Renewables and waste

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Overview

• Importance of renewables
• International methodology
• Types of renewables and waste
  - Renewable electricity and heat
  - Combustible biofuels and waste
• Conclusion
Background
Solid biomass (mainly non-commercial fuelwood) is the largest part of total renewables.

Source: UNSD database
Renewable share of TFC 2015

- Syrian Arab Republic
- Sudan
- Saudi Arabia
- Qatar
- State of Palestine
- Oman
- Nigeria
- Nepal
- Libya
- Lebanon
- Kuwait
- Jordan
- Iraq
- Equatorial Guinea
- Egypt
- Angola

Source: 2018 SDG7 Tracking: The Energy Progress Report
International methodology
Methodological challenges

There are various definitional and methodological challenges in measuring renewable energy. Ex:

• **Defining** renewable energy, taking into account sustainability considerations

• **Data availability**, collection, and management issues

• Determining what convention to use for measuring the share of renewables in the global energy mix
## IRES: Cross-classification of energy products

<table>
<thead>
<tr>
<th>Non-renewables</th>
<th>Primary products</th>
<th>Secondary products</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Hard coal</td>
<td></td>
<td>- Coal products</td>
</tr>
<tr>
<td>- Brown coal</td>
<td></td>
<td>- Peat products</td>
</tr>
<tr>
<td>- Peat</td>
<td></td>
<td>- Refinery feedstocks</td>
</tr>
<tr>
<td>- Oil shale</td>
<td></td>
<td>- Oil products</td>
</tr>
<tr>
<td>- Natural gas</td>
<td></td>
<td>- Electricity and heat from combusted fuels of fossil origin</td>
</tr>
<tr>
<td>- Conventional crude oil</td>
<td></td>
<td>- Electricity derived from chemical processes and nuclear fuels</td>
</tr>
<tr>
<td>- Natural gas liquids (NGL)</td>
<td></td>
<td>- Any other product derived from primary/secondary non-renewable products</td>
</tr>
<tr>
<td>- Additives and oxygenates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Industrial waste</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Municipal waste (partially)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Nuclear Heat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Heat from chemical processes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Renewables</th>
<th>- Biofuels (except charcoal)</th>
<th></th>
<th>- Charcoal</th>
<th>- Electricity and heat from combusted biofuels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Municipal waste (partially)</td>
<td></td>
<td></td>
<td>- Any other product derived from primary/secondary renewable products</td>
</tr>
<tr>
<td></td>
<td>- Electricity and heat from renewable sources (\text{\textsuperscript{2}})</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[1\] The part of Municipal waste coming from biomass origin is considered as renewable, whereas that coming from fossil origin is considered as non-renewable.

\[2\] Renewable sources for electricity comprise of: hydro, wind, solar (photovoltaic and solar thermal), geothermal, wave, tide and other marine energy, as well as the combustion of biofuels. Renewable sources for heat are: solar thermal, geothermal and the combustion of biofuels.
IRES: Scope of Energy statistics

Energy products refer to all products exclusively or mainly used as a source of energy.

Biomass and waste are included when and only when they are used for energy purposes. Non-energy use of these products is excluded by definition.
Types of renewables and wastes

Renewable electricity and heat
Combustible biofuels and waste
Types of renewables and wastes

- **Renewables and wastes**
  - **Electricity only**
    - Solar PV
    - Hydro
    - Wind
  - **Electricity and heat**
    - Geothermal
    - Solar thermal
  - **Non-renewable**
    - Municipal Waste*
  - **Renewable**
    - Municipal Waste*
    - Biogases
      - Liquid Biofuels
      - Biogasoline
      - Biodiesels
      - Bio jet kerosene
    - Solid biomass
      - Fuelwood, Bagasse, Vegetal Waste, Animal Waste, Black liquor
    - Charcoal
    - Biogases
      - Biogasoline
      - Biodiesels
      - Bio jet kerosene
  - **Combustible fuels**
    - Renewable
      - Industrial waste
      - Municipal Waste*
Renewable electricity and heat
Types of renewables and wastes

Renewables and wastes

- Electricity only
- Electricity and heat
- Solar PV
- Hydro
- Solar thermal
- Tide, Wave, Ocean
- Wind

Combustible fuels

- Non-renewable
- Renewable

- Municipal Waste*
- Industrial waste

- Biogases
- Liquid Biofuels

- Solid biomass
- Fuelwood, Bagasse, Vegetal Waste, Animal Waste, Black liquor
- Charcoal
- Bio jet kerosene
- Biodiesels
- Biogasoline
Renewable electricity and heat

Electricity and heat from specific sources are not “products”, but rather data items.

Consumption in industry of “hydro” does not make sense, the product is electricity.

Therefore only generation figures are collected.

Information for autoproducers will most likely not be included in data available from public grids.
Definitions – electricity from renewable

Hydro

- Electricity produced from devices driven by fresh, flowing or falling water.

Solar

- **Solar photovoltaics**: Electricity produced by the direct conversion of solar radiation through photovoltaic processes in semiconductor devices (solar cells), including concentrating photovoltaic systems.
- **Solar thermal**: Electricity produced from solar radiation captured by concentrating solar thermal systems.

Wind

- Electricity produced from devices driven by wind.
Definitions – electricity from renewables

Geothermal

• Electricity generated from the heat from geothermal sources.

Tide, wave and marine

• **Tidal**: Electricity generated from devices driven by tidal currents or the differences of water level caused by tides.

• **Wave**: Electricity produced from devices driven by the motion of waves.

• **Other marine**: Electricity generated from devices which exploit sources of marine energy not elsewhere specified. Examples of sources are non-tidal currents, temperature differences and salinity gradients in seas and between sea and fresh water.
Electricity from renewables - flows

Primary electricity

Electricity generation

Electricity consumption

Hydro
Solar PV
Wind
Tide, Wave, Ocean
Definitions – heat from renewables

Geothermal

• Heat extracted from the earth.

Solar thermal

• **High temperature heat** can be used to generate electricity, drive chemical reactions, or be used directly in industrial processes.

• **Low temperature heat** can be used for applications such as space heating, cooling, water heating, district heating and industrial processes.
## Renewable electricity and heat

<table>
<thead>
<tr>
<th>Types of Plant:</th>
<th>Electricity plant</th>
<th>CHP plant</th>
<th>Heat plant</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Types of Producer:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main activity producers</td>
<td>Report all production and all fuel used</td>
<td>Report all electricity and heat produced and all fuel used</td>
<td>Report all heat produced and all fuel used</td>
</tr>
<tr>
<td>Autoproducer</td>
<td>Report all electricity produced and heat sold with corresponding fuel used</td>
<td></td>
<td>Report heat sold and corresponding fuel used</td>
</tr>
</tbody>
</table>

Reminder: all electricity should be reported in the electricity, but only the heat sold to third parties in autoproducer heat plants.
Direct use of geothermal & solar thermal heat

• For household solar hot water systems, heat is generated but no commercial transaction takes place.

• This should therefore be excluded from the heat generation.

Should this be excluded from our energy statistics?
Direct use of geothermal & solar thermal heat

- If this is excluded we do not have a full account of household energy consumption
- To account for it but to maintain consistent methodology, only data on consumption are collected (and separate direct use/tables are given in the UNSD questionnaire).
Direct use of geothermal & solar thermal heat

- Collected separately from the electricity and heat products (to maintain “heat sold” principle)
- Allows full household energy to be measured
- It shows consumption only, no production (this is back-calculated for balances using theoretical efficiencies)
Heat from renewable - flows

- Geothermal
- Solar thermal

- Direct consumption of heat

- Heat production
- Heat consumption
- Electricity generation
- Electricity consumption

Primary heat
Data challenges

Commercial transactions are recorded (producers, operators, distributors).

How can we measure non-financial activities?
Renewables data measurement

- With fossil fuels and commercial electricity production we often have supply, output, deliveries and consumption data.

- With “non-commercial” renewables, “production” will be back-calculated from consumption levels.

- Household surveys are needed, plus administrative data.
Combustible biofuels and waste
Combustible biofuels and wastes

- Renewables and wastes
  - Electricity only
  - Electricity and heat
    - Solar PV
    - Hydro
    - Solar thermal
    - Geothermal
  - Non-renewable
    - Municipal Waste*
  - Renewable
    - Biogases
      - Biogasoline
      - Biodiesels
      - Bio jet kerosene
    - Liquid Biofuels
      - Bio jet kerosene
    - Solid biomass
      - Fuelwood, Bagasse, Vegetal Waste, Animal Waste, Black liquor
      - Charcoal
    - Renewable Municipal Waste*
    - Industrial waste

- Combustible fuels
  - Charcoal
  - Fuelwood, Bagasse, Vegetal Waste, Animal Waste, Black liquor
  - Bio jet kerosene
  - Biodiesels
  - Biogasoline
  - Liquid Biofuels
  - Biogases
  - Renewable Municipal Waste*
  - Industrial waste
  - Non-renewable Municipal Waste*
Apart from differences on how to account for primary energy, and what is in the scope of energy statistics (as seen before), can be treated similarly to fossil fuels.

Concepts of production, stock changes, trade all make sense and can be collected, so a complete commodity balance can be constructed.
# Classification SIEC

<table>
<thead>
<tr>
<th>Section/Division/Group</th>
<th>Class</th>
<th>Title</th>
<th>CPC Ver.2</th>
<th>HS 2007</th>
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</thead>
<tbody>
<tr>
<td>5</td>
<td></td>
<td>Biofuels</td>
<td></td>
<td></td>
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<tr>
<td>51</td>
<td></td>
<td>Solid biofuels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>511</td>
<td>5110</td>
<td>Fuelwood, wood residues and by-products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5111</td>
<td></td>
<td>Wood pellets</td>
<td>39280*</td>
<td></td>
</tr>
<tr>
<td>5119</td>
<td>51190</td>
<td>Other fuelwood, wood residues and by-products</td>
<td>03130, 31230, 39280*</td>
<td></td>
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<tr>
<td>512</td>
<td>5120</td>
<td>Bagasse</td>
<td>39140*</td>
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<td>513</td>
<td>5130</td>
<td>Animal waste</td>
<td>34654*</td>
<td></td>
</tr>
<tr>
<td>514</td>
<td>5140</td>
<td>Black liquor</td>
<td>39230*</td>
<td></td>
</tr>
<tr>
<td>52</td>
<td></td>
<td>Liquid biofuels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>521</td>
<td>5210</td>
<td>Biogasoline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>522</td>
<td>5220</td>
<td>Biodiesels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>523</td>
<td>5230</td>
<td>Bio jet kerosene</td>
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<tr>
<td>529</td>
<td>5290</td>
<td>Other liquid biofuels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>53</td>
<td></td>
<td>Biogases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>531</td>
<td>5310</td>
<td>Biogases from anaerobic fermentation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5311</td>
<td></td>
<td>Landfill gas</td>
<td>33420*</td>
<td>2711.29*</td>
</tr>
<tr>
<td>5312</td>
<td></td>
<td>Sewage sludge gas</td>
<td>33420*</td>
<td>2711.29*</td>
</tr>
<tr>
<td>5319</td>
<td></td>
<td>Other biogases from anaerobic fermentation</td>
<td>33420*</td>
<td>2711.29*</td>
</tr>
<tr>
<td>532</td>
<td>5320</td>
<td>Biogases from thermal processes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Waste</td>
<td></td>
<td></td>
</tr>
<tr>
<td>61</td>
<td></td>
<td>Industrial waste</td>
<td></td>
<td></td>
</tr>
<tr>
<td>610</td>
<td>6100</td>
<td>Industrial waste</td>
<td>3921, 39220, 39240, 39250, 39260, 39270, 39290</td>
<td>2525.30, 2601, 3915, 4004, 4012.20, 4115.20, 4707, 5003, 5103.20, 5103.30, 5104, 5202, 5505.6309, 6310</td>
</tr>
<tr>
<td>62</td>
<td></td>
<td>Municipal waste</td>
<td></td>
<td></td>
</tr>
<tr>
<td>620</td>
<td>6200</td>
<td>Municipal waste</td>
<td>39910</td>
<td>3825.10</td>
</tr>
</tbody>
</table>
Post-consumer waste

- **Industrial waste**: non-renewable by definition (any "industrial" waste of bio origin is classified as a biofuel). Burnt separately from municipal waste (pollution)
  - Examples: used car tires, medical waste

- **Municipal waste**: from households, companies and public services
  - Will typically be part-renewable. Many countries/organisations assume a 50/50 split without better data
Product: biogases

- Biogases often used on site, but can be blended into the natural gas distribution network too.
- All data on the **total quantity of biogases produced** should be collected, regardless of their production process.
Liquid biofuels

- Biogasoline (includes bioethanol, biomethanol)
  - Used pure or blended in gasoline engines
- Biodiesels (methyl-esters, Fischer Tropsch oil)
  - Used pure or blended in diesel engines
- Bio jet kerosene
- Other liquid biofuels

SIEC classification is made by use rather than chemistry.

What fuel is it being blended with? What engine is it used in?
## Liquid biofuels: energy statistics

### Oil

<table>
<thead>
<tr>
<th></th>
<th>Production</th>
<th>Receipt from other sources</th>
<th>Consumption in road</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor gasoline (MO)</td>
<td>100</td>
<td>50</td>
<td>150</td>
</tr>
</tbody>
</table>

### Biogasoline (ZG)

- Receipt from other sources: 50
- Consumption in road: 50

### Biogasoline (AL)

<table>
<thead>
<tr>
<th></th>
<th>Production</th>
<th>Consumption in road</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>70</td>
<td>70</td>
</tr>
</tbody>
</table>

- All Biogasoline has to be allocated for final consumption
  - = 20 pure + 50 blended
# Liquid biofuels: energy balances

## Oil

<table>
<thead>
<tr>
<th>Category</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>100</td>
</tr>
<tr>
<td>Receipt from other sources</td>
<td>50</td>
</tr>
<tr>
<td>Consumption in road</td>
<td>150</td>
</tr>
</tbody>
</table>

Values refers to only to fossil fuel. Portion of biogasoline blended with motor gasoline is not reported under oil.

## Motor gasoline (MO)

<table>
<thead>
<tr>
<th>SubCategory</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>100</td>
</tr>
<tr>
<td>Receipt from other sources</td>
<td>50</td>
</tr>
<tr>
<td>Consumption in road</td>
<td>150</td>
</tr>
</tbody>
</table>

### Of which: Biogasoline (ZG)

<table>
<thead>
<tr>
<th>SubCategory</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receipt from other sources</td>
<td>50</td>
</tr>
<tr>
<td>Consumption in road</td>
<td>50</td>
</tr>
</tbody>
</table>

## Renewables

### Biogasoline (AL)

<table>
<thead>
<tr>
<th>SubCategory</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>70</td>
</tr>
<tr>
<td>Consumption in road</td>
<td>70</td>
</tr>
</tbody>
</table>

All Biogasoline has to be allocated for final consumption.

= 20 pure + 50 blended
Definitions – solid biofuels and waste

Fuelwood, wood residues and by-products

- Fuelwood or firewood (in log, brushwood, pellet or chip form) obtained from natural or managed forests or isolated trees. Also included are wood residues used as fuel and in which the original composition of wood is retained.

Charcoal

- The solid residue from the carbonisation of wood or other vegetal matter through slow pyrolysis.

Bagasse

- The fuel obtained from the fibre which remains after juice extraction in sugar cane processing.
Definitions – Solid biofuels and waste

**Animal waste**
Excreta of animals, meat and fish residues which, when dry, are used directly as a fuel.

**Black liquor**
The alkaline-spent liquor obtained from the digesters during the production of sulphate or soda pulp required for paper manufacture.

**Other vegetal material and residues**
- Solid primary biofuels not specified elsewhere, including straw, vegetable husks, ground nut shells, pruning brushwood, olive pomace and other wastes arising from the maintenance, cropping and processing of plants.

**Municipal waste**
- Household waste and waste from companies and public services that resembles household waste and which is collected at installations specifically designed for the disposal of mixed wastes with recovery of combustible liquids, gases or heat.
Combustible biofuels and waste – flows

Supply

- Production
- Imports
- Stock build
- Stock draw

- Exports

Transformation
- Energy own use
- Losses
- Final consumption
# Charcoal production

## Transformation of biofuels

### Fuelwood → Charcoal Transformation Plant → Charcoal

### Table 6: Fuelwood to charcoal conversion table

<table>
<thead>
<tr>
<th></th>
<th>Coniferous wood</th>
<th>Average tropical hardwoods</th>
<th>Preferred tropical hardwoods</th>
<th>Mangrove (rhizophora)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charcoal</td>
<td>115</td>
<td>170</td>
<td>180</td>
<td>285</td>
</tr>
</tbody>
</table>

### Influence of wood moisture content on charcoal production

<table>
<thead>
<tr>
<th>Moisture content (dry basis)</th>
<th>100</th>
<th>80</th>
<th>60</th>
<th>40</th>
<th>20</th>
<th>15</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of wood required (cubic metres)</td>
<td>17.6</td>
<td>16.2</td>
<td>13.8</td>
<td>10.5</td>
<td>8.1</td>
<td>6.6</td>
<td>5.8</td>
</tr>
<tr>
<td>Weight of wood required (tons)</td>
<td>12.6</td>
<td>11.6</td>
<td>9.9</td>
<td>7.5</td>
<td>5.8</td>
<td>4.7</td>
<td>4.1</td>
</tr>
</tbody>
</table>

Data challenges

Commercial transactions are recorded (producers, operators, distributors).

How can we measure non-financial activities?
## Average densities of selected fuelwood

(12% moisture content)

<table>
<thead>
<tr>
<th>Non-coniferous fuelwood</th>
<th>Density (kg/m³)</th>
<th>Non-coniferous fuelwood</th>
<th>Density (kg/m³)</th>
<th>Coniferous fuelwood</th>
<th>Density (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All-inclusive standard</td>
<td>750</td>
<td>All-inclusive standard</td>
<td>750</td>
<td>All-inclusive standard</td>
<td>625</td>
</tr>
<tr>
<td>Acacia, albida</td>
<td>633</td>
<td>Mahogany</td>
<td>705</td>
<td>Cedar, white, red</td>
<td>352</td>
</tr>
<tr>
<td>Acacia, nigrescens</td>
<td>1111</td>
<td>Mangrove, heriteria</td>
<td>901</td>
<td>Cypress</td>
<td>465</td>
</tr>
<tr>
<td>Apple</td>
<td>705</td>
<td>Mangrove, rhizophora</td>
<td>1176</td>
<td>Fir, Douglas</td>
<td>513</td>
</tr>
<tr>
<td>Ash, black</td>
<td>545</td>
<td>Mangrove, sonneratia</td>
<td>775</td>
<td>Fir, balsam</td>
<td>401</td>
</tr>
<tr>
<td>Ash, white</td>
<td>673</td>
<td>Maple, sugar</td>
<td>689</td>
<td>Hemlock</td>
<td>465</td>
</tr>
<tr>
<td>Bamboo</td>
<td>725</td>
<td>Maple, white</td>
<td>529</td>
<td>Pine, Oregon</td>
<td>513</td>
</tr>
<tr>
<td>Birch, sweet yellow</td>
<td>705</td>
<td>Oak, chestnut</td>
<td>737</td>
<td>Pine, red</td>
<td>481</td>
</tr>
<tr>
<td>Cherry, wild red</td>
<td>433</td>
<td>Oak, live</td>
<td>866</td>
<td>Pine, white</td>
<td>433</td>
</tr>
<tr>
<td>Chestnut</td>
<td>481</td>
<td>Oak, red, black</td>
<td>673</td>
<td>Pine, southern</td>
<td>642</td>
</tr>
<tr>
<td>Elm, white</td>
<td>561</td>
<td>Oak, white</td>
<td>770</td>
<td>Pine, Norway</td>
<td>541</td>
</tr>
<tr>
<td>Erythrophleum africanum</td>
<td>1010</td>
<td>Poplar</td>
<td>433</td>
<td>Redwood, California</td>
<td>417</td>
</tr>
<tr>
<td>Eucalyptus, microcorys</td>
<td>847</td>
<td>Tamarind</td>
<td>855</td>
<td>Spruce, white, red</td>
<td>449</td>
</tr>
<tr>
<td>Eucalyptus, paniculata</td>
<td>1000</td>
<td>Teak, African</td>
<td>994</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hickory</td>
<td>769</td>
<td>Teak, Indian</td>
<td>769</td>
<td>For unknown species</td>
<td>725</td>
</tr>
<tr>
<td>Irvingia malayana</td>
<td>1099</td>
<td>Walnut, black</td>
<td>593</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locust</td>
<td>722</td>
<td>Willow</td>
<td>449</td>
<td></td>
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</tr>
</tbody>
</table>

**Sources:**
- J. Bryce, *The Commercial Timbers of Tanzania* (Dar es Salaam, Government Printers, 1967);
- P. Sono, *Merchantable Timbers of Thailand* (Bangkok, Forest Products Division, Royal Forest Department, 1974);
- United Nations, “Concepts and methods for the collection and compilation of statistics on biomass used as energy”, by K. Openshaw (ESA/STAT/AC.30/6)
Flows – energy industries

**Transfers**
- Electricity plants
- Combined Heat and Power (CHP) plants
- Heat plants
- Gas-to-liquids (GTL) plants
- Other transformations

**Transformation**
- Oil and gas extraction
- Gasworks
- Blast furnaces
- Oil refineries
- Liquefaction/regasification plants (LNG)
- Electricity, heat and CHP plants
- Other own use

**Own use by energy industries**

**Losses**
Flows – final consumption

Manufacturing, construction and non-fuel mining industry
- Iron and steel
- Chemical and petrochemical
- Other manufacturing
- Construction
- Non-fuel mineral industry

Transport
- Road
- Domestics navigation
- Pipeline transport
- Others

Other
- Households
- Agriculture, forestry, fishing
- Commerce and public services
- Not elsewhere specified (other)
### UN Energy Statistics Questionnaire

#### Combustible biofuels and waste:
- **Fuelwood**; Cubic meters
- **Charcoal**; Metric tons
- **Bagasse**; Metric tons
- **Animal waste**; TJ
- **Other Vegetal Material and Residues**; TJ
- **Municipal Wastes**; TJ
- **Industrial Waste**; TJ
- **Black liquor**; TJ
- **Biogasoline**; Metric tons
- **Biodiesel**; Metric tons
- **Bio jet kerosene**; Metric tons
- **Other liquid biofuels**; Metric tons
- **Biogases**; TJ

<table>
<thead>
<tr>
<th>Fuelwood (FW); Cubic metres, thousand (CSR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FW01 Production</td>
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<tr>
<td>FW03 Imports</td>
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<td>FW04 Exports</td>
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<td>FW06 Stock changes</td>
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<td><strong>FWGA</strong> Total energy supply</td>
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<td>FW08 Transformation</td>
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<td>FW088 Transformation in electricity, CHP and heat plants</td>
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<td>FW085CH Charcoal plants</td>
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<td>FW089 Other transformation</td>
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<td>FW09 Energy industries own use</td>
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<td>FW0923 Briquetting plants</td>
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<td>FW0925 Oil refineries</td>
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<td>FW0927 Electricity, CHP and heat plants</td>
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<td>FW0933 Charcoal plants</td>
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<td>FW0928 Other energy industry own use</td>
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<tr>
<td><strong>FWNA</strong> Final consumption</td>
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<tr>
<td>FW11 Non-energy uses</td>
</tr>
<tr>
<td>FW12 Final energy consumption</td>
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<tr>
<td>FW121 Manufacturing, construction and non-fuel mining industry</td>
</tr>
<tr>
<td>FW1211 Iron and steel</td>
</tr>
<tr>
<td>FW1213 Chemical and petrochemical</td>
</tr>
<tr>
<td>FW1214 Other manuf., const. and non-fuel min. ind.</td>
</tr>
</tbody>
</table>
## Total Electricity (EL); Kilowatt-hours, million (HWU)

- **EL015HY** Hydro – Main activity
- **EL015PH** Of which: Pumped hydro – Main activity
- **EL015GE** Geothermal – Main activity – Electricity plants
- **EL015GC** Geothermal – Main activity – CHP plants
- **EL015S** Solar – Main activity
- **EL015SP** Solar photovoltaic – Main activity
- **EL015ST** Tide, wave and marine – Main activity
- **EL015W** Wind – Main activity
- **EL016PH** Of which: Pumped hydro – Autoproducer
- **EL016GE** Geothermal – Autoproducer – Electricity plants
- **EL016GC** Geothermal – Autoproducer – CHP plants
- **EL016S** Solar – Autoproducer
- **EL016SP** Solar photovoltaic – Autoproducer
- **EL016ST** Solar thermal – Autoproducer
- **EL016T** Tide, wave and marine – Autoproducer
- **EL016W** Wind – Autoproducer

## Heat (ST); Terajoules (HSO)

- **ST015G** Geothermal – Main activity
- **ST015GH** Geothermal – Main activity – Heat plants
- **ST015GC** Geothermal – Main activity – CHP plants
- **ST015ST** Solar thermal – Main activity
- **ST016G** Geothermal – Autoproducer
- **ST016GH** Geothermal – Autoproducer – Heat plants
- **ST016GC** Geothermal – Autoproducer – CHP plants
- **ST016ST** Solar thermal – Autoproducer

## Direct use of geothermal heat (DG); Terajoules (HSO)

- **DG12** Final energy consumption
- **DG121** Manufacturing, construction and non-fuel mining industry
- **DG1211** Iron and steel
- **DG1213** Chemical and petrochemical
- **DG1214** Other manuf., const. and non-fuel min. ind.
  - **DG1214a** Non-ferrous metals
  - **DG1214b** Non-metallic minerals
- **DG123** Other
  - **DG1231** Households
  - **DG1232** Agriculture, forestry and fishing
  - **DG1235** Commerce and public services
  - **DG1234** Not elsewhere specified (other)

## Direct use of solar thermal heat (DS); Terajoules (HSO)
Conclusion
Conclusion

- Commodity balances can be constructed for combustible biofuels
- Data sources are typically more sparse than for fossil fuels
- "Non-commercial" products need to be included in energy statistics. This includes:
  - Fuelwood or other biomass collected by households for own use
  - By-products of certain industries typically used for energy purposes (e.g., bagasse, black liquor)
- Electricity and heat generated from renewable sources should be collected from power plants and households
Conclusion

• Renewables are important and will become more so

• Measurement challenges exist, but solutions are available

• Follow international methodology:
  - Deviations from it that are relevant for national policies should be signaled in the metadata, and ideally adjusted for international reporting