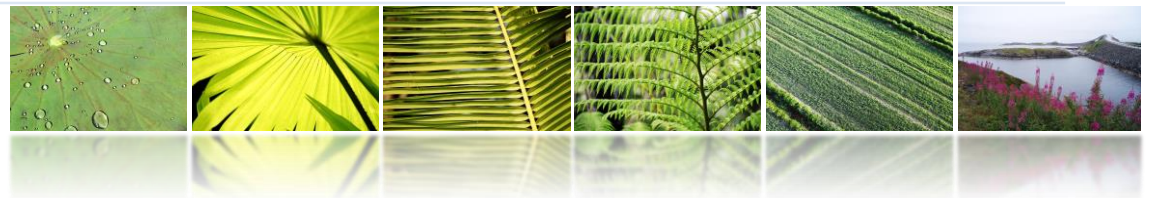




United Nations  
Statistics Division

# Renewables and waste



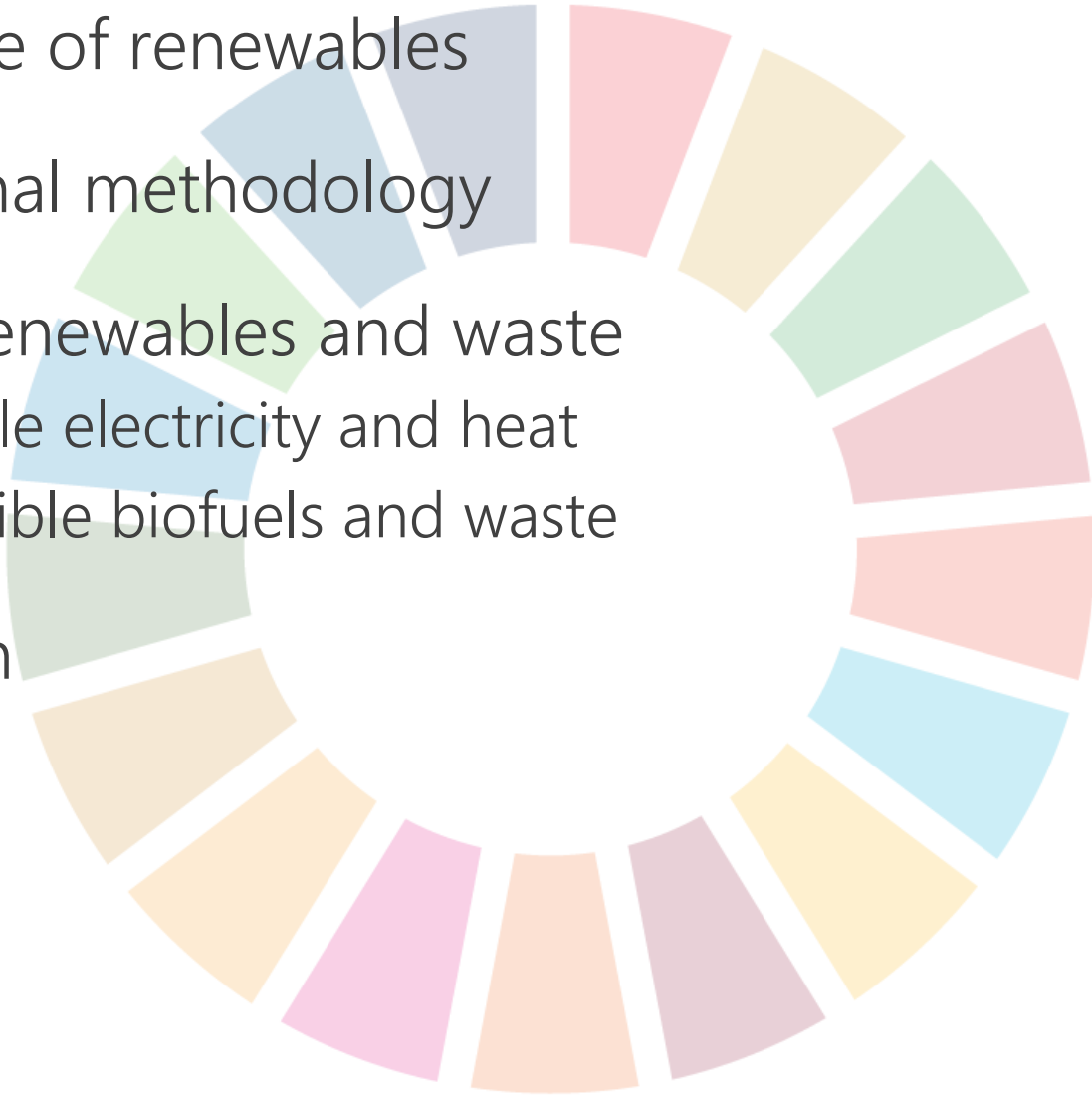
Agnieszka KOSCIELNIAK  
Statistician, Energy Statistics Section

Energy Balance Workshop  
Beirut, Lebanon, 14 December 2018

# Overview

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- Importance of renewables
- International methodology
- Types of renewables and waste
  - Renewable electricity and heat
  - Combustible biofuels and waste
- Conclusion

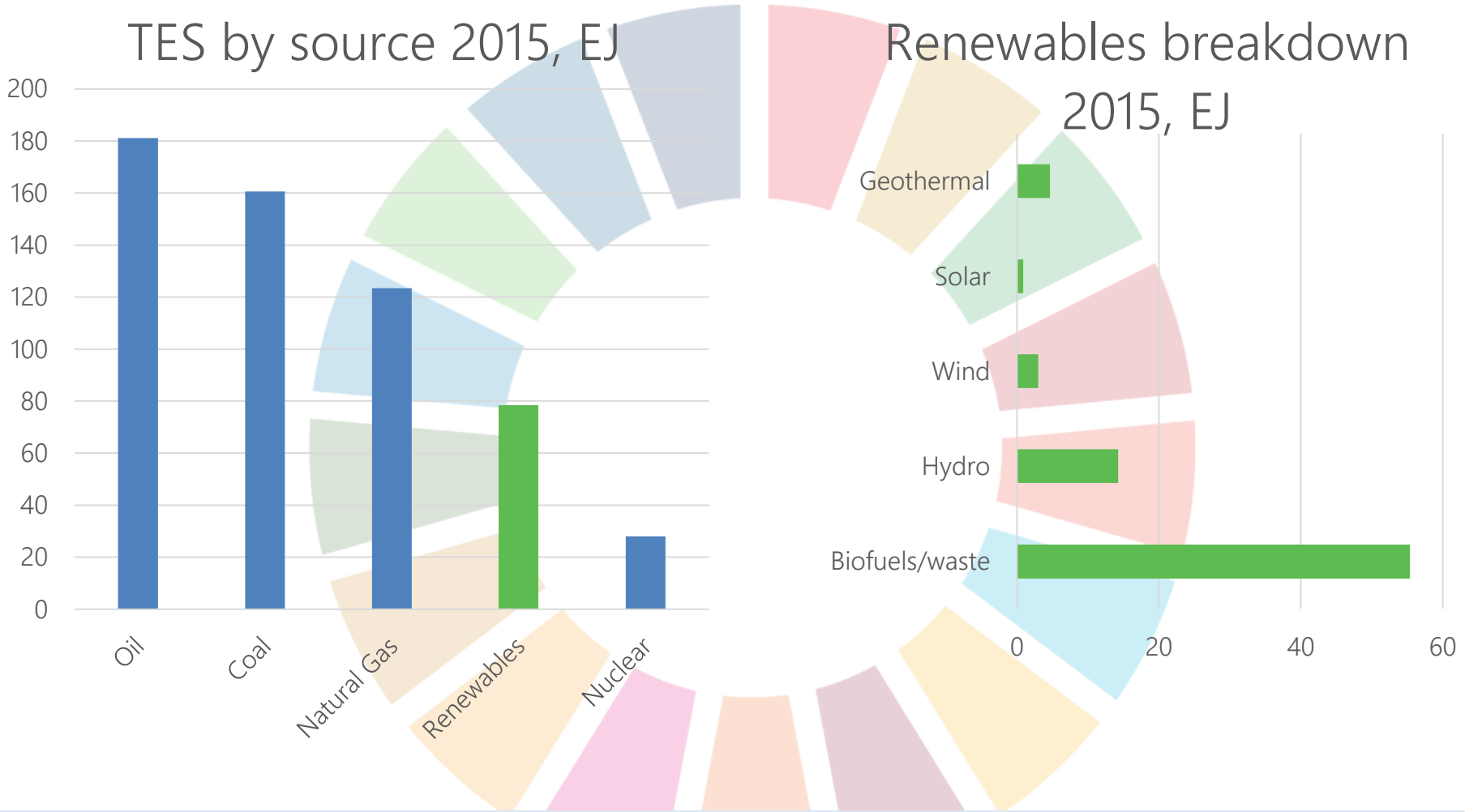




# Background

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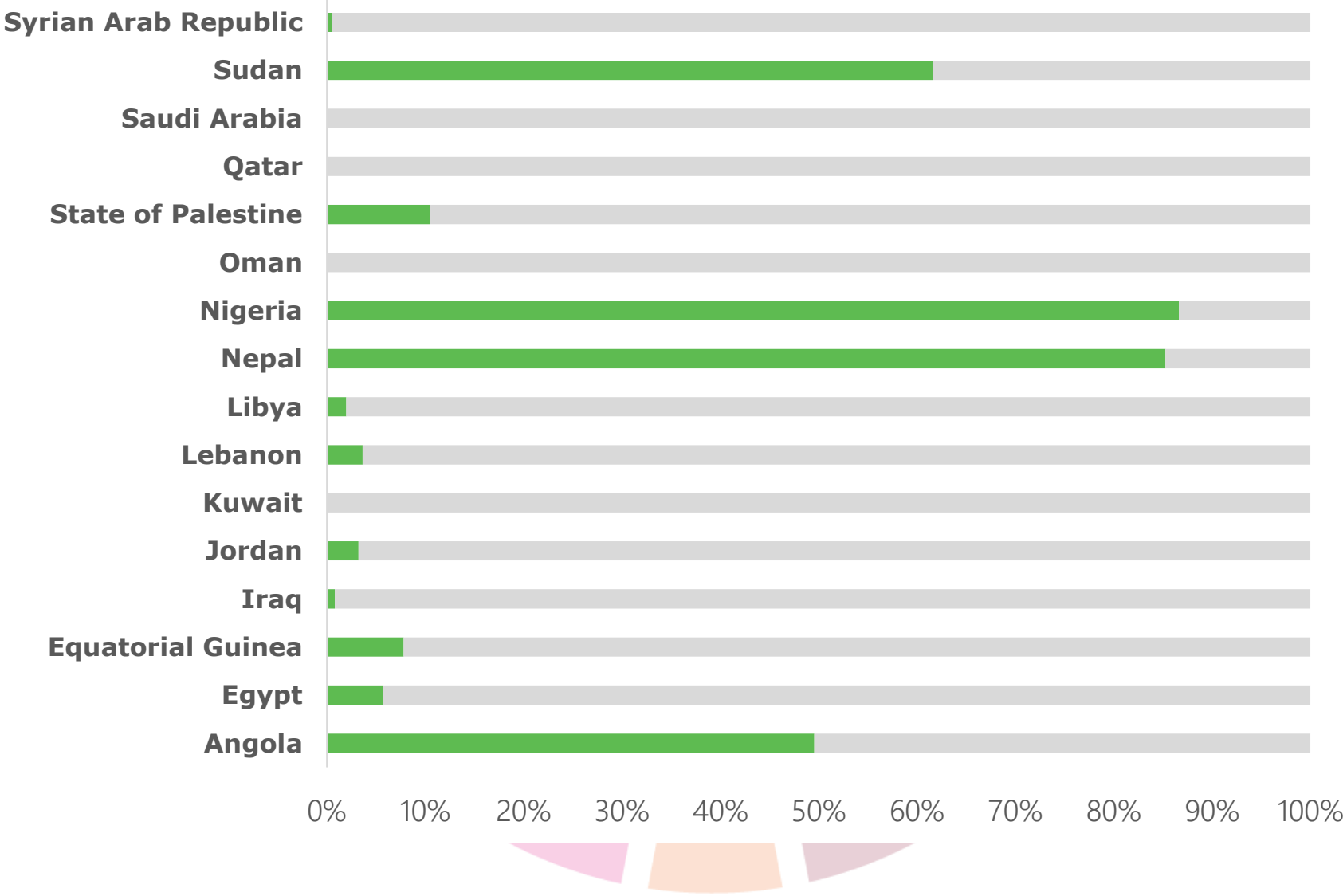
# World Energy Supply



Solid biomass (mainly non-commercial fuelwood) is the largest part of total renewables.

Source: UNSD database

# Renewable share of TFC 2015



Source: 2018 SDG7 Tracking: The Energy Progress Report



# International methodology

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# Methodological challenges

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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

	Primary products	Secondary products
Non-renewables	<ul style="list-style-type: none"> <li>- Hard coal</li> <li>- Brown coal</li> <li>- Peat</li> <li>- Oil shale</li> <li>- Natural gas</li> <li>- Conventional crude oil</li> <li>- Natural gas liquids (NGL)</li> <li>- Additives and oxygenates</li> <li>- Industrial waste</li> <li>- Municipal waste (partially<sup>1</sup>)</li> <li>- Nuclear Heat</li> <li>- Heat from chemical processes</li> </ul>	<ul style="list-style-type: none"> <li>- Coal products</li> <li>- Peat products</li> <li>- Refinery feedstocks</li> <li>- Oil products</li> <li>- Electricity and heat from combusted fuels of fossil origin</li> <li>- Electricity derived from chemical processes and nuclear fuels</li> <li>- Any other product derived from primary/secondary non-renewable products</li> </ul>
Renewables	<ul style="list-style-type: none"> <li>- Biofuels (except charcoal)</li> <li>- Municipal waste (partially<sup>1</sup>)</li> <li>- Electricity and heat from renewable sources<sup>2</sup></li> </ul>	<ul style="list-style-type: none"> <li>- Charcoal</li> <li>- Electricity and heat from combusted biofuels</li> <li>- Any other product derived from primary/secondary renewable products</li> </ul>

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

<sup>[2]</sup> 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

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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.





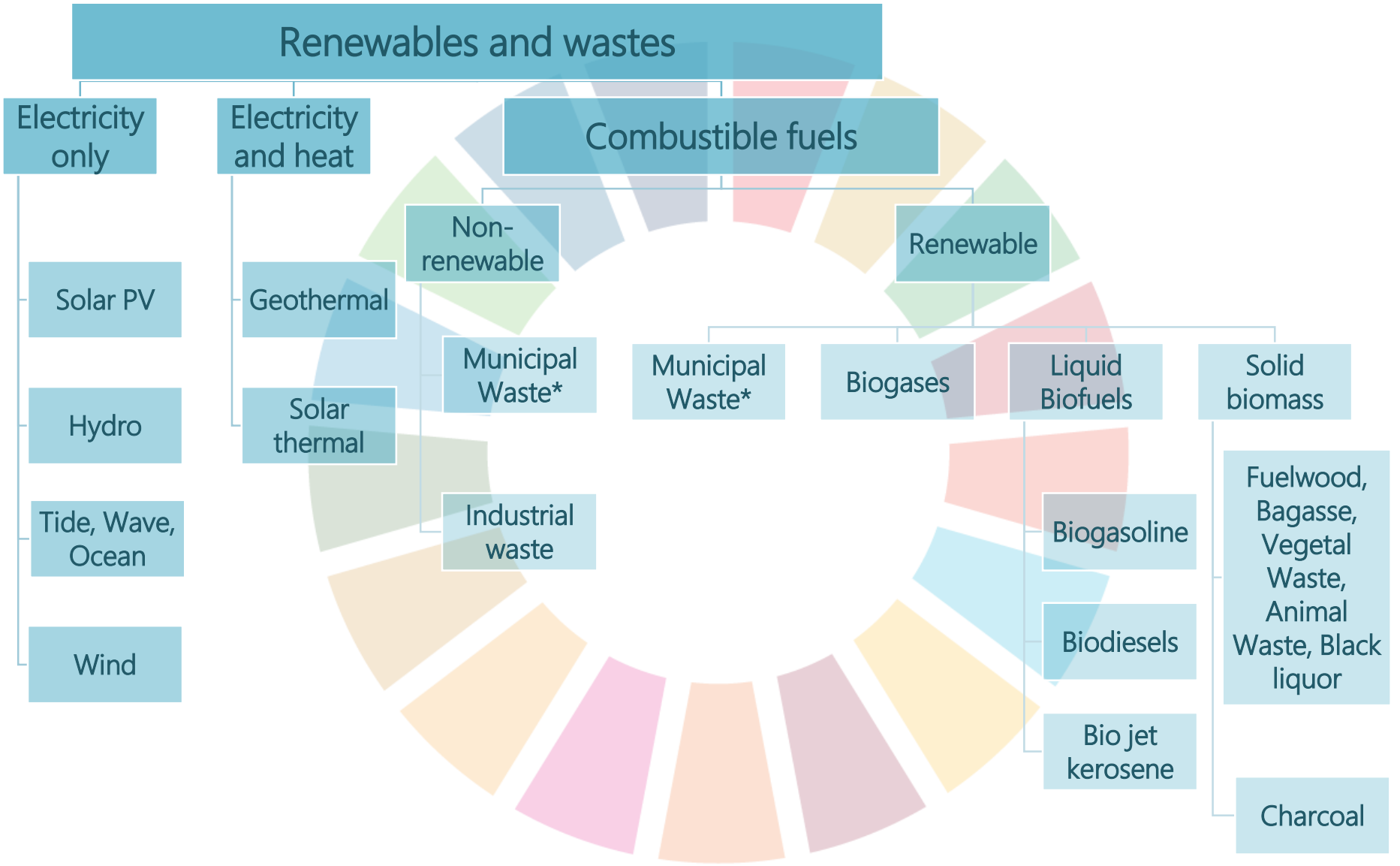
# Types of renewables and wastes

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Renewable electricity and heat

Combustible biofuels and waste

# Types of renewables and wastes

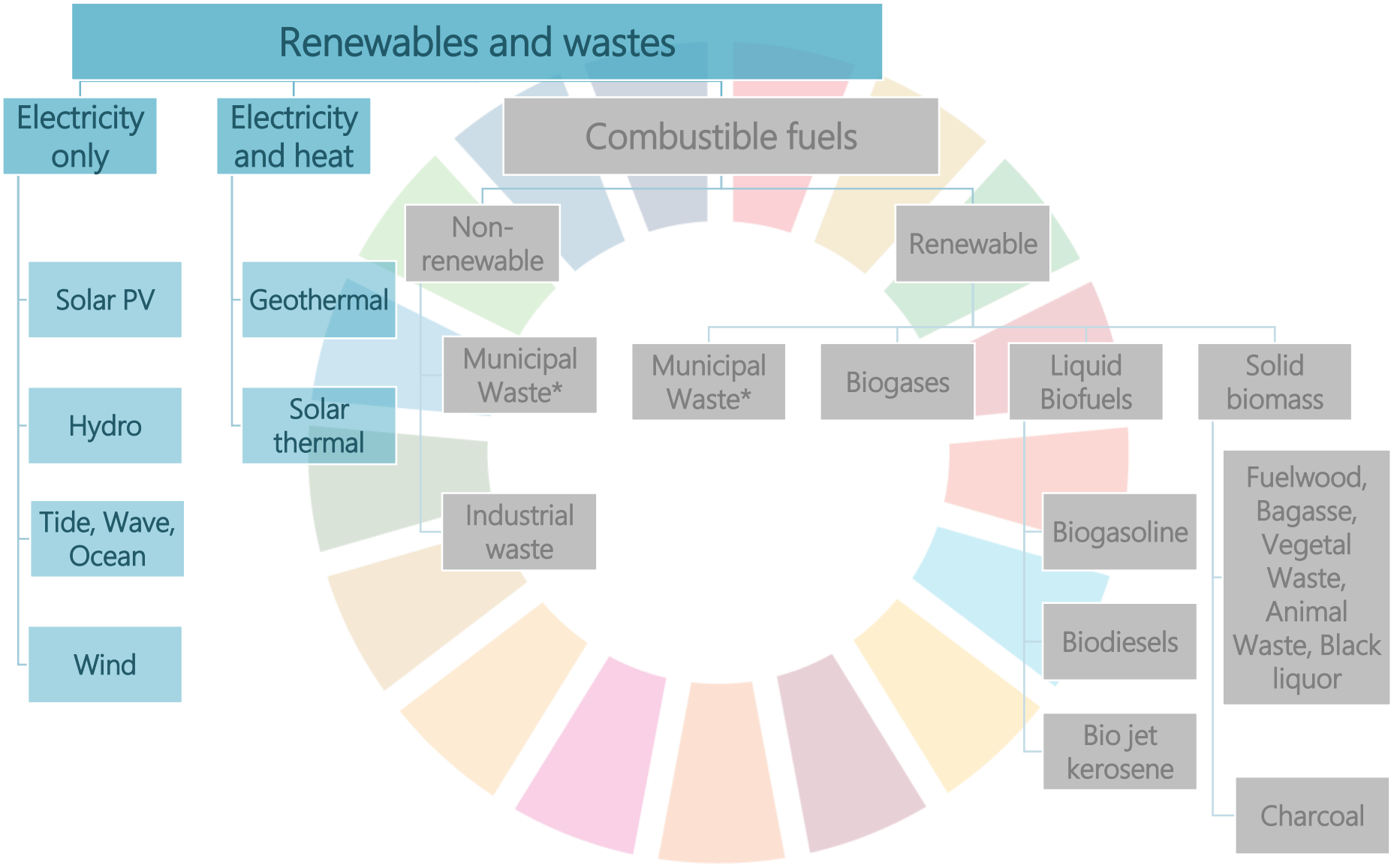




# Renewable electricity and heat

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# Types of renewables and wastes



# Renewable electricity and heat

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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

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## Hydro

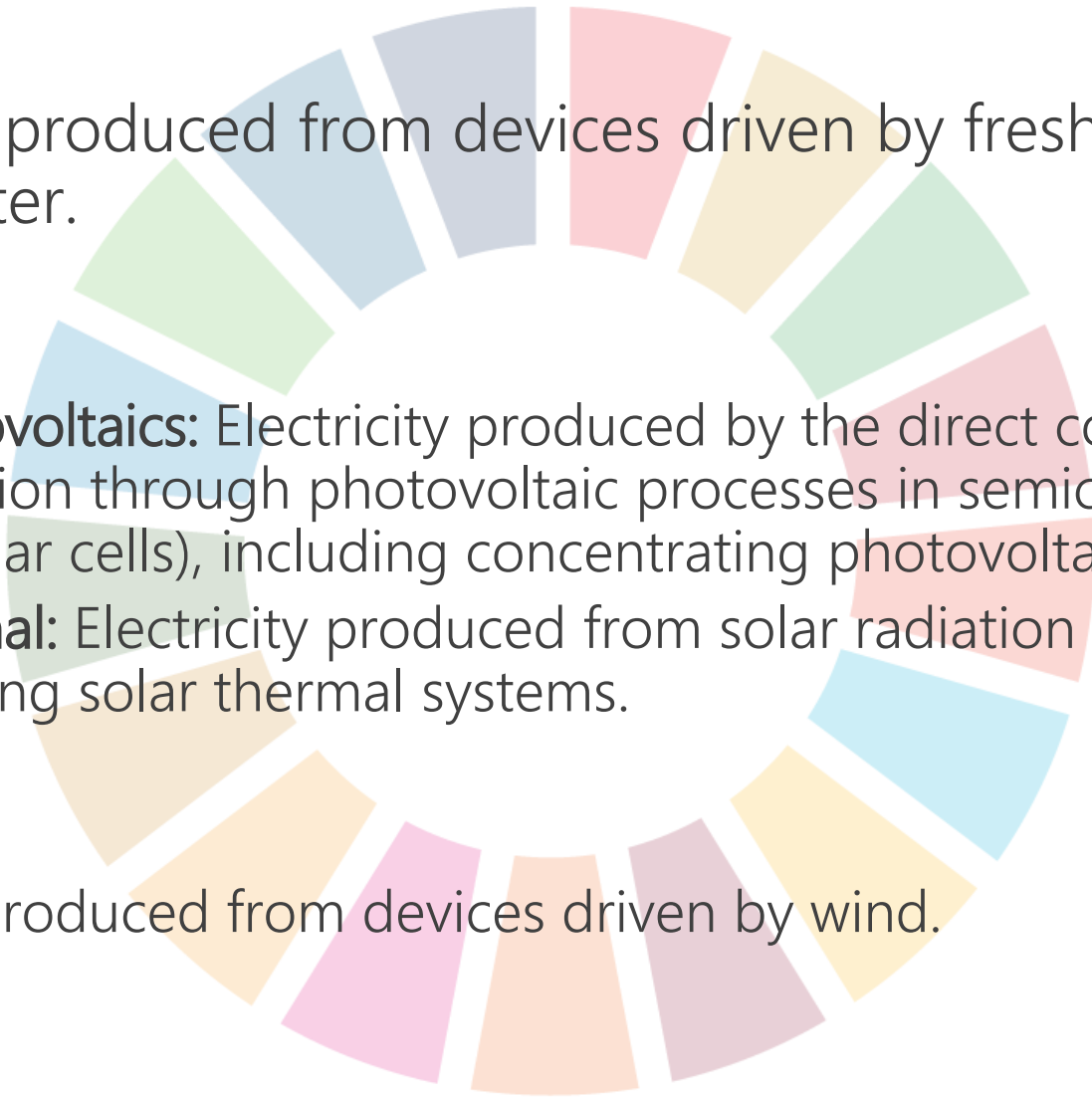
- Electricity produced from devices driven by fresh, flowing or falling water.

## 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

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## Geothermal

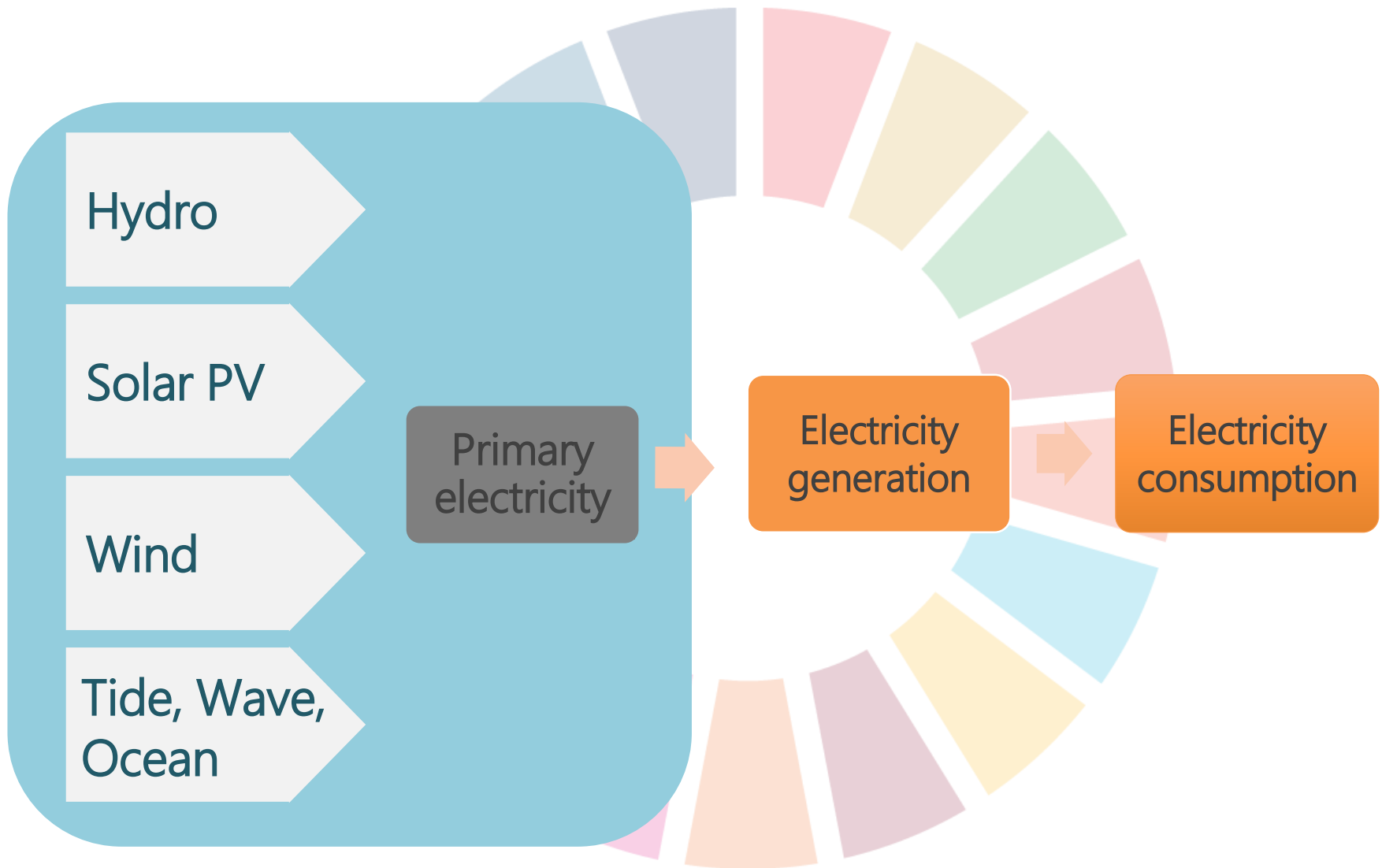
- Electricity generated from the heat from geothermal sources.

## 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



# Definitions – heat from renewables

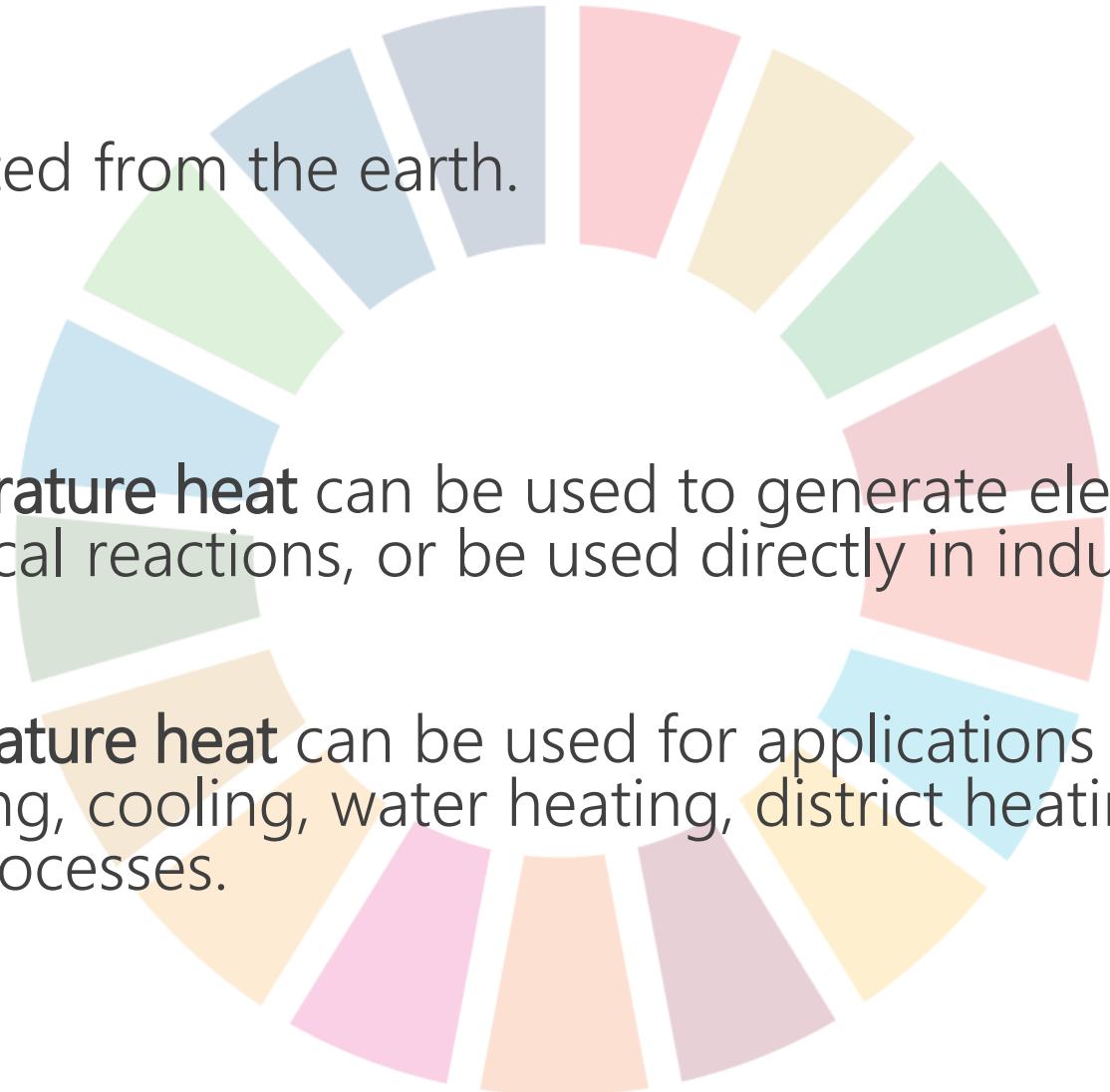
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## Geothermal

- 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

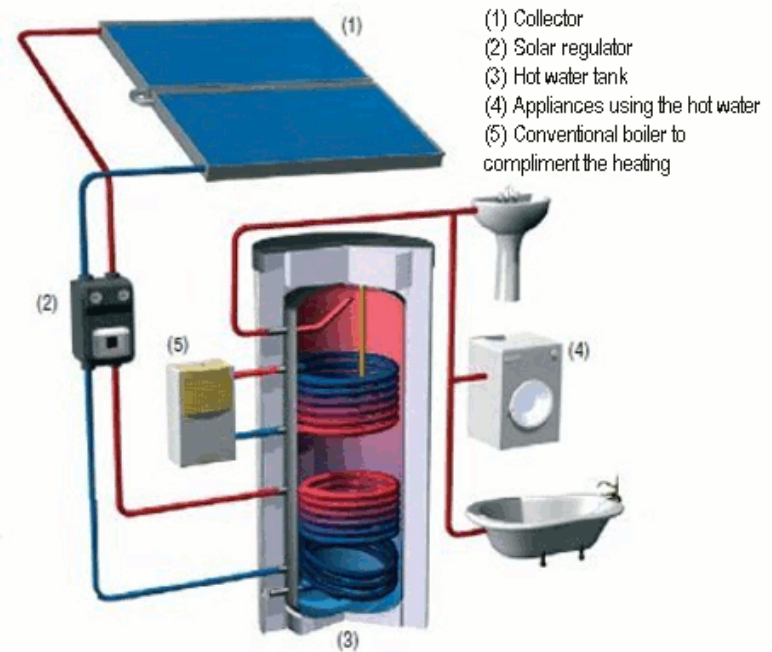
Types of Plant:	Electricity plant	CHP plant	Heat plant
Types of Producer:			
Main activity producers	Report all production and all fuel used	Report all electricity and heat produced and all fuel used	Report all heat produced and all fuel used
Autoproducer	Report all production and all fuel used	Report all electricity produced and heat sold with corresponding fuel used	Report heat sold and corresponding fuel used

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

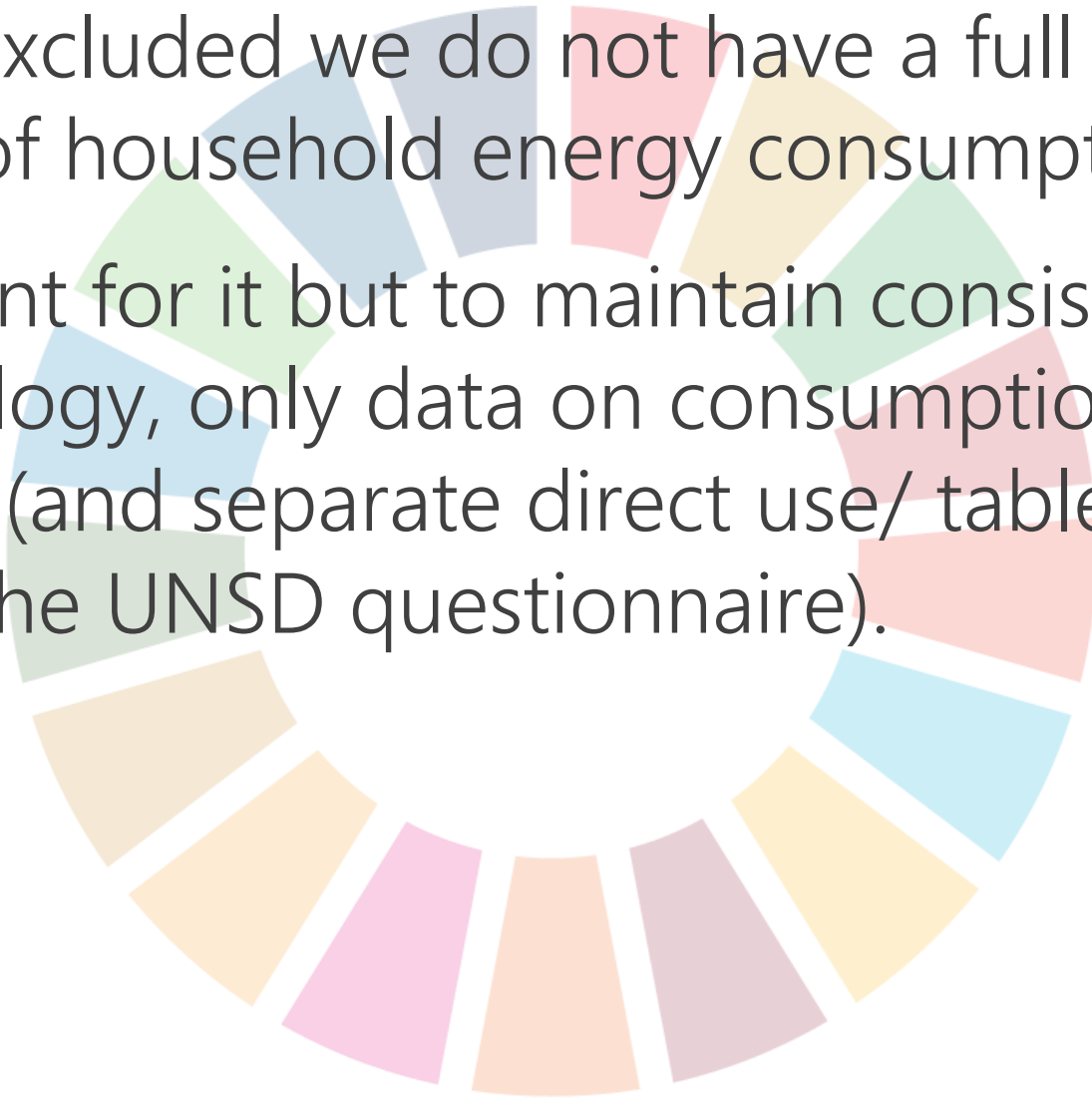
Should this be excluded from our energy statistics?



# Direct use of geothermal & solar thermal heat

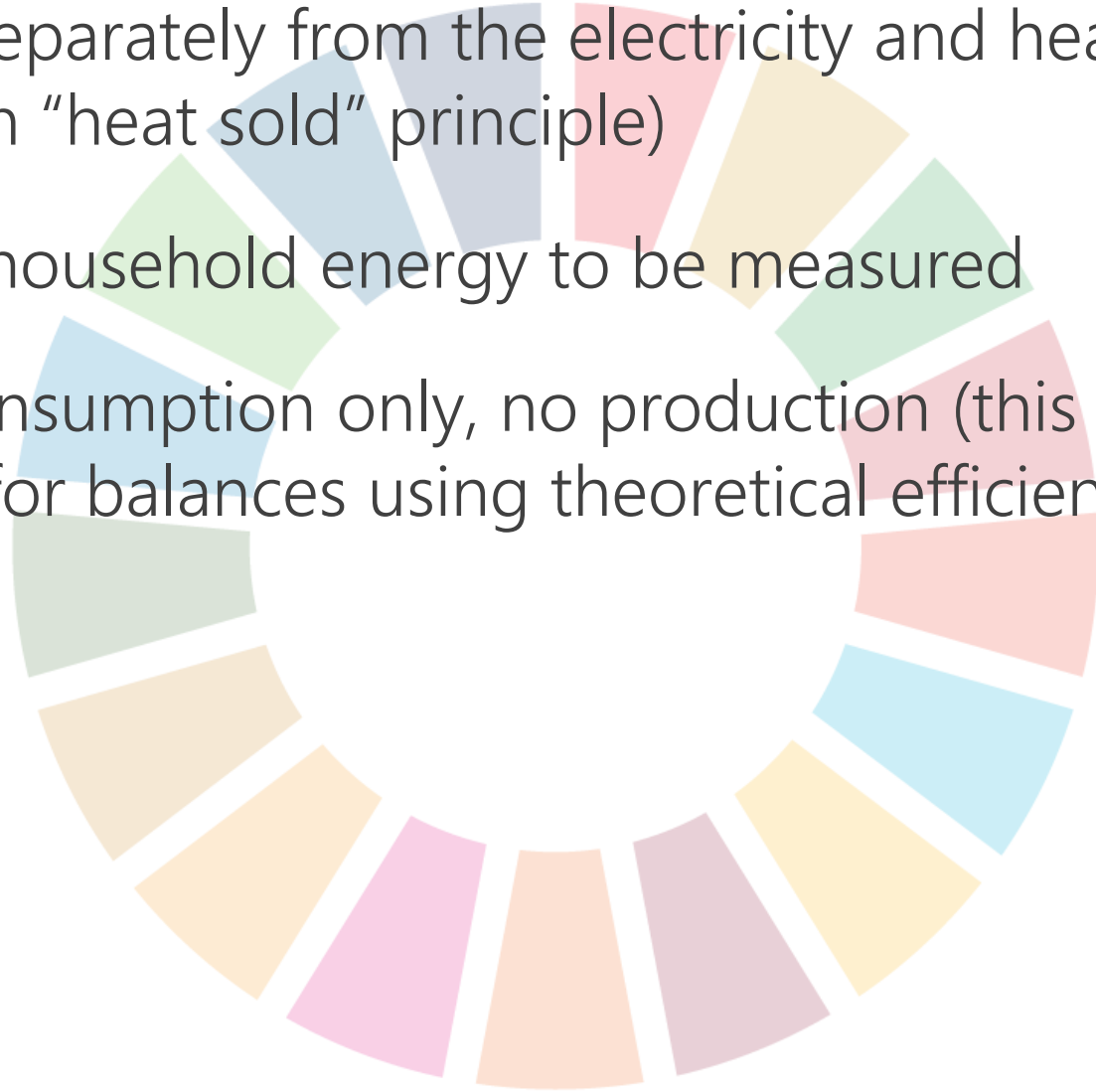
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- If this is excluded we do not have a full account of household energy consumption
- To account for it but to maintain consistent methodology, only data on consumption are collected (and separate direct use/ tables are given in the UNSD questionnaire).

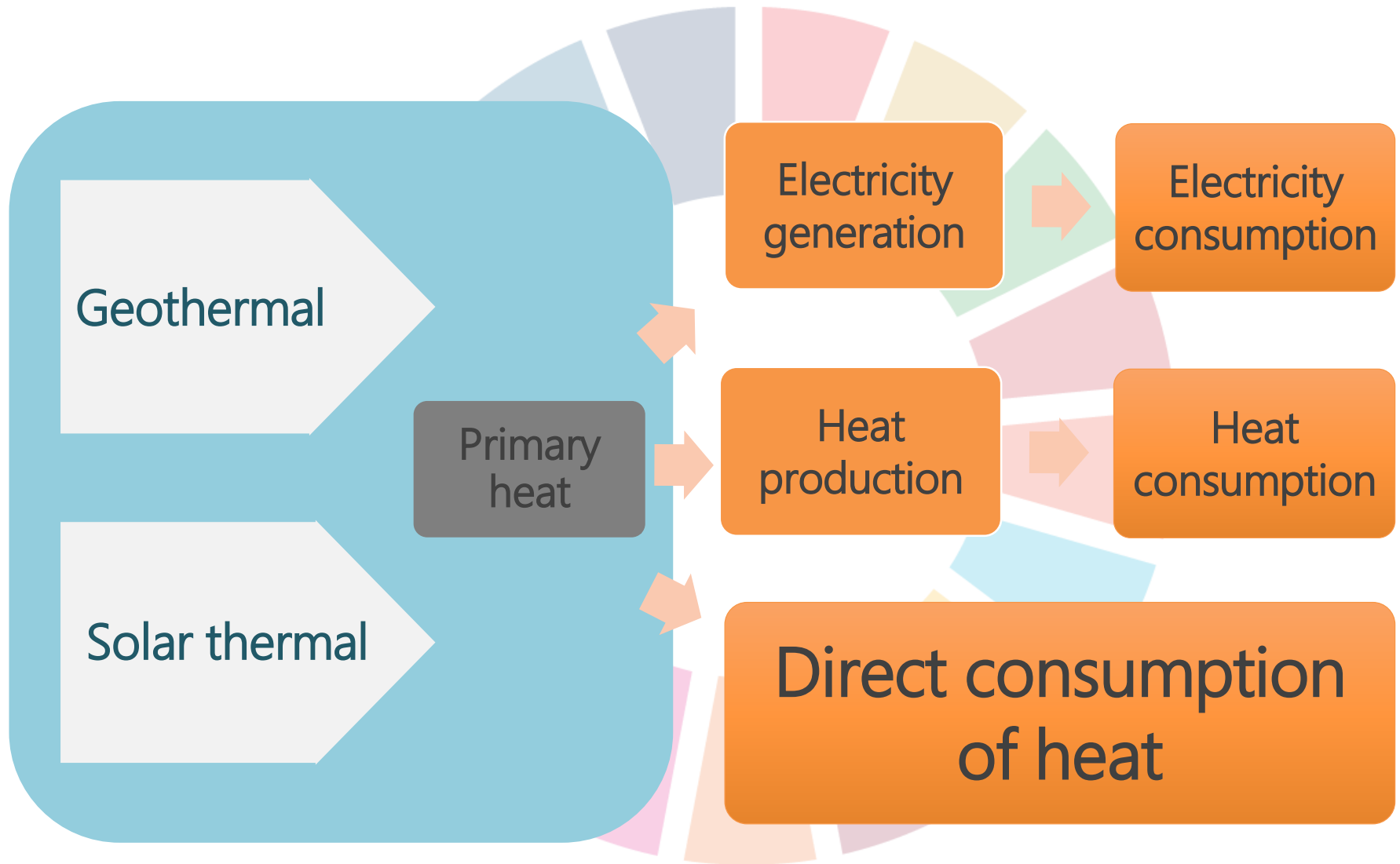


# Direct use of geothermal & solar thermal heat

- 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)

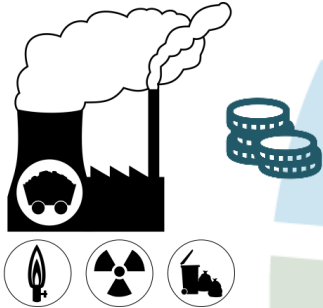


# Heat from renewable - flows



# Data challenges

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



How can we measure non-financial activities?

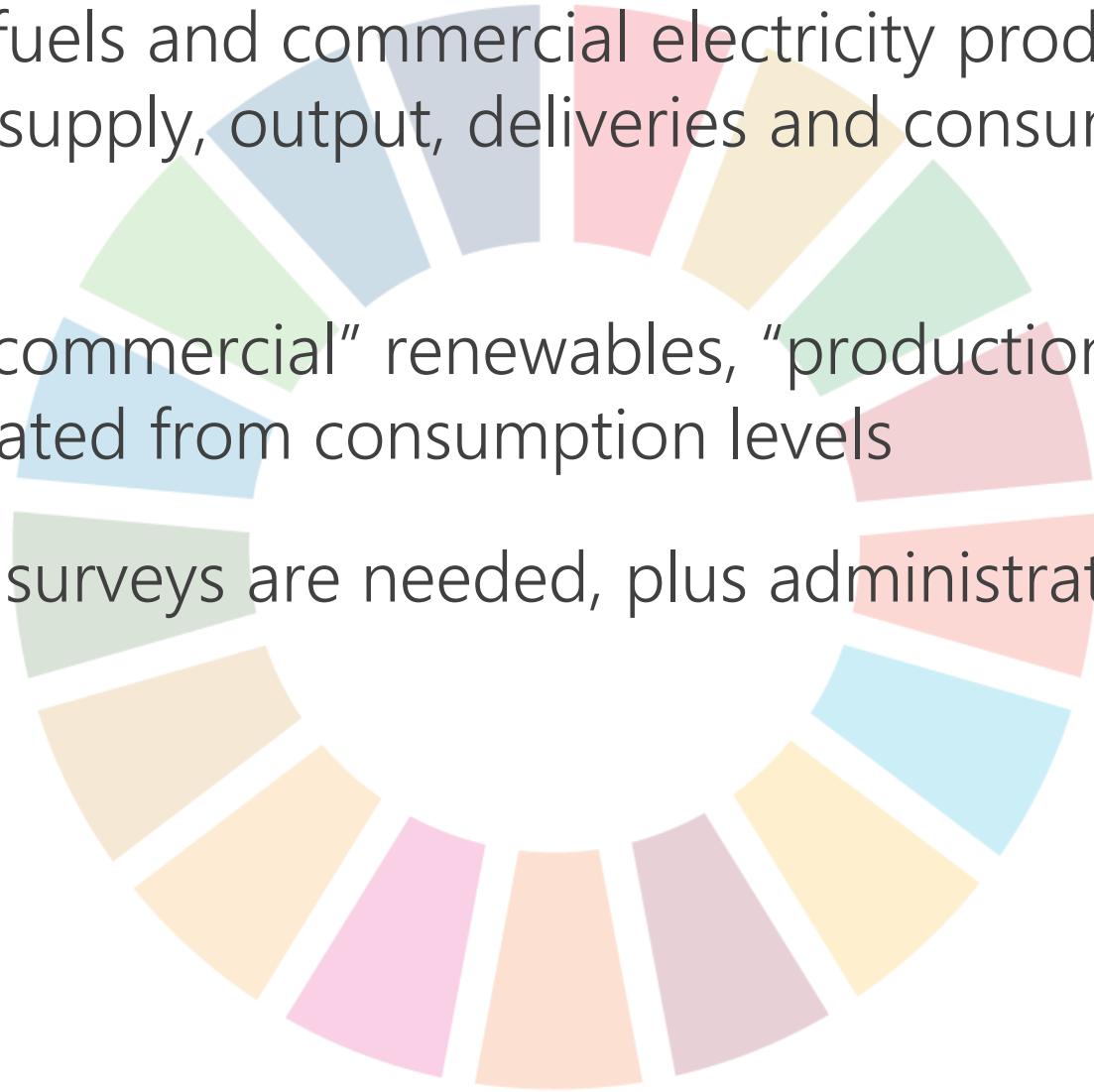




# Renewables data measurement

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- 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

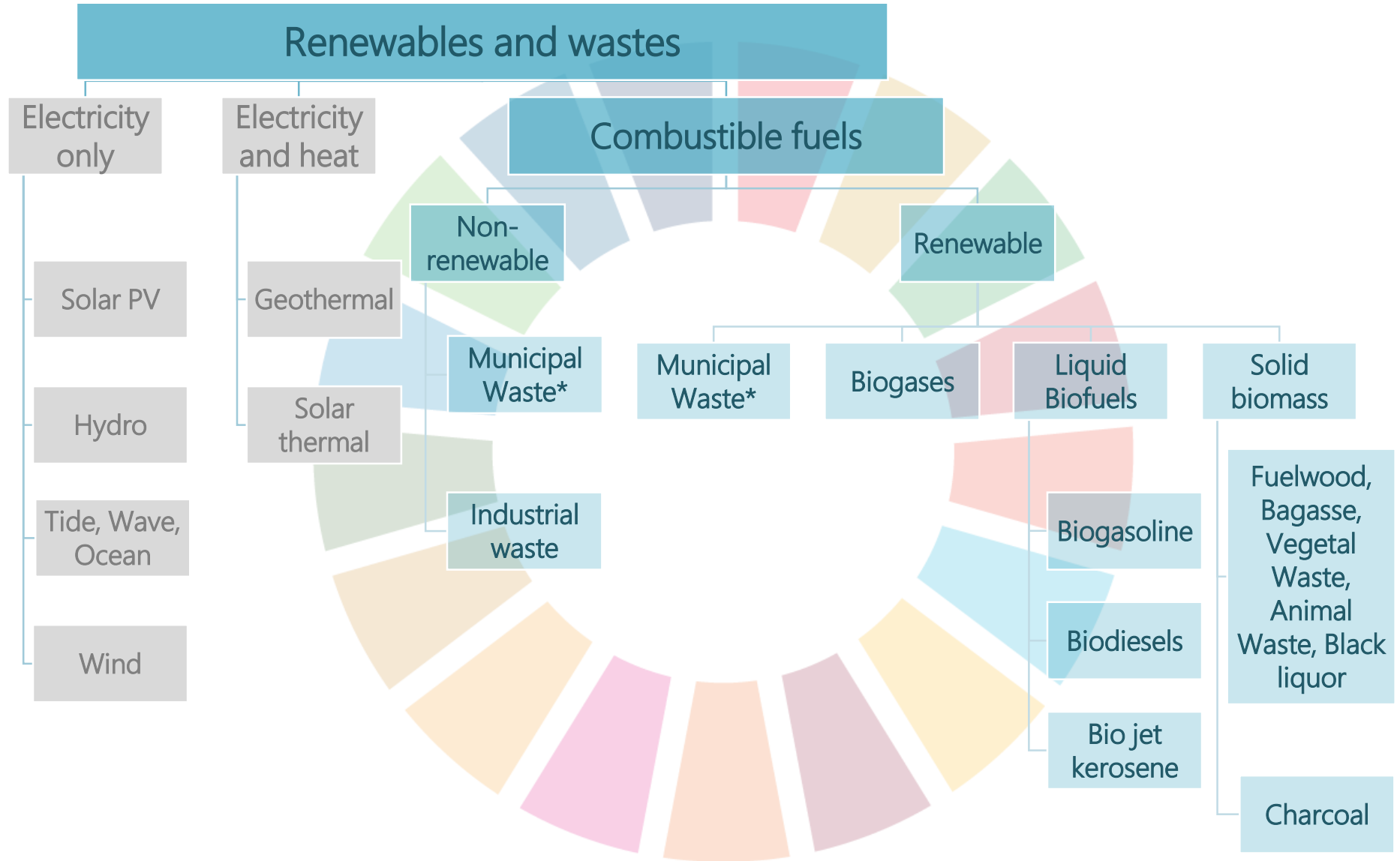




# Combustible biofuels and waste

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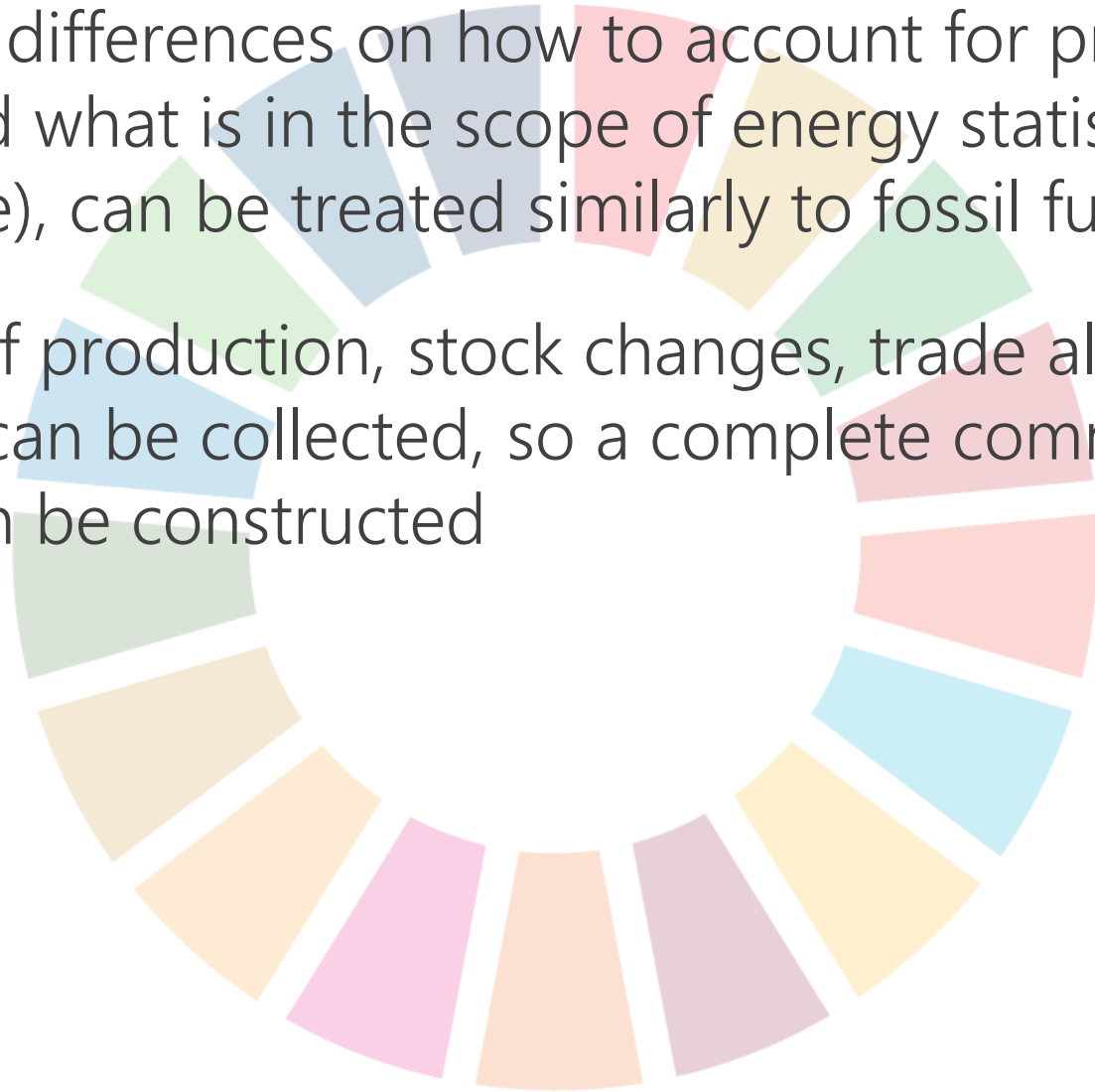
# Combustible biofuels and wastes



# Combustible biofuels and waste

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- 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

SIEC Headings			Correspondences	
Section/ Division/ Group	Class	Title	CPC Ver.2	HS 2007
5		Biofuels		
51		Solid biofuels		
511		Fuelwood, wood residues and by-products		
	5111	Wood pellets	39280*	
	5119	Other fuelwood, wood residues and by-products	03130, 31230, 39280*	
512	5120	Bagasse	39140*	
513	5130	Animal waste	34654*	
514	5140	Black liquor	39230*	

SIEC Headings			Correspondences	
Section/ Division/ Group	Class	Title	CPC Ver.2	HS 2007
515	5150	Other vegetal material and residues	01913, 21710, 34654*, 39120*, 39150*	0901.90*, 1213, 1802*, 2302*, 2304, 2305, 2306, 3101
516	5160	Charcoal	34510	4402
52		Liquid biofuels		
521	5210	Biogasoline	34131*, 34139*, 34170*	2207.20*, 2905.11*, 2905.13*, 2905.14*, 2909.19*
522	5220	Biodiesels	35490*	3824.90*
523	5230	Bio jet kerosene		
529	5290	Other liquid biofuels		
53		Biogases		
531		Biogases from anaerobic fermentation		
	5311	Landfill gas	33420*	2711.29*
	5312	Sewage sludge gas	33420*	2711.29*
	5319	Other biogases from anaerobic fermentation	33420*	2711.29*
532	5320	Biogases from thermal processes		
6		Waste		
61		Industrial waste		
610	6100	Industrial waste	3921, 39220, 39240, 39250, 39260, 39270, 39290	2525.30, 2601, 3915, 4004, 4012.20, 4115.20, 4707, 5003, 5103.20, 5103.30, 5104, 5202, 5505, 6309, 6310
62		Municipal waste		
620	6200	Municipal waste	39910	3825.10



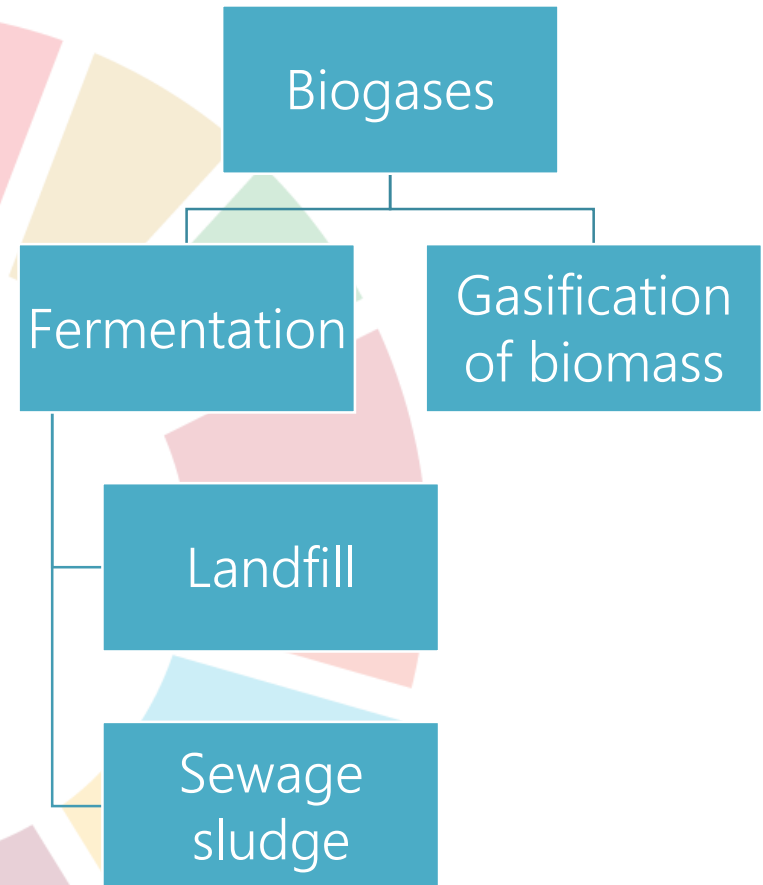
# Post-consumer waste

- **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

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- 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

Motor gasoline data include biogasoline blended

Portion of Biogasoline blended with motor gasoline

### Motor gasoline (MO)

Production	100
Receipt from other sources	50
Consumption in road	150

### Of which: Biogasoline (ZG)

Receipt from other sources	50
Consumption in road	50

## Renewables

### Biogasoline (AL)

Production	70
Consumption in road	70

All Biogasoline has to be allocated for final consumption

= 20 pure + 50 blended

# Liquid biofuels: energy balances

## Oil

Values refers to only to fossil fuel

Portion of biogasoline blended with motor gasoline is not reported under oil

### Motor gasoline (MO)

Production	100
<del>Receipt from other sources</del>	<del>50</del>
Consumption in road	<del>150</del>

### Of which: Biogasoline (ZG)

<del>Receipt from other sources</del>	<del>50</del>
Consumption in road	50

## Renewables

### Biogasoline (AL)

Production	70
Consumption in road	70

All Biogasoline has to be allocated for final consumption

= 20 pure + 50 blended

# Definitions – solid biofuels and waste

---

## Fuelwood, wood residues and by-products CUBIC METERS

- 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 METRIC TONS

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

## Bagasse METRIC TONS

- The fuel obtained from the fibre which remains after juice extraction in sugar cane processing.

# Definitions – Solid biofuels and waste

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## Animal waste TERAJOULES

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

## Black liquor TERAJOULES

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

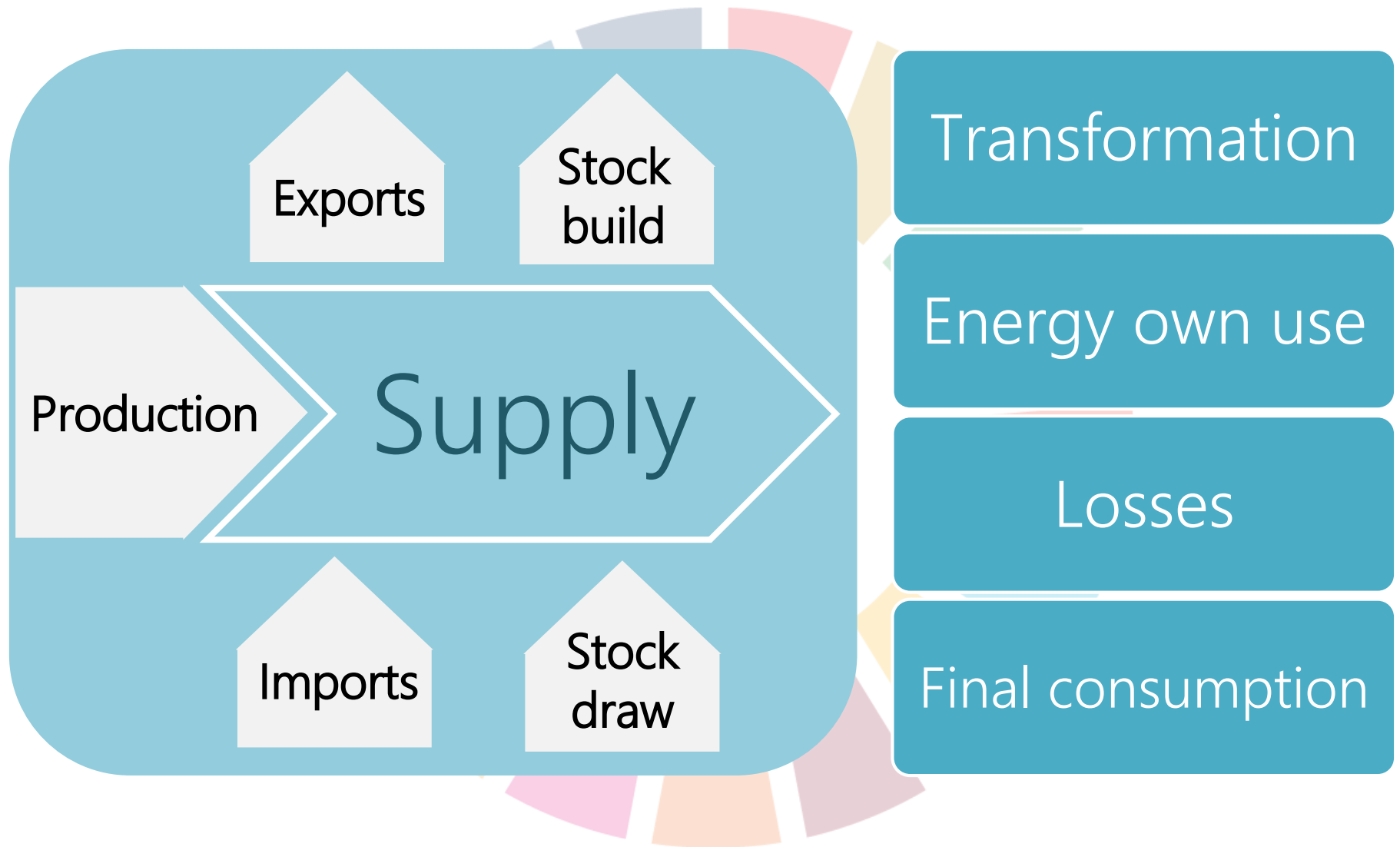
## Other vegetal material and residues TERAJOULES

- 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 TERAJOULES

- 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



# Charcoal production



**Table 6**  
**Fuelwood to charcoal conversion table**

Influence of parent wood density on charcoal production (Weight (kg) of charcoal produced per cubic metre fuelwood)							
	Coniferous wood	Average tropical hardwoods		Preferred tropical hardwoods	Mangrove (rhizophora)		
Charcoal	115	170		180	285		
Influence of wood moisture content on charcoal production (Quantity of wood required to produce 1 ton of charcoal)							
Moisture content (dry basis)	100	80	60	40	20	15	10
Volume of wood required (cubic metres)	17.6	16.2	13.8	10.5	8.1	6.6	5.8
Weight of wood required (tons)	12.6	11.6	9.9	7.5	5.8	4.7	4.1

Source: United Nations, IRES, International Recommendations for Energy Statistics, New York, 2011

# Data challenges

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



How can we measure non-financial activities?



# Average densities of selected fuelwood

(12% moisture content)

Non-coniferous fuelwood	Density (kg/m <sup>3</sup> )	Non-coniferous fuelwood	Density (kg/m <sup>3</sup> )	Coniferous fuelwood	Density (kg/m <sup>3</sup> )
All-inclusive standard	750	All-inclusive standard	750	All-inclusive standard	625
Acacia, albida	633	Mahogany	705	Cedar, white, red	352
Acacia, nigrescens	1111	Mangrove, heriteria	901	Cypress	465
Apple	705	Mangrove, rhizophora	1176	Fir, Douglas	513
Ash, black	545	Mangrove, sonneratia	775	Fir, balsam	401
Ash, white	673	Maple, sugar	689	Hemlock	465
Bamboo	725	Maple, white	529	Pine, Oregon	513
Birch, sweet yellow	705	Oak,chestnut	737	Pine, red	481
Cherry, wild red	433	Oak, live	866	Pine, white	433
Chestnut	481	Oak, red, black	673	Pine, southern	642
Elm, white	561	Oak, white	770	Pine, Norway	541
Erythrophleum africanum	1010	Poplar	433	Redwood, California	417
Eucalyptus, microcorys	847	Tamarind	855	Spruce, white, red	449
Eucalyptus, paniculata	1000	Teak, African	994		
Hickory	769	Teak, Indian	769	For unknown species	725
Irvingia malayana	1099	Walnut, black	593		
Locust	722	Willow	449		

Sources: T. Baumeister and others, Marks' Standard Handbook for Mechanical Engineers, 8th ed. (New York, McGraw-Hill, 1978); 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

## Transformation

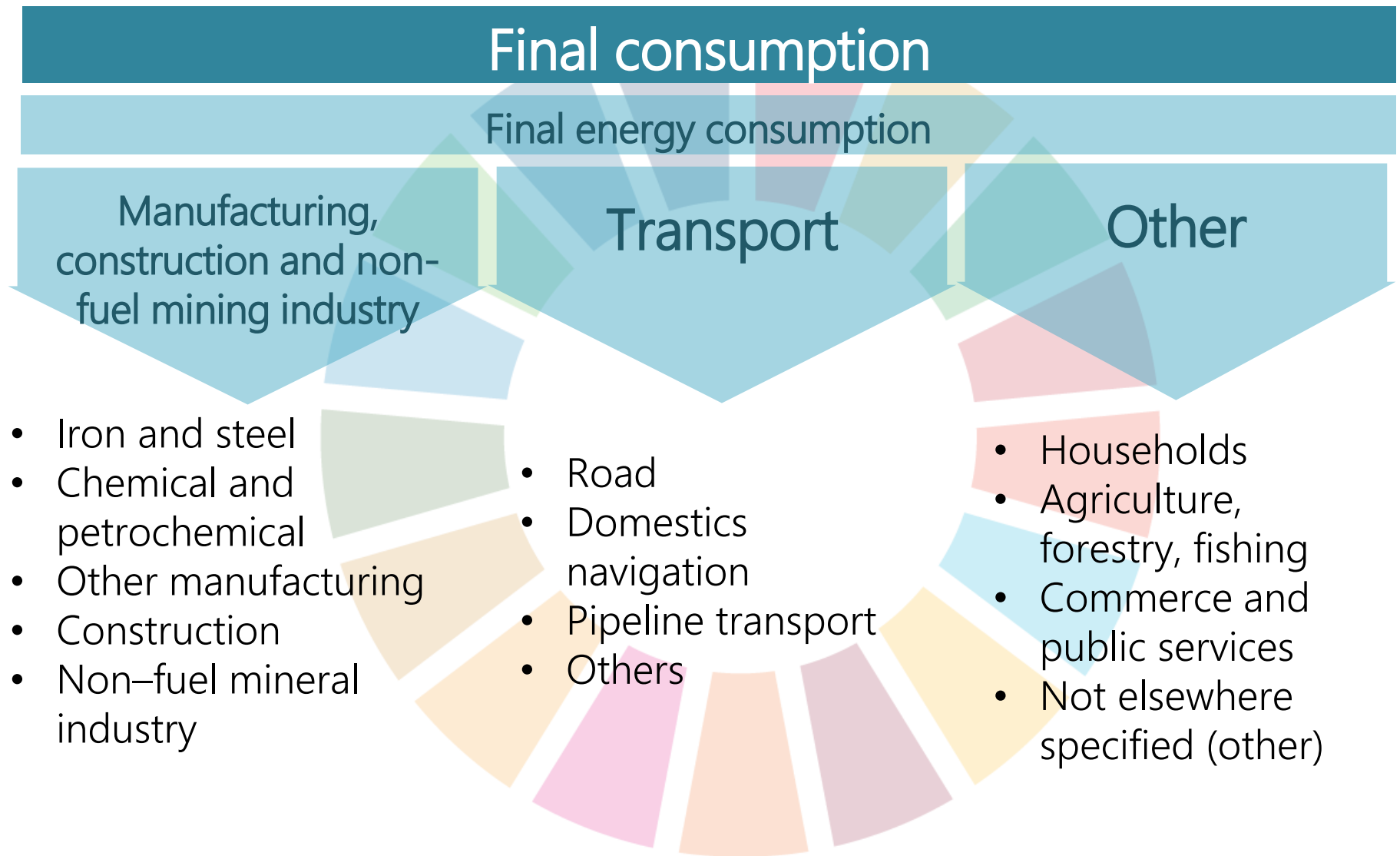
- Electricity plants
- Combined Heat and Power (CHP) plants
- Heat plants
- Gas-to-liquids (GTL) plants
- Other transformations

## Own use by energy industries

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

## Losses

# Flows – final consumption



# 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

## Fuelwood (FW); Cubic metres, thousand (CSR)

FW01	Production
FW03	Imports
FW04	Exports
FW06	Stock changes
<b>FWGA</b>	<b>Total energy supply</b>
FWSD	Statistical differences
FW08	Transformation
FW088	Transformation in electricity, CHP and heat plants
FW085CH	Charcoal plants
FW089	Other transformation
FW09	Energy industries own use
FW0923	Briquetting plants
FW0925	Oil refineries
FW0927	Electricity, CHP and heat plants
FW0933	Charcoal plants
FW0928	Other energy industry own use
<b>FWNA</b>	<b>Final consumption</b>
FW11	Non-energy uses
FW12	Final energy consumption Manufacturing, construction and non-fuel mining industry
FW121	
FW1211	Iron and steel
FW1213	Chemical and petrochemical
FW1214	Other manuf., const. and non-fuel min. ind.

# UN Energy Statistics Questionnaire

For renewable sources of electricity and heat:

## Total Electricity (EL); Kilowatt-hours, million (HWU)

EL015HY	<b>Hydro</b> – Main activity
EL015PH	Of which: Pumped hydro – Main activity
EL015G	<b>Geothermal</b> – Main activity
EL015GE	Geothermal – Main activity – Electricity plants
EL015GC	Geothermal – Main activity – CHP plants
EL015S	<b>Solar</b> – Main activity
EL015SP	Solar photovoltaic – Main activity
EL015ST	Solar thermal – Main activity
EL015T	<b>Tide, wave and marine</b> – Main activity
EL015W	<b>Wind</b> – Main activity
EL016PH	Of which: Pumped hydro – Autoproducer
EL016G	Geothermal – 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	<b>Geothermal</b> – Main activity
ST015GH	Geothermal – Main activity – Heat plants
ST015GC	Geothermal – Main activity – CHP plants
ST015ST	<b>Solar thermal</b> – 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

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# Conclusion

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- 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

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- 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





# SUSTAINABLE DEVELOPMENT GOALS

17 GOALS TO TRANSFORM OUR WORLD

<http://un.org>

<http://unstats.un.org/unsd>

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