COUNTRY SAVINGS ASSESSMENT FOR HEAT PUMPS

GENERAL AND SCENARIO INTRODUCTION

Heat pumps are air conditioning devices capable of meeting both cooling and heating requirements by regulating the refrigerant flow. These are often regarded as more energy-efficient as they use the vapour compression cycle to transport the heat in or out of a room as compared to the conventional heating systems such as boiler systems. This analysis outlines the savings potential in both delivered energy[1] use and carbon emissions from the introduction of energy-efficient heat pumps in selected developing and emerging economies with high heating degree days, namely Albania, Algeria, Argentina, Azerbaijan, Belarus, Bhutan, Bosnia and Herzegovina, Chile, China, Ecuador, Iran, Iraq, Jordan, Kazakhstan, Korea, Kyrgyz Republic, Lebanon, Macedonia, Montenegro, Peru, Russian Federation, Serbia, South Africa, Tunisia, Turkey, Turkmenistan, Ukraine, Uruguay, and Uzbekistan.

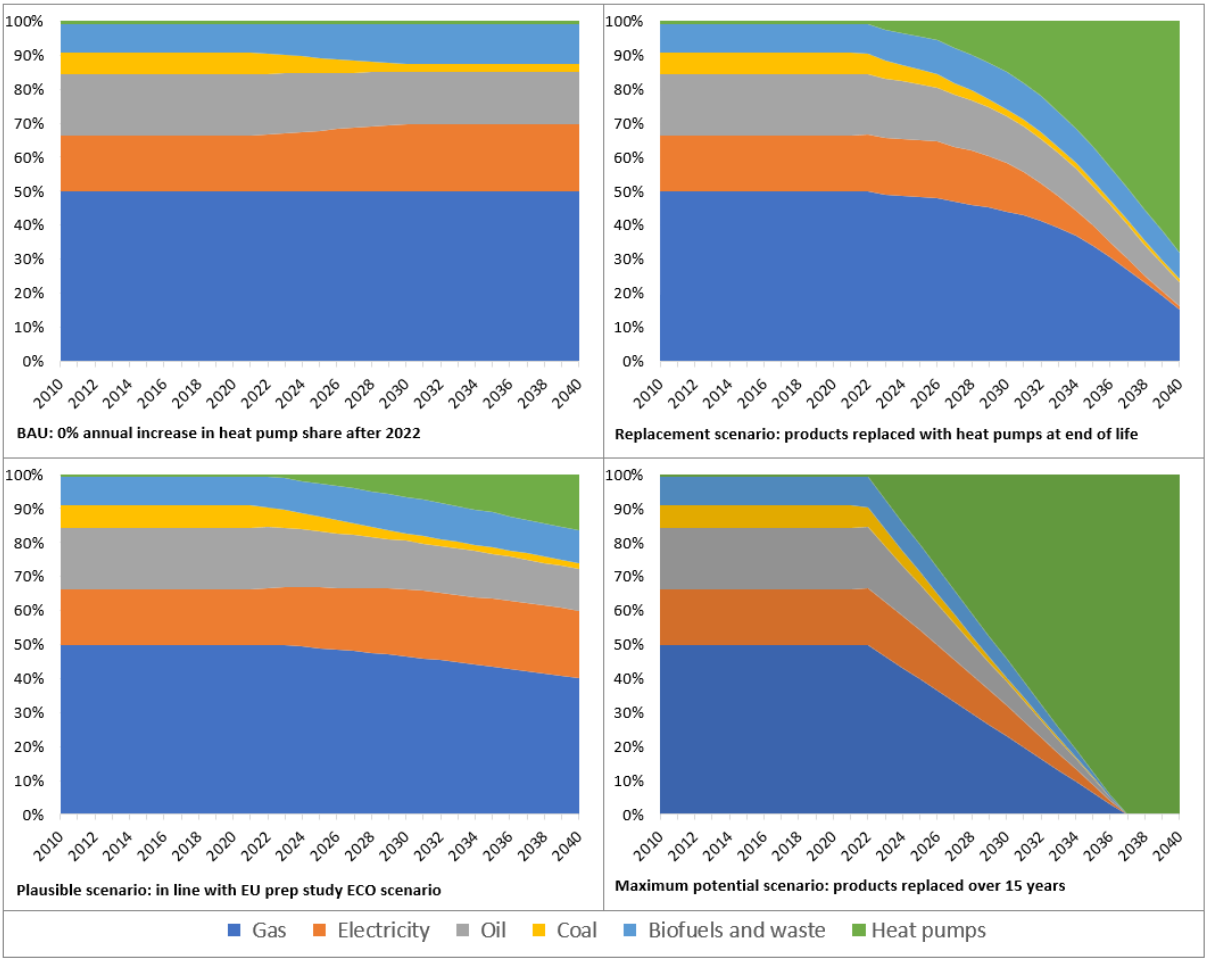
The savings potential presented can be primarily attributed to:
A) The introduction of heat pumps into the market to meet heating demand traditionally met by energy sources such as gas, coal, oil, and biofuels. This shift represents the majority of potential savings.
B) Enhancing energy efficiency within the heat pumps by implementing minimum energy performance standards (MEPS).

The savings presented are derived based on the product characteristics, which include but are not limited to typical efficiency, lifetime, and emissions factors. The impact of changes in these product characteristics on annual energy usage are estimated under the following policy scenarios:

- **Business as Usual scenario** which assumes no intervention, allowing market transition to continue as before.
- **Minimum and high-ambition scenarios** which assume the implementation of MEPS for heat pumps on 1 January 2023 and under two market penetration rates:
  - Plausible scenario which uses the assumptions from the ECO scenario[2] in the 2019 EU preparatory study for space and combination heaters.
  - Replacement scenario which uses a simple s-curve model to predict the end of life for existing space heating equipment with an average lifetime and assumes all future heating demand is met through heat pumps alone.
- **Maximum Potential scenario** analyses the savings, assuming the market is transformed linearly over a period of 15 years. This would result in a 6.7% increase in the heat pump share of the technology mix per year.

[1] Delivered energy is the amount of energy delivered at the domestic level and covers non-electrical appliances such as fossil fuel burners and boilers, as well as electrical appliances.
[2] For details, see Tasks 1 and 7 here: https://www.eceee.org/ecodesign/products/boilers/

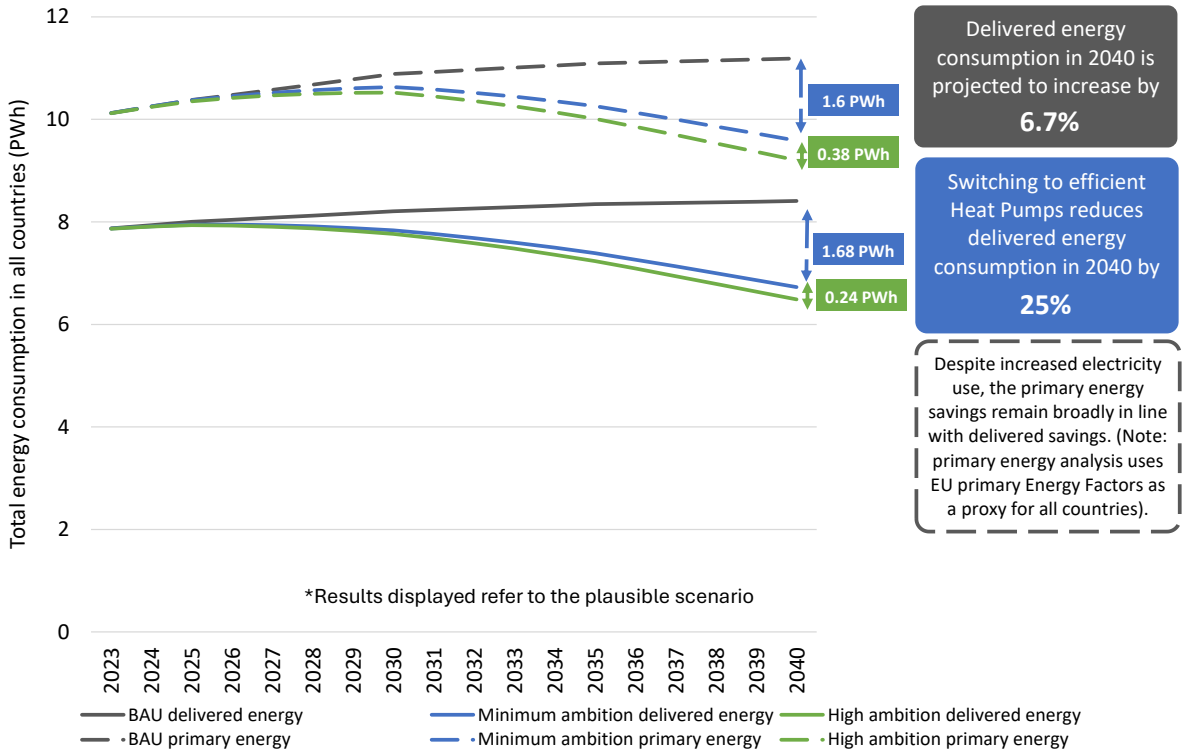
The figures below show the market share of the six technologies included in the analysis over time and how these change in each of the four scenarios listed above:



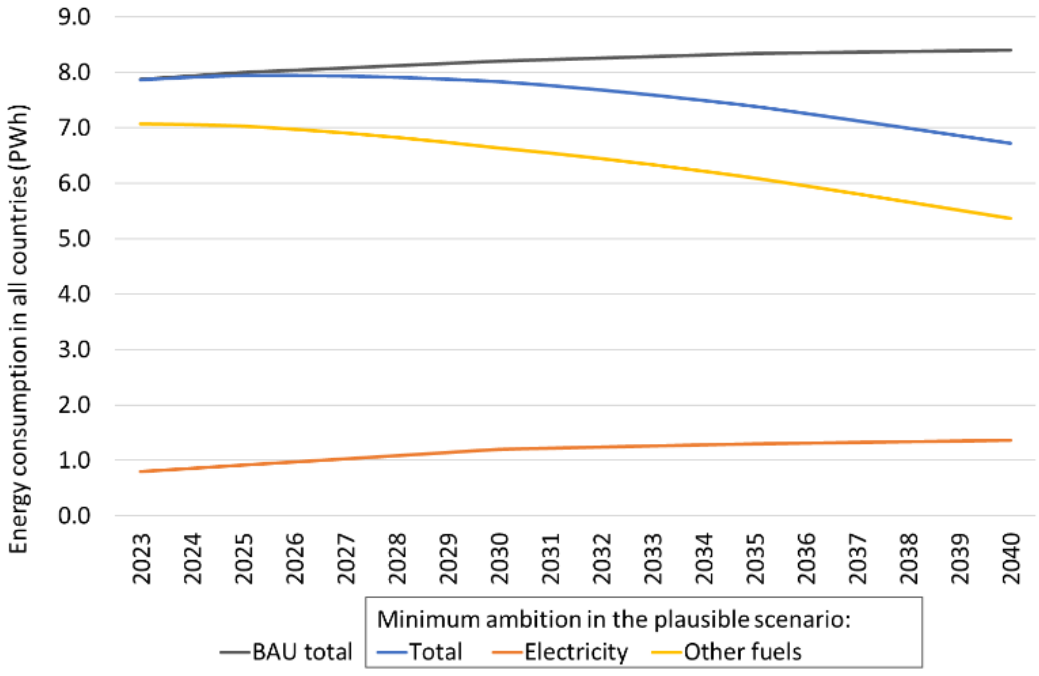
HEAT PUMPS REDUCE OVERALL ENERGY IN 2040*

This analysis involves both technology and fuel switching, which creates several differences to the simple electricity savings from MEPS for other products. Note that the savings are in delivered energy rather than delivered electricity, which actually increases. Primary energy[3] also needs to be considered as different distribution systems mean this can vary considerably in comparison to delivered energy depending on the fuel type.

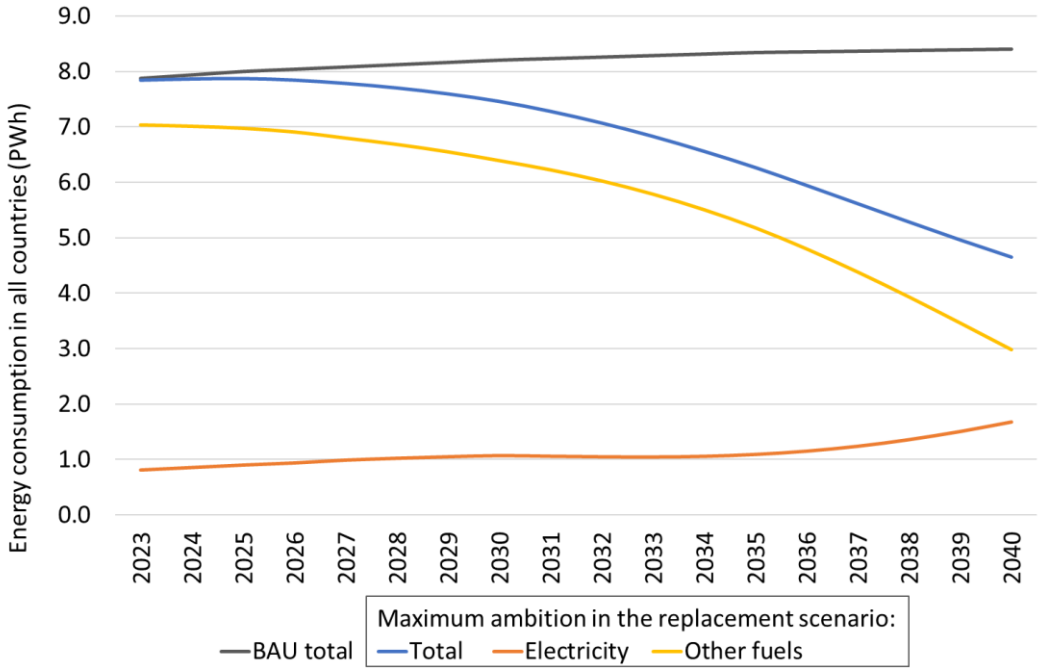
[3] Primary energy is a commonly used term for the energy found 'in nature' that has not been subjected to any human engineered extraction, conversion and delivery processes. This can be both fossil fuels or renewable energy.



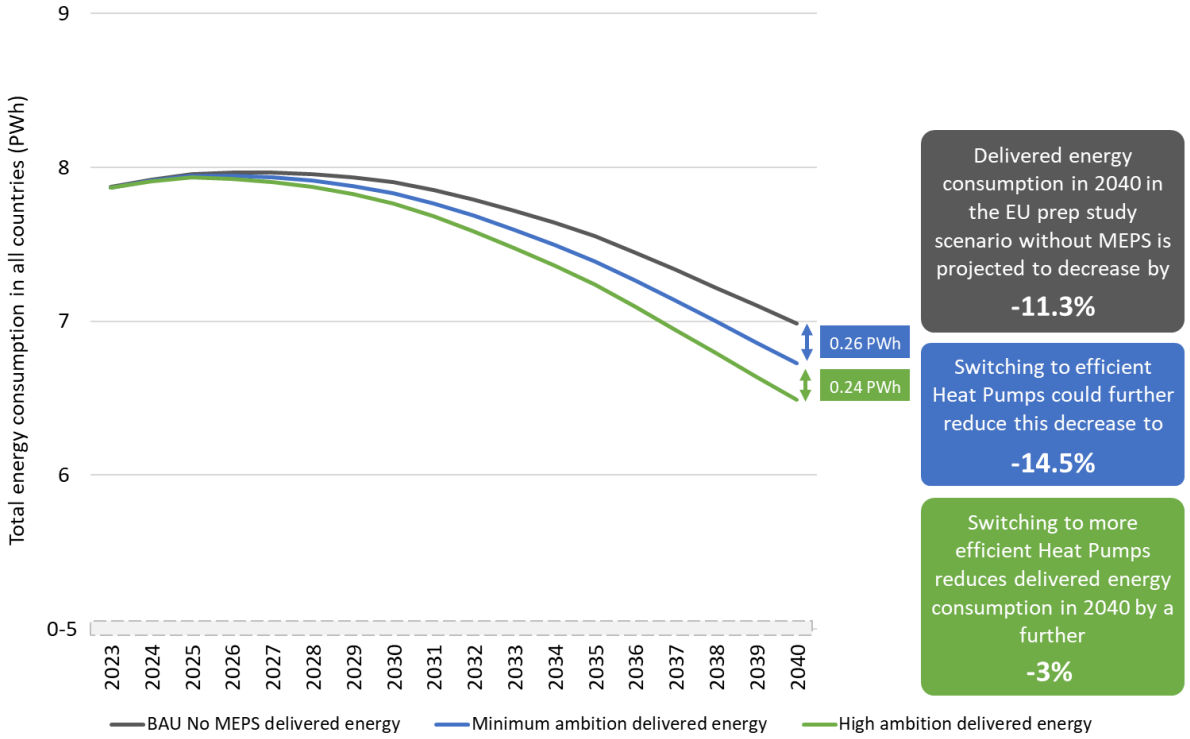
Despite the decrease in total energy, electricity usage will inherently increase due to the switching of heat demand from fossil fuel-based sources to electricity-run heat pumps.



The faster the transition to heat pumps, the more pronounced this pattern becomes:

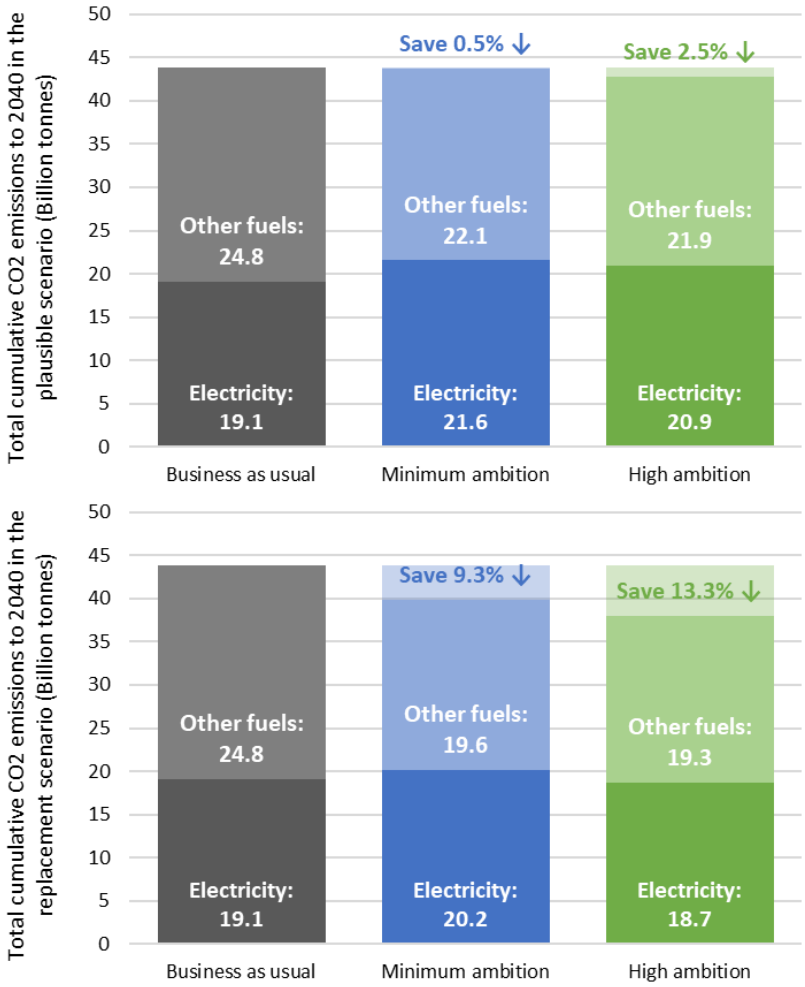


DELIVERED ENERGY SAVINGS POTENTIAL FROM MEPS IN 2040

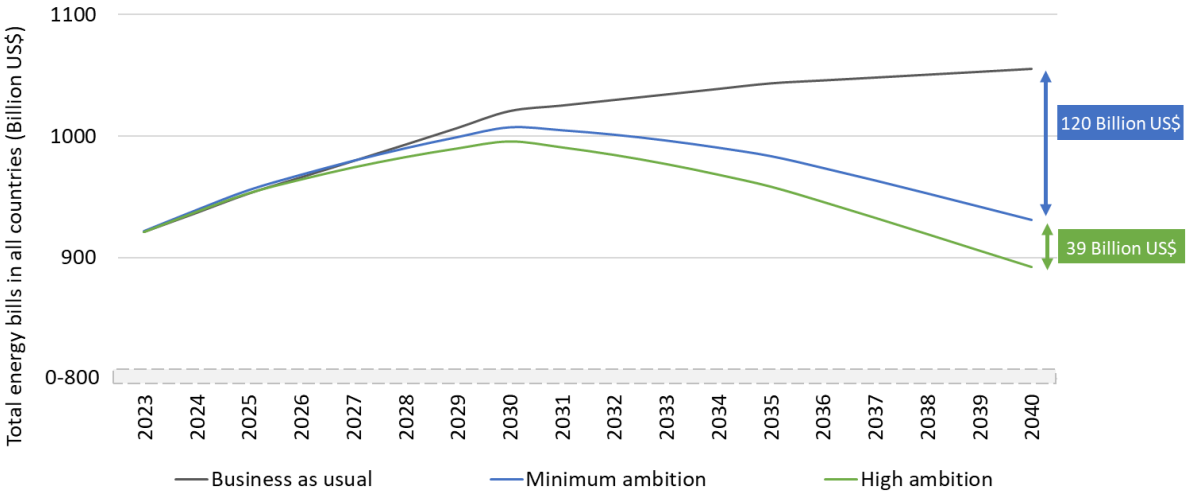


COUNTRY SAVINGS ASSESSMENT FOR HEAT PUMPS

CARBON MITIGATION POTENTIAL BY 2040



ECONOMIC SAVINGS BY SWITCHING TO HEAT PUMPS*



*Results displayed refer to the plausible scenario (values rounded)

COUNTRY SAVINGS ASSESSMENT FOR HEAT PUMPS

ANNUAL SAVINGS IN 2040 UNDER ALL SCENARIOS

	Annual Savings	Plausible Scenario		Replacement Scenario	
		Minimum Ambition	High Ambition	Minimum Ambition	High Ambition
	Delivered energy (PWh)	1.7	1.9	3.8	4.1
	Primary energy (PWh)	1.6	2.0	3.6	4.3
	Energy Bills (billion US$)	124	163	268	346
	CO_2 Emissions (Billion tonnes)	0.1	0.2	0.3	0.6

The analysis under the maximum potential scenario reveals that switching all residential and commercial heating and hot water to heat pumps by 2040 would save 5.0 PWh (1 PWh = 10^12 kWh) of delivered energy per year. Implementing MEPS for those heat pumps could save an additional 0.68 PWh annualy. Primary energy savings from switching are lower at 2.6 PWh in 2040 but the consequent savings from MEPS increase to 1.7 PWh.

CUMULATIVE SAVINGS IN 2040 UNDER ALL SCENARIOS

	Cumulative Savings	Plausible Scenario		Replacement Scenario	
		Minimum Ambition	High Ambition	Minimum Ambition	High Ambition
	Delivered energy (PWh)	11.6	13.5	25.3	28.2
	Primary energy (PWh)	9.90	12.9	27.2	32.7
	Energy Bills (billion US$)	702	1004	2238	2812
	CO_2 Emissions (Billion tonnes)	0.22	1.08	4.1	5.9

TYPICAL PRODUCT ASSUMPTIONS AND EXCLUSIONS

This analysis focuses on residential heating only. The scope includes:

- Sectors: residential properties with heating demand.
- Products: air-to-air heat pumps, air-to-water heat pumps, gas boilers (furnaces), oil burners, coal burners, electric heaters, biomass energy.

The following are out of scope[4]:

- Sectors: District heating, residential properties with solely hot water demand and commercial, and industrial space heating/hot water.
- Products: Ground source heat pumps[5].

The table beneath summarizes the assumptions for typical efficiency, lifetime, and CO_2e emission factor of various space heating products.

Heating Medium	2023	2030	2040	Lifetime	CO_2e (kg/kWh)
Gas boiler/furnace	80%	82%	84%	16	0.185
Electric heater	86%	86%	86%	11	As per country
Oil burner	65%	67%	68%	18	0.245
Coal burner	70%	72%	73%	18	0.494
Biofuels and waste burner	87%	90%	90%	22	0.059
BAU heat pumps	266%	267%	271%	16	As per country
Minimum ambition heat pumps	300%	303%	311%	16	As per country
High ambition heat pumps	333%	340%	351%	16	As per country

Heat pumps currently require policy incentives other than MEPS to encourage uptake. This analysis assumes these are introduced equally in all the policy scenarios leading to an increase in heat pump usage. The savings shown in the minimum ambition scenario are largely due to the increased uptake of heat pumps from these policies. The additional savings in the high ambition scenario demonstrate the scale of savings attributable to implementing more ambitious MEPS.

[4] While reversible heat pumps are within scope, their market is not included in the analysis at this time.
[5] These are not included in U4E model regulation guidelines and, therefore, are not included in the analysis.