy land for food crops
		Waste share collected for energy Manure deposited as slurry
	Waste Reduction	Share Recycled - Dry Waste (excluding inert)
		Share Recycled - Wet Waste (excluding manure)
		Share Recycled - Waste Water
		Share Recycled - Used Cooking Oil
		Share Open Burning - Dry Waste (excluding inert)
		Share to Energy - Dry Waste (excluding inert)
		Share to Composting - Wet Waste (excluding manure)
		Share to Energy - Wet Waste (excluding manure)
		Share to Energy - Used Cooking Oil

		Share Released as Fugitive Emissions - Landfill Gas Reduce Production - Dry Waste (excluding inert) Reduce Production - Wet Waste (excluding manure) Reduce Production - Used Cooking Oil Reduce Production - Wate Water (excluding inert)

3 KCERT 2050 Net Zero Emissions Pathway

Table S2 includes the levers and level of ambition needed for the net zero pathway by 2050.

Table S2: Sector Levers and the levels of ambition for the net zero emissions pathway

Sector	**Lever**	**Net Zero Pathway Level of Ambition**	**Net Zero Pathway Level of Ambition Description**
Transport	Kenya Transport Demand	2.70750	By 2050 the average annual distance travelled per person is 32% less than in 2015. 30% of this is done by car.
	International Aviation	1.03955	By 2050 the average annual distance travelled per person internationally is 121% further than in 2015.
	Light Vehicles - Electric	2.67108	50% of cars are electric by 2050 (50% of vans and 25% of small trucks).
	Light Vehicles - Hydrogen	1.06815	0% of cars are hydrogen-fuelled by 2050 (0% of vans and 0% of small trucks).
	Light Vehicles - Hybrid	1.06147	0% of cars are hybrids by 2050 (0% of vans and 0% of small trucks).
	Light Vehicles - Biofuel	2.12953	20% of fuel used in conventional cars is biofuel by 2050 (20% of vans and 1% of small trucks).
	Heavy Vehicles - Electric	2.81491	10% of large trucks, 30% of buses and 90% of passenger trains are electric by 2050.
	Heavy Vehicles - Hydrogen	1.41058	0% of large trucks and 0% of buses are hydrogen-fuelled by 2050.
	Heavy Vehicles - Hybrid	1.27815	1% of large trucks and 20% of buses are hybrids by 2050.
	Heavy Vehicles - Biofuel	1.36877	20% of buses, 0% of passenger trains and 1% of large trucks use biofuel by 2050.
	Aviation Efficiency	1.16397	Aircrafts are 18% more efficient than in 2015 and 0% are plug-in hybrid electric vehicles, by 2050.
	Aviation Biofuel	1.09043	0% of liquid fuel used in aircraft is biofuel by 2050.
Buildings	Buildings Hot Water and Temperature	1.016489948	By 2050, domestic hot water demand is 30% more than in 2015. By 2050, for residential buildings, 23% more homes use wood to heat water than in 2015. the use of solar in homes is the same as in 2015. 23% less homes use electricity to heat

			water than in 2015. By 2050. For non-residential buildings, 3% more buildings use wood to heat water than in 2015. 0.1% more buildings use solar to heat water than in 2015. 2.6% less buildings use electricity to heat water than in 2015. 0.4 % less buildings use fossil fuel to heat water than in 2015.
	Domestic Dwelling Cooking	1.59746	By 2050, for residential buildings there will be 5% more usage of biofuels in cooking than in 2015. For fossil fuel use in cooking in residential buildings it will be , 55.2% less than in 2015. For wood fuel use in cooking in residential buildings it will be , 37.56% less than in 2015. For electricity use in cooking it will be 28.43% more than in 2015.
	Lighting and Appliances	1.00000	By 2050, compared to 2015, domestic lighting demand per person is 50% higher and the same efficiency, appliance demand is 50% higher and the same efficiency
Industry	Industrial Efficiency	2.11185	20% decrease in energy consumption and 30% decrease in process emissions, per unit of output by 2050
	Industry Electrification	3.23600	70% of heat generated from electricity in industry sub-sectors by 2050 (compared to 0% in 2015).
	Industry Shift to Biomass	2.14700	35% to 100% of heat generated from biomass in industry steel and cement sub-sectors by 2050 (compared to 0% in 2015).
	Industry Shift to Gas	1.00000	15% to 30% of heat generated from gas in industry sub-sectors by 2050 (compared to 0% in 2015).
	Industry CCS	1.00000	0% of processes have CCS applied across industrial sub-sectors by 2060 (compared to 0% in 2015).
CO2 Removal & Gases	Hydrogen - Imports	1.00000	No hydrogen imported
	Greenhouse Gas Removal	1.00000	No emissions captured
	Bioconversion with CCS	1.27661	33% of bio-conversion processes have CCS applied by 2070
	CCS Capture Rate	1.00000	0% capture rate range for CCS processes by 2070.
Electricity	Seasonal Storage	1.00000	No electricity stored between seasons (none stored in 2015).
	Hydo Electric Power	1.00000	0.698 GW capacity by 2050 (0 GW in 2015) capable of generating up to 5 TWh per year.

	Geothermal	1.00000	0 GW capacity by 2050 (0.77 GW in 2015) capable of generating up to 26 TWh per year.
	Thermal - Mini Grid	1.00000	Decommissioned by 2050.
	Natural Gas	1.08174	2.514 GW capacity by 2050 (0 GW in 2015)
	Power Imports	1.00000	1.154 GW capacity by 2050
	Nuclear	1.00000	0.698 GW capacity by 2050 (0 GW capacity in 2015) capable of generating up to 5 TWh per year. Equivalent to 0.2 3 GW plants.
	Onshore Wind	1.00000	3.2 GW capacity by 2050, 3.2 GW onshore (10.1x the 0.3 GW capacity in 2015) capable of generating up to 13 TWh per year.
	Solar	1.00000	1.669 GW capacity by 2050 (33.4x the 0.1 GW capacity in 2015) capable of generating up to 3 TWh per year.
Land, Bioenergy & Waste	Farming Yield & Efficiency	4.00000	In 2050, emissions intensity is 25-51% lower, land yield is 100-213% higher, there are 25% fewer cattle, 51% more poultry and 25% fewer other livestock compared to 2015.
	Forestry	4.00000	9% of Kenya land area covered by forest by 2070 (compared to 7% in 2015).
	Land for Bioenergy	1.00000	0.6% of Kenya land area covered by bio crops by 2050 (compared to 0% in 2015) and 8-40% of agricultural wastes are collected for energy.
	Waste Reduction	3.59702	By 2050, 30% decrease in dry waste (30% recycled, 3% used for energy), 30% decrease in wet waste (60% recycled, 8% used for energy).