

## Zambia MTF Survey Data Processing: Annex.

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Raw data collected from the Zambia MTF survey is available at: <https://energydata.info/dataset/zambia-multi-tier-framework-mtf-survey> and <https://mtfenergyaccess.esmap.org/country/zambia>. This data is in .*dat* format used by statistical analysis software (e.g. Stata). The data is converted into .*csv* files using a Python script and the *pandas* library:

```
C:\Users\b3046420\OneDrive - Newcastle University\Python\MECS\Open_STAT_data_v0p1.py
```

In addition to the raw data, there are two useful documents giving the questionnaire and a cross-reference for the data variables and questions labels. The filenames are: *mtf\_hh\_quest\_ver\_56\_14\_09\_17\_clean\_zambia.docx* and *codebook\_zambia.xlsx*

## Processing for Use Case 1

Use case 1 considers grid-connected households in Zambia

In the MTF Zambia survey questions about electrical household appliance ownership are in Section N. For lights, fan, radio and TV there is a field to record the duration of use in hours per day, as shown in .

Question C2 of the questionnaire records whether the household has a grid connection or not. Note that the record of this is in the *EXPRESS SECTIONS* of the raw data, rather than *SECTION C SUPPLY AND DEMAND FOR ELECTRICITY C120-C123* where it might be expected to be found.

| Item Number | Item                                 | a. How many [ITEM] in working condition does your household own?<br><br><i>Write 0 if none<br/>0 → NEXT ROW</i> | b. How many hours does your household use [ITEM] in a typical day? (Only for lights, fan, radio and TV)<br><br>Number of hours |
|-------------|--------------------------------------|---|--|
| N.1         | Incandescent Light Bulb              |   |  |
| N.2         | Fluorescent Tube                     |   |  |
| N.3         | Compact Fluorescent Light (CFL) Bulb |   |  |
| N.4         | LED Light Bulb                       |   |  |
| N.5         | Torch/flashlight/lantern             |   |  |
| N.6         | Radio/CD Players/sound system        |   |  |
| N.7         | VCD/DVD                              |   |  |
| N.8         | Fan                                  |   |  |
| N.9         | Refrigerator                         |   |  |
| N.10        | Microwave oven                       |   |  |
| N.11        | Electric Iron                        |   |  |
| N.12        | Hair dryer                           |   |  |
| N.13        | Electric food processor/blender      |   |  |
| N.14        | Rice cooker                          |   |  |
| N.15        | Freezer                              |   |  |
| N.16        | Washing machine                      |   |  |
| N.17        | Electric sewing machine              |   |  |
| N.18        | Indoor Air cooler                    |   |  |
| N.19        | Air Conditioner (AC)                 |   |  |
| N.20        | Space Heater                         |   |  |
| N.21        | Electric water heater                |   |  |
| N.22        | Solar based water heater             |   |  |
| N.23        | Computer                             |   |  |
| N.24        | Electric hot water pot/kettle        |   |  |
| N.25        | Smartphone (internet phone) charger  |   |  |
| N.26        | Regular mobile phone charger         |   |  |
| N.27        | Black & White TV                     |   |  |
| N.28        | Regular Color TV                     |   |  |
| N.29        | Flat color TV                        |   |  |
| N.30        | Electric Water Pump                  |   |  |
| N.31        | Other, specify                       |   |  |
| N.32        | None                                 |   |  |

Figure 1 Zambia MTF questionnaire section N

The data is processed by the Python script `process_MTF_zambia_assets_a_v0p3b.py`

Processing steps:

1. Load data for Section N ( $N_{\text{households}} = 3612$ )
2. Set up data structure for the asset numbers and names, according to .
3. Remove any HH where number of any of appliances is negative ( $N_{\text{households}} = 3607$ )
4. Remove HH where number of appliances in nan ( $N_{\text{households}} = 3603$ )
5. Select urban only, N households = 1808
6. Select grid-connected only, N households = 1074
7. Remove HH with any of: microwave oven, food processor, rice cooker, hot water pot/kettle ( $N_{\text{households}} = 726$ )

8. For each appliance calculate the sum, mean and std over all the households and sort this by mean number of appliances per household. This is shown in Figure 2.

| "NITEM" | Appliance                       | sum  | mean  | std   |
|---------|---------------------------------|------|-------|-------|
| 1       | Incandescent Light Bulb         | 1076 | 1.490 | 2.485 |
| 4       | LED Light Bulb                  | 859  | 1.190 | 1.960 |
| 26      | Regular mobile phone charger    | 817  | 1.132 | 1.189 |
| 3       | Compact Fluor. Light (CFL) Bulb | 597  | 0.827 | 1.771 |
| 11      | Electric Iron                   | 482  | 0.668 | 0.486 |
| 6       | Radio/CD Players/sound system   | 445  | 0.616 | 0.556 |
| 28      | Regular Color TV                | 429  | 0.594 | 0.550 |
| 9       | Refrigerator                    | 412  | 0.571 | 0.530 |
| 7       | VCD/DVD                         | 357  | 0.494 | 0.573 |
| 25      | Smartphone charger              | 354  | 0.490 | 0.917 |
| 2       | Fluorescent Tube                | 337  | 0.467 | 1.120 |
| 8       | Fan                             | 266  | 0.368 | 0.494 |
| 29      | Flat color TV                   | 183  | 0.253 | 0.454 |
| 15      | Freezer                         | 177  | 0.245 | 0.449 |
| 5       | Torch/flashlight/lantern        | 135  | 0.187 | 0.529 |
| 23      | Computer                        | 40   | 0.055 | 0.252 |
| 12      | Hair dryer                      | 12   | 0.017 | 0.128 |
| 27      | Black & White TV                | 9    | 0.012 | 0.144 |
| 17      | Electric sewing machine         | 7    | 0.010 | 0.134 |
| 19      | Air Conditioner (AC)            | 6    | 0.008 | 0.117 |
| 30      | Electric Water Pump             | 5    | 0.007 | 0.098 |
| 20      | Space Heater                    | 3    | 0.004 | 0.064 |
| 16      | Washing machine                 | 3    | 0.004 | 0.064 |
| 22      | Solar based water heater        | 2    | 0.003 | 0.053 |
| 21      | Electric water heater           | 2    | 0.003 | 0.053 |
| 18      | Indoor Air cooler               | 2    | 0.003 | 0.074 |

Figure 2 appliance list after processing, sorted by the mean number of an appliance per household

The list is used to generate two groups of households: those with the most 'common' appliances up to 'Refrigerator' and those with the most 'common' appliances up to 'black and white TV'. Appliances with a mean occurrence of less than 0.01/household are not considered. The second group contains all the appliances in the first group.

### Rationalising the appliances

Since there are more appliances in the questionnaire than is required for the MECS-CREST model, the list of appliances Figure 2 is mapped to a smaller set of appliances as given in Figure 3. This set of appliances is a subset of appliances given in the Beyond Connections report in Table 6 and Appendix 2. This set of appliances can be changed if necessary.

| Appliance        |
|------------------|
| Task Lighting    |
| Phone Charging   |
| Radio            |
| General Lighting |
| Air Circulation  |
| Television       |
| Food Processing  |
| Washing Machine  |
| Refrigerator     |
| Iron             |
| Air Conditioner  |
| Computer         |
| Water Pump       |
| Hair Dryer       |

Figure 3

Some of the appliances in Figure 2 are mapped to a single appliance in Figure 3. For example, in the upper group in Figure 2, *Incandescent Light Bulb* and *LED Light Bulb* are grouped together under *Task Lighting* (Figure 3).

The spreadsheet `Appliance_Ownership_Model_2Groups_zambia.xlsx` located at `C:\Users\b3046420\Newcastle University\MECS - Documents\Modelling Group\CREST model 1p0B` maps the survey appliances to the MECS-CREST appliances in the tabs *Group 1 Mapping* and *Group 2 Mapping*. In the tabs *Group 1 MECS-CREST* and *Group 2 MECS-CREST* where there is more than one appliance mapped to a single MECS-CREST appliance the aggregate values for mean and standard deviation have been calculated on the left-hand side. The tables on the left-hand side can be used to produce an inventory of appliances for a household. Note that it would have been better to filter out the two household groups in the Python script to produce the mean and standard deviation figures for number of appliances / household, for each group. However, for the time being, it is in Excel...