Domestic Refrigerated Appliances
Actions and Assumptions: USA NPD Group, Inc.[1] Data

The aim of this document is to detail the actions and assumptions made in interpreting and processing the data specified above during the mapping and benchmarking of domestic refrigerated appliances. It is designed to be read in parallel with the "Summary Overall Mapping and Benchmarking Approach to Domestic Refrigerated Appliances". Section numbers in each document should align.

1 Overview of the mapping and benchmarking outputs for domestic refrigerated appliances

No data specific actions.

2 The mapping and benchmarking process for domestic refrigerated appliances

2.1 Data Cleaning and Pre-processing

2.1.1 Data cleaning

a. To revert to "as tested" unit energy consumption, reported chest freezer energy consumption has been multiplied by 1/0.7, and upright and compact freezer energy consumption has been multiplied by 1/0.85. These "adjusted to test" values are only used for benchmarking (i.e. not the mapping report).

b. Monthly sales values for a model consolidated to a single model entry by year

c. Volumes converted to litres (declared x 28.3168466). For freezers only, a range of volume was supplied. It has been assumed that the volume is a mid-point of the range as follows:

Size range of model	Volume assumed
10.5 - 11.4 Cu. Ft.	10.95
11.5 - 12.4 Cu. Ft.	11.95
12.5 - 13.4 Cu. Ft.	12.95
13.5 - 14.4 Cu. Ft.	13.95
14.5 - 15.4 Cu. Ft.	14.95
15.5 - 16.4 Cu. Ft.	15.95
16.5 - 17.4 Cu. Ft.	16.95
17.5 - 18.4 Cu. Ft.	17.95
18.5 - 19.4 Cu. Ft.	18.95
19.5 - 20.4 Cu. Ft.	19.95

[1] This data was purchased by the US Department of Energy from *The NPD Group, Inc./Retail Tracking Service* (formerly *National Purchase Diary*) - https://www.npd.com/wps/portal/npd/uk/home.

Size range of model	Volume assumed
20.5 - 21.4 Cu. Ft.	20.95
21.5 - 22.4 Cu. Ft.	21.95
22.5 - 23.4 Cu. Ft.	22.95
24.5 - 25.4 Cu. Ft.	24.95
25.5 + Cu. Ft.	26
6.5 - 7.4 Cu. Ft.	6.95
7.5 - 8.4 Cu. Ft.	7.95
8.5 - 9.4 Cu. Ft.	8.95
9.5 - 10.4 Cu. Ft.	9.95
Less than 6.0 Cu. Ft.	5

In NPD Group, Inc. data, model volumes are provided as aggregated values (i.e. a total of fresh and frozen compartments). These compartment volumes have been split into separate fresh and frozen volumes based on a regression analysis conducted by Lawrence Berkley National Laboratories. The values of the slope and intercept for each product type derived from the regression analysis are shown in the table below:

US product type	Slope	Intercept
1	1.0816	0
2	1.0874	0
3	1.1591	0
4	1.2318	0
5	1.1863	0
5A	1.1872	0
6	1.1863	0
7	1.2349	0
11	1.1288	0
12	1.1037	0
13	1.1855	0
14	1.1539	0

Based on the US categories, the values in this table were used to convert total product volumes to adjusted volumes. Subtracting the total volume from the adjusted volume gives the “freezer adjustment volume”. The “freezer adjustment volume” can then be used to calculate *actual* freezer volume by simple multiplication of the “freezer adjusted volume” by the inverse of the freezer thermodynamic volume adjustment factor, e.g. for the frozen compartment of refrigerator-freezers the multiplication factor would be 1/(1-1.63). Fresh compartment volume is then calculated simply as total volume minus freezer volume.

2.1.2 Pre-processing

The pre-processing of data:

a. Allocation of US, Mapping and Benchmarking and EU product types. This allocation was based on the “Type Ref” and "Icemkr" or “Type Frzr” and "Defrost" fields. Allocation for the Refrigerators and Freezers Data sets as follows:

	US Type[2]	M&B Type	M&B Conifg	EU
Compact-Icemaker Optional	11, 12, **13, 14 or 15**	Fridge/Freezer	Freezer Top	7
Compact-Icemaker Standard	11, 12, **13, 14 or 15**	Fridge/Freezer	Freezer Top	7
Compact-No Icemaker	11, 12, **13, 14 or 15**	Fridge/Freezer	Freezer Top	7
Compact-Not Specified	11, 12, **13, 14 or 15**	Fridge/Freezer	Freezer Top	7
Freezer on Bottom-Icemaker Optional	**5** or 15	Fridge/Freezer	Freezer Bottom	7
Freezer on Bottom-Icemaker Standard[3]	**5** or 15	Fridge/Freezer	Freezer Bottom	7
Freezer on Bottom-No Icemaker	**5** or 15	Fridge/Freezer	Freezer Bottom	7
Freezer on Bottom-Not Specified	**5** or 15	Fridge/Freezer	Freezer Bottom	7
Freezer on Top-Icemaker Optional	**3** or 13	Fridge/Freezer	Freezer Top	7
Freezer on Top-Icemaker Standard	6	Fridge/Freezer	Freezer Top	7
Freezer on Top-No Icemaker	**3** or 13	Fridge/Freezer	Freezer Top	7
Freezer on Top-Not Specified	**3** or 13	Fridge/Freezer	Freezer Top	7
French Doors-Icemaker Optional	5	Fridge/Freezer	Freezer Bottom	7
French Doors-Icemaker Standard[3]	5	Fridge/Freezer	Freezer Bottom	7
French Doors-No Icemaker	5	Fridge/Freezer	Freezer Bottom	7
French Doors-Not Specified	5	Fridge/Freezer	Freezer Bottom	7
Not Specified-Icemaker Standard	?	?	Config.U	
Not Specified-Not Specified	?	?	Config.U	
Refrigerator only-No Freezer-Icemaker Standard	1	Refrigerator with Freezer	Freezer Top	5
Refrigerator only-No Freezer-No Icemaker	1	Refrigerator with Freezer	Freezer Top	5
Refrigerator only-No Freezer-Not Specified	1	Refrigerator with Freezer	Freezer Top	5

[2] Note that a number of units have been allocated two potential “USA types”. In general this is where the unit may be “standard” or “compact”, but there is insufficient data available to differentiate. However, for the purposes of the mapping and benchmarking analysis, both standard and compact units are grouped with no differentiation; therefore the model is assumed to be “standard”. Where more than two types of product are shown, this relates to the potential combinations of products based on a defrost type which is unknown. In these cases, assumptions default to automatic defrost (which dominates the US market) with the exception of refrigerators which are assumed to be manual defrost unless specifically listed otherwise. These types are shown in bold font in the table.

[3] Note it is unclear how US categorisations treat Refrigerator/Freezers with bottom mounted freezer and through the door ice service. Therefore these products have been categorised as US Type 5. Similarly, French Door units are considered as refrigerator/freezers where the freezer is located at the bottom, and again where ice service is provided these units have been categorised as US Type 5.

	US Type[2]	M&B Type	M&B Conifg	EU
Side by Side-Icemaker Optional	**4** or 14	Fridge/Freezer	Side-by-Side	7
Side by Side-Icemaker Standard	7	Fridge/Freezer	Side-by-Side	7
Side by Side-No Icemaker	**4** or 14	Fridge/Freezer	Side-by-Side	7
Side by Side-Not Specified	**4** or 14	Fridge/Freezer	Side-by-Side	7
Single Door-Internal Freezer-Icemaker Standard	1	Refrigerator with Freezer	Not Applicable	5
Single Door-Internal Freezer-No Icemaker	1	Refrigerator with Freezer	Not Applicable	5
Chest-Defrost Drain	**10** or 18	Freezer only	Chest	9
Chest-Frost-Free	**10** or 18	Freezer only	Chest	9
Chest-Manual Defrost	**10** or 18	Freezer only	Chest	9
Chest-Not Specified	**10** or 18	Freezer only	Chest	9
Compact-Defrost Drain	16	Freezer only	Upright	8
Compact-Frost-Free	17	Freezer only	Upright	8
Compact-Manual Defrost	16	Freezer only	Upright	8
Upright-Defrost Drain	**8** or 16	Freezer only	Upright	8
Upright-Frost-Free	**9** or 17	Freezer only	Upright	8
Upright-Manual Defrost	**8** or 16	Freezer only	Upright	8
Upright-Not Specified	**9** or 17	Freezer only	Upright	8

b. Subsequent to the allocation of product types in the table above, and the volume analysis described in 2.1.1 e., any model that had a freezer volume of less than 14 litres was reallocated to EU type 1 and M&B type "refrigerator only".
c. In a small number of cases, it was unclear whether freezer units were upright or chest. Where there was doubt, products have been assumed to be upright. In cases where this assumption was incorrect, this will only affect the calculation of EEI., with the calculated EEI being slightly lower than the true model value (i.e. the product EEI will indicate the unit is slightly more efficient than is actually the case). It is believed the overall effect on the market average is minimal, but the specific impact is unknown.

The pre-processing of data:

d. Compartments within the various US unit types were allocated to one of mapping and benchmarking compartment categories based on the table below (note this table also gives the assumed test temperatures for each compartment for each product type under US test conditions).

EU Categorisations	Fresh Comp Temp	Frozen Comp Temp	Compartment Allocations for Fresh, Frozen and "Other Compartment" Volumes (T=degC)					
			14 > T > 5	5 >= T > 0	T = 0	0 > T => -6	-6> T => -12	-12> T => -18
Refrigerators	3.33C	-9.44C[4]		Fresh			Frozen	
Refrigerators with Freezers	7.22C	-9.44C		Fresh			Frozen	
Fridge Freezers	7.22C	-15C		Fresh				Frozen
Freezers		-17.77C						Frozen

2.2 Production of Graphical Mapping Outputs

Local adjusted volume test methodology used:

*Total Adjusted Volume = Volume fresh + n*Volume frozen*

Where

USA Classification	*n*
Refrigerators (excluding all refrigerators)	1.44
Fridge-Freezers	1.63
Freezers	1.73
All Refrigerators	1

2.3 Normalisation

2.3.1 Normalisation Overview

No data specific actions.

2.3.2 Allocation of declared UEC to compartments

The adaptation of the EU methodology used in this analysis requires knowledge of compartment defrost type. It is also possible that we will use information on climate class, whether or not the unit is built in and whether or not the unit has an ice maker in a separate specific piece of benchmarking analysis. Data was provided directly on whether units were built in and had ice makers. The allocation of defrost type was based on the "Refrigerator Type-Description" field.

[4] US regulations do not specify a standardized compartment temperature for the freezer compartment of an "all-refrigerator" units, therefore the actual temperature during tests could vary. However, a nominal temperature of -9.44 has been allocated based on the freezer temperature of "refrigerators" to enable benchmarking with other countries. This is *likely* to lead to a slightly lower unit energy consumption per litre in comparison with other countries.

Refrigerator Type-Description	US Type	Defrost type
Compact-Icemaker Optional	11, 12, 13	Automatic
Compact-Icemaker Standard	11, 12, 13	Automatic
Compact-No Icemaker	11, 12, 13	Automatic
Compact-Not Specified	11, 12, 13	Automatic
Freezer on Bottom-Icemaker Optional	5 or 15	Automatic
Freezer on Bottom-Icemaker Standard	5 or 15	Automatic
Freezer on Bottom-No Icemaker	5 or 15	Automatic
Freezer on Bottom-Not Specified	5 or 15	Automatic
Freezer on Top-Icemaker Optional	3 or 13	Automatic
Freezer on Top-Icemaker Standard	6	Automatic
Freezer on Top-No Icemaker	3 or 13	Automatic
Freezer on Top-Not Specified	3 or 13	Automatic
French Doors-Icemaker Optional	5	Automatic
French Doors-Icemaker Standard	5	Automatic
French Doors-No Icemaker	5	Automatic
French Doors-Not Specified	5	Automatic
Not Specified-Icemaker Standard	?	Unknown
Not Specified-Not Specified	?	Unknown
Refrigerator only-No Freezer-Icemaker Standard	1	Manual
Refrigerator only-No Freezer-No Icemaker	1	Manual
Refrigerator only-No Freezer-Not Specified	1	Manual
Side by Side-Icemaker Optional	4 or 14	Automatic
Side by Side-Icemaker Standard	7	Automatic
Side by Side-No Icemaker	4 or 14	Automatic
Side by Side-Not Specified	4 or 14	Automatic
Single Door-Internal Freezer-Icemaker Standard	1	Manual
Single Door-Internal Freezer-No Icemaker	1	Manual
Chest-Defrost Drain	10 or 18	Manual
Chest-Frost-Free	10 or 18	Automatic
Chest-Manual Defrost	10 or 18	Manual
Chest-Not Specified	10 or 18	Manual

Refrigerator Type-Description	US Type	Defrost type
Compact-Defrost Drain	16	Manual
Compact-Frost-Free	17	Automatic
Compact-Manual Defrost	16	Manual
Upright-Defrost Drain	8 or 16	Manual
Upright-Frost-Free	9 or 17	Automatic
Upright-Manual Defrost	8 or 16	Manual
Upright-Not Specified	9 or 17	Automatic

2.3.3 Normalisation of "compartment EC" for test temperature variations and calculation of normalised UEC

The assumed test temperatures for each compartment for each product type are given in the table in section 0 b).

External test temperature is 32.2^{o}C

2.3.4 Calculation of Normalised UEE

No data specific actions.

2.3.5 Calculation of normalised EEI

No data specific actions.