IRENA WORKING PAPER

Statistical issues: bioenergy and distributed renewable energy

About IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international cooperation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy in the pursuit of sustainable development, energy access, energy security and low carbon economic growth and prosperity.

Acknowledgement

This paper was prepared by the International Renewable Energy Agency (IRENA) and benefited from the comments of Yasmina Abdelilah (IEA), Anselm Eisentraut (IEA) and David Vilar (ECREEE).

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Contents

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INTRODUCTION

The aim of this paper is to present an improved way of collecting generation and capacity data for renewable energy, in order to make the accounting of the renewable sources within global energy supply and consumption more accurate. Some energy services provided by renewable energy are not captured in statistics, while other published values are only estimates. Most of the difficulties in properly measuring renewable sources, for the moment, involve bioenergy, and more specifically its distributed uses for cooking and heating. Off-grid and mini-grid power generation from other renewable sources also needs prompt attention, as distributed generation gains importance with rapidly decreasing solar photovoltaic (PV) costs.

This paper explains several methodology issues related to bioenergy statistics and distributed generation, and proposes a way forward in improving their measurement with an IRENA statistical questionnaire. These improvements will help to better track countries' progress in fulfilling their renewable energy as well as energy access goals.

Problems with bioenergy and distributed renewable energy statistics have also been identified as a major data gap within the Sustainable Energy for All *Global Tracking Framework*. While this paper proposes important steps in improving renewable energy statistics, much more needs to be done to fully meet the measurement needs for renewable energy and energy access.

CONTRIBUTION OF RENEWABLE ENERGY TO TOTAL ENERGY SUPPLY AND CONSUMPTION

Renewable energy represented 18% of global final energy consumption in 2010, a percentage that has remained relatively stable over the last decade. But several facts are hidden behind this number. First, reporting for fossil energy sources has improved significantly, as they are at the heart of energy security concerns for many countries, and the price of fossil fuels is a significant burden for many economies. Second, renewable energy sources are also growing, but their extent and growth are not captured properly in energy statistics. This is due mainly to the smaller size and the more distributed nature of renewable installations compared to fossil ones, with both factors making the accounting of renewable energy more complex and more demanding.

Renewable energy generated and consumed at the residential level is often not measured, because it does not feed into the power grid, is not part of a larger heating system, or is sourced outside formal markets. As all these factors imply, measuring the contribution of renewable energy sources is more complicated, and the resulting statistics more uncertain, than those for fossil fuels. This problem, far from being purely statistical, affects the design and evaluation of energy policies.

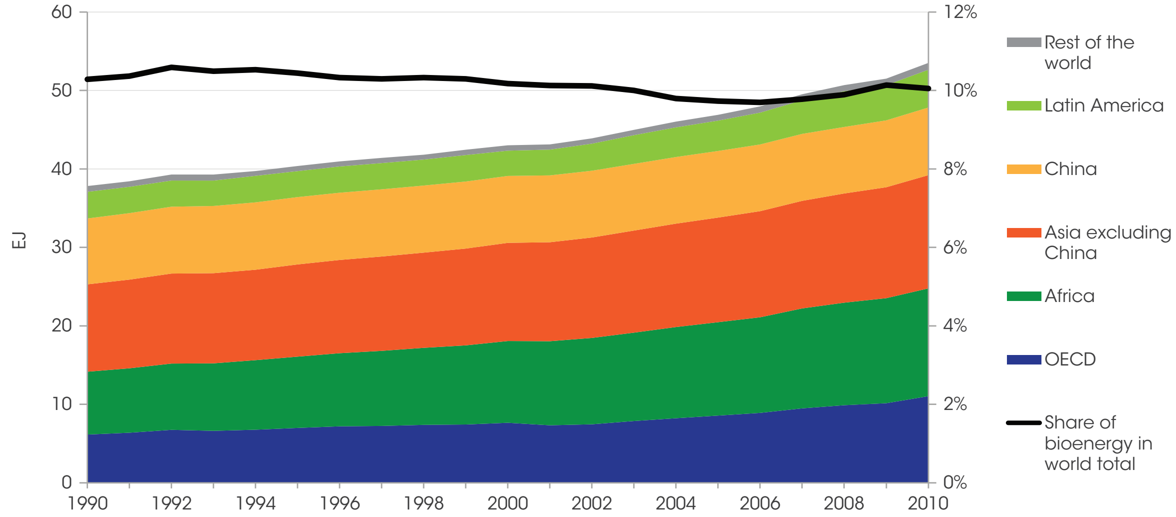
To date, a large part of global renewable energy production involves biomass, which accounted for almost 10%[1] of the world's Total Primary Energy Supply (TPES) in 2010 – a proportion that has barely changed since 1990 (see Figure 1). The uses of biomass for energy are very diverse: from the traditional, low-efficiency burning of wood in open fires for cooking purposes to the more modern use of wood pellets for the production of power and heat, and the use of biodiesel and bioethanol as a substitute for oil-based products in transport.

Other renewable energy sources, *i.e.* hydropower, wind, solar, geothermal and ocean energy, accounted for roughly 3%[2] of world TPES in 2010, mostly from power generation. This number, for most countries, excludes off-grid renewable power generation, as well as renewable energy cooking and heating based on sources other than biomass (*i.e.* solar and geothermal). These contributions are difficult to measure and are assumed to be small at the moment.

[1] *These estimates are based on the Physical Energy Content accounting method, used by the International Energy Agency and Eurostat. Further details on accounting methods can be found on page 7 of this paper.*

[2] *Ibid.*

Figure 1: World bioenergy supply (EJ) and its share in total energy supply (%)



Source: IRENA based on IEA (2012b)

BIOENERGY: BACKGROUND AND DEFINITIONS

Solid biomass (mostly wood) represents the bulk of bioenergy consumed in the world. Asian countries (excluding China) and Africa each account for about 30% of the world's total consumption of solid biomass, while China alone accounts for an additional 17%. Africa covers 48% of its energy needs with this energy source, mostly in the residential sector. Solid biomass provides an estimated 83% of residential energy use in Africa and 74% in Asia. These uses are overwhelmingly traditional and associated with health and environmental issues, and biomass is often sourced in an unsustainable way.

Bioenergy is arguably the most versatile of renewable energy sources. It is the only source that comes in solid, gaseous or liquid form and can provide power and heat as well as transport fuels. Bioenergy, unlike most other renewable energy sources, can be stored relatively easily and can, therefore, provide energy to dispatch as needed. Given the diversity of sources of bioenergy, the related terminology is important to avoid confusion.

IRENA's definition of renewable energy explicitly states the notion of sustainability: "Renewable energy includes all forms of energy produced from renewable sources in a sustainable manner, including bioenergy, geothermal energy, hydropower, ocean energy, solar energy and wind energy." However, in practice, current statistical databases count all energy production from renewable sources, whether sustainable or not, as "renewable energy".

With bioenergy in particular, traditional uses of biomass in the residential sector, along with some of the uses in the transport sector and for power generation, raise concerns about overall sustainability. These concerns range across the three pillars of sustainability: environmental, economic and social. For example, the greenhouse gas balance associated with using a particular source of feedstock or a certain transformation process needs to be carefully considered, on a case by case basis. Overall economic and social implications must also be carefully considered. Important methodological issues, meanwhile, are unresolved, such as how to account for the indirect impact of bioenergy production on land-use.

Solid biomass as a source of bioenergy is a very large category, covering fuel wood, charcoal, agricultural and forestry wastes, renewable wastes from the paper and pulp industry (*e.g.* black liquor), renewable municipal wastes and other sources. Biogases include gases from landfills, sewage sludge and other renewable

Box 1

DEFINITIONS RELATED TO BIOENERGY

Biomass is any organic, *i.e.* decomposing, matter derived from plants or animals available on a renewable basis. Biomass includes wood, agricultural crops, herbaceous and woody energy crops, municipal organic wastes and manure.

Bioenergy is energy derived from the conversion of biomass, where biomass may be used directly as fuel or processed into liquids and gases.

Traditional biomass use refers to the use of wood, charcoal, agricultural residues and animal dung for cooking and heating in the residential sector. It tends to have very low conversion efficiency (10% to 20%) and often relies on unsustainable biomass supply.

Primary bioenergy supply refers to the energy content of biomass feedstocks before conversion. Final bioenergy consumption refers to the use of biomass in different end-use sectors. In some cases in energy statistics this category is equal to the biomass input (*e.g.* buildings, industry).

Useful bioenergy refers to the net-energy generation (*i.e.* electricity, heat) excluding transformation losses.

Biofuels are liquid and gaseous fuels produced from biomass and used in the transport sector.

Source: IEA, 2012a

gases derived through anaerobic digestion and thermal processes. Liquid biofuels fall into two main categories: bioethanol and biodiesel. Mature technologies produce sugar- of starch-based bioethanol and oil crop-based biodiesel, as well as straight vegetable oil. Typical feedstocks for bioethanol include sugarcane and sugar beet, and for biodiesel oil crops like rapeseed (canola), soybean and oil palm, and in some cases animal fat and used cooking oils. Advanced biofuel technologies include hydrotreated oils based on animal fat and plant oil, biofuels based on lignocellulosic biomass, such as cellulosic-ethanol, and biomass-to-liquids and algae-based biofuels. (IEA, 2011)

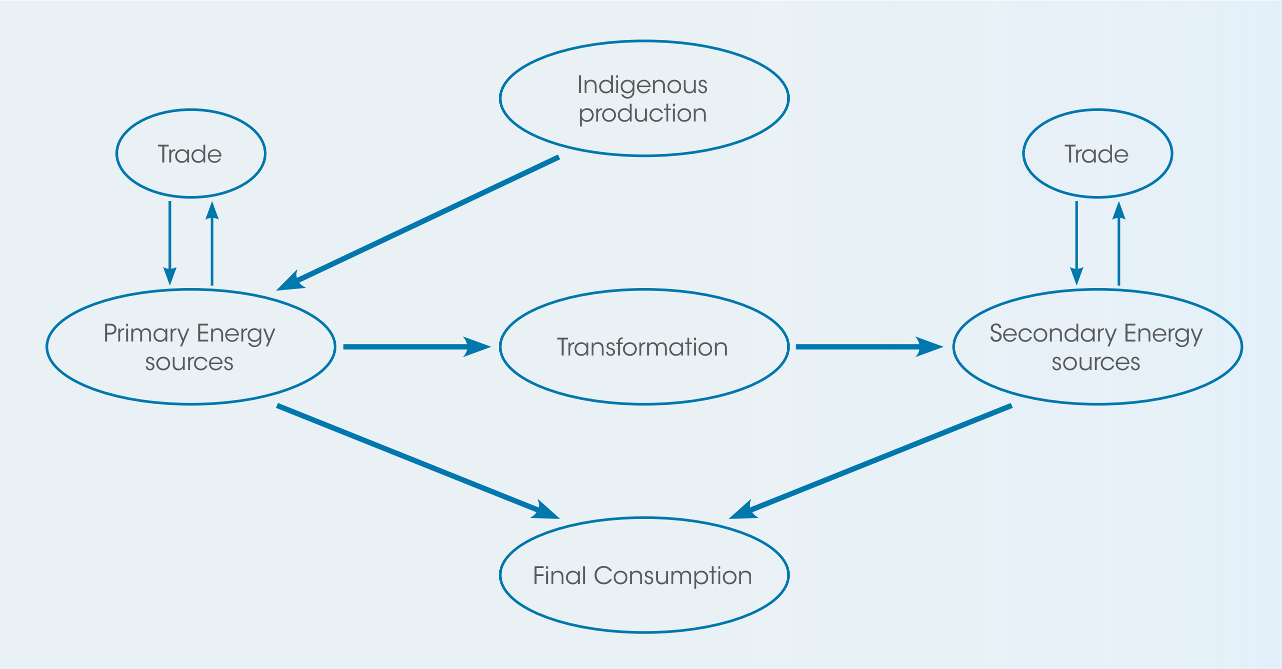
STATISTICAL METHODS OF ENERGY ACCOUNTING AND THEIR IMPLICATIONS FOR RENEWABLE ENERGY ACCOUNTING

Diverse and often non-standardised sources greatly complicate the statistical accounting of bioenergy, with many different physical units typically being used to measure bioenergy supply. Moreover, conversion into energy units is often approximate, because calorific values depend heavily on the type and moisture content of various bioenergy sources.

In statistical accounting, bioenergy is treated similarly to combustible fossil fuels. For combustibles, supply differs substantially from useful service, due to the losses that occur during combustion. For bioenergy, these losses can range from very high (up to 95%), when biomass is used in traditional three-stone fires for cooking, to very low (10%) in some modern co-generation biomass plants. When calculating the energy balance for bioenergy, a typical process would be to know the physical units of input into energy production, estimate the calorific value, and assume the efficiency of the conversion process. Sometimes even the input needs to be estimated: in some developing countries, people simply gather biomass for traditional uses or obtain it through an informal market. This leaves far greater uncertainty about the real contribution of bioenergy to energy supply, in comparison with other, standardised combustible energy products and their conversion processes. The uncertainty is significant, considering that bioenergy represents 10%[3] of world TPES.

[3] *This result differs depending on the accounting method used. For details, see Table 1.*

FIGURE 2: ENERGY BALANCE - MAIN FLOWS



Source: IRENA

The method of calculating energy balances also matters. In fact, different methods have various consequences for the levels of contribution of non-combustible energy sources, including nuclear as well as all renewables except bioenergy, *i.e.* hydro, geothermal, wind, solar and ocean power. Consequently, the percentage of all sources in the total also depends on the methods used. As the amount of non-combustible energy sources in the global energy system increases, the differences resulting from various accounting methods are sure to become more pronounced.

The contribution of different energy sources can be considered at various levels in the energy balance: production of energy, primary energy supply, and final energy consumption. At the final energy consumption level, the methods of calculation matter far less since this is the level where many energy sources appear after conversion, as final energy products, such as electricity. In 2010, the share of renewable energy in world TPES ranged from 13% to 17%, depending on the method used, while the share of renewable energy in Total Final Energy Consumption (TFEC) was 18% with the three methods of calculation.

Most of the world's biomass use takes place in the final consumption sector. What is captured in statistics is the energy content of the biomass that households consume (*i.e.* inputs into final energy consumption), not the amount of useful energy that it produces. In fact, very little is known about how much useful energy is consumed globally, whether from bioenergy or other sources. Useful energy is not practical to measure and, therefore, is not part of energy statistics.

In the case of bioenergy, the consequences of the difference between final energy consumption and useful energy are quite dramatic. Statistics show that traditional uses of biomass could account for up to 9%[4] of global TFEC. Such uses are very inefficient, with losses as high as 95% in traditional three-stone fires for cooking. A simple transition to improved cookstoves doubles or triples the efficiency, and more sophisticated means of cooking can lead to even higher energy savings. Since improved cooking has the potential to divide the amount of biomass consumed by at least two or three, while keeping the energy service identical, this transition makes a visible impact on the global energy balance. Yet the decline in final consumption of solid biomass should not necessarily be

[4] *There is an uncertainty associated with this number, as traditional uses are defined in a relatively vague way and are not explicitly measured.*

Table 1: Total world primary energy supply in 2010 (EJ)

	Physical content method		Direct equivalent method		Substitution method	
	Value (EJ)	Share in total	Value (EJ)	Share in total	Value (EJ)	Share in total
Fossils	433	81%	433	85%	433	79%
Nuclear	30	6%	10	2%	26	5%
Renewables:	69	13%	68	13%	91	17%
Hydro	12	2.32%	12	2.42%	33	5.92%
Wind	1	0.23%	1	0.24%	3	0.59%
Bioenergy	52	9.78%	52	10.21%	52	9.49%
Solar	1	0.14%	1	0.14%	1	0.17%
Geothermal	3	0.51%	1	0.11%	1	0.17%

Source: IRENA based on IEA (2012b)

interpreted as a shift away from renewable energy, as it is more likely to reflect improved efficiency in final uses of biomass. Improvements in biomass efficiency also bring social benefits in developing countries, as traditional biomass gatherers (typically women and children) can dedicate less time to wood collection.

PRIMARY AND SECONDARY RENEWABLE ENERGY SOURCES

A primary energy source is defined as one that is captured directly from natural resources. A secondary energy source is one obtained from a primary energy source through a transformation process, typically with the aim to make it suitable for a particular energy use. For example, gasoline is a secondary product better suited for motor transport uses than crude oil, the primary product from which it is made. Electricity production based on hydropower, solar PV, wind and ocean energy is considered to be primary energy. For geothermal and solar thermal, however, heat is the primary energy, which can be transformed into secondary geothermal or solar electricity.

Bioenergy is a large category, and not all bioenergy sources are primary energy products. This causes complications in bioenergy accounting, especially because biomass, unlike coal or other fossil fuels, is not typically used for energy purposes. Only a small fraction of global biomass resources ends up as bioenergy. Not surprisingly, therefore, the general definition does not apply very well to biomass. In fact, primary bioenergy sources should be defined as those sources that are first in the downstream chain destined for energy purposes. Fuelwood, for example, is a primary bioenergy source that serves for the production of charcoal, which is a secondary energy product. Wood wastes that are combusted for energy purposes are well downstream in the wood production chain, but in energy terms they are also considered a primary energy product.

However, the case of liquid biofuels is more complicated. Some liquid biofuels are produced from sources that are not primarily cultivated for energy purposes (*e.g.* soybean, sugar cane), while advanced biofuel methods allow for the production of lignocellulosic biofuels, produced from biomass that could also have served energy purposes without such processing. Therefore, some liquid biofuels are primary energy sources, while others can be secondary energy sources. In practical terms, the transformation of solid biomass to liquid biofuels should be possible to account for, except that not all liquid biofuels need to be produced from solid biomass and in addition to liquid biofuels other products can be produced from the primary biomass at the same time. Consequently, assessing the efficiency of this transformation, along with ensuring data consistency, is difficult in practice.

RENEWABLE ENERGY TRADE ACCOUNTING

Except for bioenergy, all other renewable energy sources directly produce electricity and heat. Heat is not usually traded across borders. Electricity trade is common, but once energy sources are transformed into electricity their renewable or non-renewable origin becomes impossible to track.

As for bioenergy trade, international trade of wood pellets and liquid biofuels has been growing steadily in recent years. Some countries, like the United States and Brazil for biofuels and Canada for wood pellets, have become important exporters of these bioenergy commodities. Other bioenergy products, such as fuelwood, wood chips, and some forestry wastes and other organic wastes, are also traded, but their trade is much more difficult to track. The problem arises from the impossibility of determining the final use of these products at the border, as they may be declared for energy use only after entering their final destination country. While this skews bioenergy trade statistics, the volumes are assumed to be insignificant. However, even accounting for visible parts of the bioenergy trade is a challenge. For example, liquid biofuel blends are sometimes omitted from the reporting for biofuel trade, or their biofuel share is not reported accurately.

DECENTRALISED AND OFF-GRID SYSTEMS

Bioenergy uses, like other renewable energy installations, are often of a decentralised nature, providing services directly to households or small businesses. These energy uses are typically not measured, because their output is not subject to a financial transaction, so measurement would have no purpose except for keeping statistics.

Biomass-based heating systems with high efficiency are common in some emerging or developed markets. In addition, solar water heating systems and ground-source heat pumps are widespread, while decentralised power is typically provided by wind and solar PV, usually connected to the distribution grid. In developing countries, the most common decentralised and off-grid renewable systems include stand-alone solar PV equipment (lanterns, solar home systems, communication towers, etc.), biomass cookstoves (traditional or improved), family and community-size biogas digesters, and hybrid systems and minigrids (combining a renewable energy technology, such as solar PV, wind, small hydro or bioenergy, with a diesel generator or batteries). In the least developed communities, open fireplaces are still common for cooking. Fuels for these uses, including collected wood and various types of agricultural and other wastes, are typically not purchased.

Just as bioenergy consumption for decentralised uses is typically not measured, decentralised power and heat often do not appear on any meter. In order to capture these uses, statisticians use several methods. The most common are household surveys, which are repeated periodically, though often not every year. Yearly data, however, can be extrapolated from the collected data sample and past trends. In countries with smart metering or residential feed-in-tariffs, decentralised power connected to the grid is measured because of associated payments. For heating and cooking equipment, estimates can be based on sales of the equipment and average expected service and equipment lifetime. However, discrepancies between the actual working lifetime of the equipment, as opposed to the assumed lifetime, cause significant imprecisions. Cultural realities also alter the picture. For example, households equipped with an improved cookstove may still choose to cook some traditional dishes on an open fire.

For biomass-based heating and cooking equipment, estimates of the sales of devices are not sufficient. Statistics need to account also for the biomass used in these devices. The amount of biomass consumed heavily depends on the method of use: open fires are the least efficient, followed by traditional cookstoves and improved

[4] *There is an uncertainty associated with this number, as traditional uses are defined in a relatively vague way and are not explicitly measured.*

cookstoves, each consuming a different quantity of wood for the same service. Sophisticated biomass-based heating systems in developed countries are much more efficient and consume much less energy, typically provided by wood pellets. Therefore, in order to arrive at a realistic estimate of the amount of bioenergy consumed in the residential sector, the shares and comparative efficiency of different uses need to be known.

A common deficiency of estimation methods is to use population growth as a proxy for the growth of consumption in traditional uses of biomass. Such estimates fail to account for urbanisation trends and for the improvement in efficiency that occurs with the transition from open fires to traditional and advanced biomass cookstoves, which can save up to two thirds of biomass consumption. Moreover, the typical next steps in achieving access to modern energy include passing to liquefied petroleum gas (LPG) and other non-renewable fuels, further complicating the statistical picture. Frequent surveys of fuel use, therefore, are essential to attain accurate bioenergy consumption statistics. To facilitate the survey process, synergies can often be found between household energy uses and their health impacts. Cooperation with health agencies, including the World Health Organization (WHO), can therefore be valuable, even if their specific goals differ from those of energy statisticians

Residential-scale biogas, especially in developing countries, is particularly challenging to account for, even though it can provide precious fuel for cooking and heating services for poor households. Biogas digesters at household or community level are locally sourced, typically from agricultural wastes, with the resulting energy service rarely being measured. Estimating the capacity of biodigesters is the first step towards proper accounting of this growing renewable energy segment. Household surveys can further indicate the diversity of uses of the produced biogas. Biogas is also rapidly growing in smaller applications in Europe, especially on farms, primarily for power generation with heat as a by-product that is only used when circumstances permit.

RENEWABLE ENERGY USES NOT CAPTURED IN CURRENT ENERGY BALANCES

Renewable energy use is not an invention of the 20th or 21st century. In fact, wind and water have been used to produce mechanical energy through mills, while the sun was used to dry food, for centuries. These traditional energy forms were later displaced by more modern forms based on fossil fuel combustion. While mechanical power and ambient heat cannot be accounted for in an energy balance, it is useful to remember that these old renewable energy uses save energy that would otherwise need to be obtained, mostly in the form of fossil fuels. In these cases, the renewable sources basically account as energy efficiency in energy balances rather than appearing as renewable energy production.

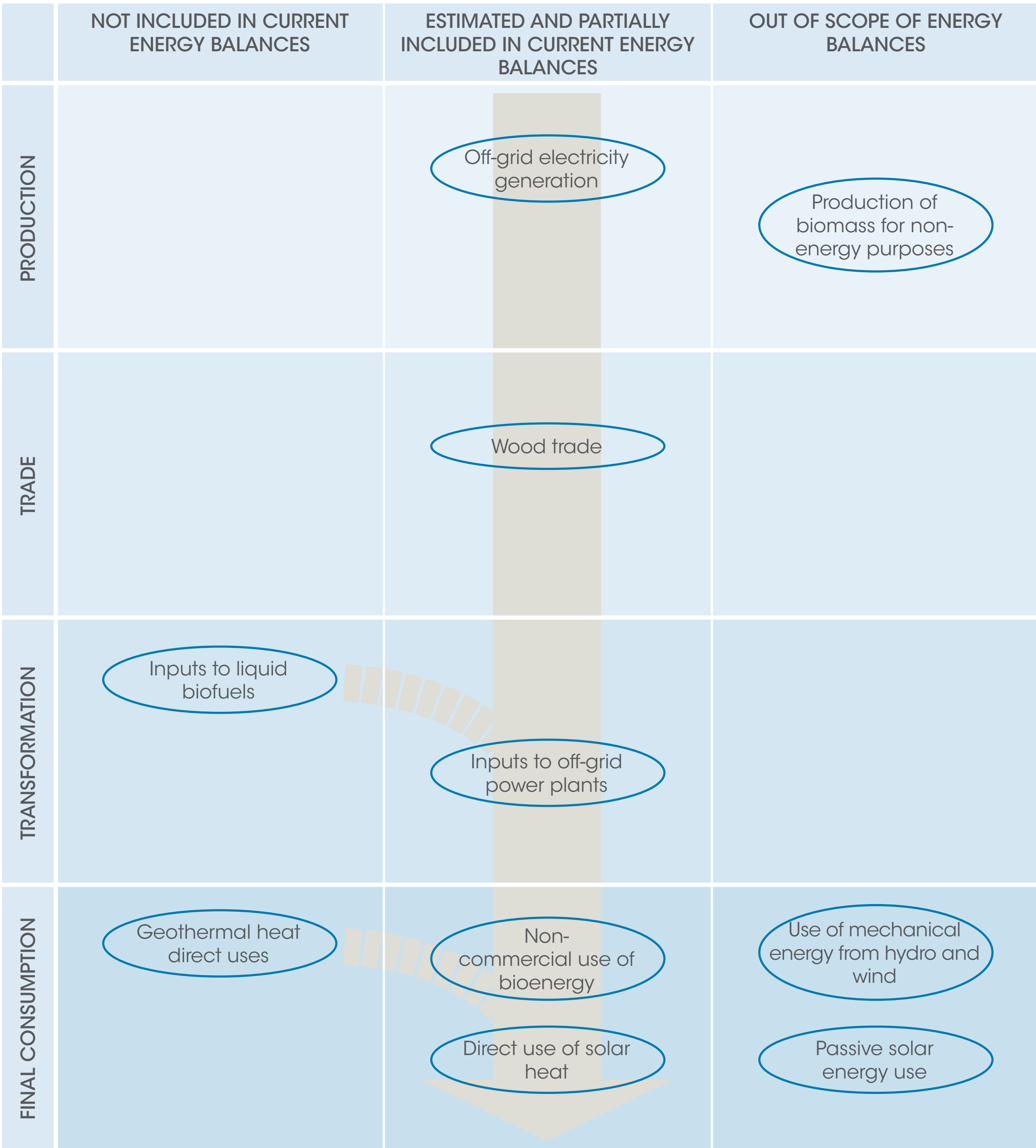
Several other distinct, modern applications of renewable energy are gaining importance and yet, due to their stand-alone nature, do not necessarily appear in energy statistics. These are desalination, heat pumps, water pumps and communication towers powered by renewable sources.

Desalination is highly energy intensive and very often vital in hot, dry countries, including those without abundant fossil resources. Renewable energy-based desalination is therefore gaining more and more importance. Some desalination methods draw on renewable energy directly, while others use electricity and heat produced from renewable sources. Yet desalination plants producing renewable energy for their own consumption are often omitted from renewable energy statistics. In cases where renewable electricity and heat are produced first, and then used in the desalination process, these should be part of the energy balance.

Heat pumps are very efficient devices, providing heating and cooling by recuperating heat from the air, ground or water. For each unit of energy consumed, they are able to deliver many units of heat. Heat pumps cannot automatically be counted as a renewable energy application, since they can be powered by fossil-based electricity and may extract heat from such sources as waste water, which is not a renewable energy source. Most heat pumps can be counted as renewable, although, again, residential heat pumps do not appear in the energy balance, since their input is power and their output is not measured. They behave in the energy balance like any other residential electric appliance. Due to their low consumption relative to the service provided, they serve as an energy efficiency device. Large-scale heat pumps that produce commercial heat are typically accounted for as heat plants, with electricity input.

The pumping of water for drinking or irrigation purposes is an important energy-consuming

FIGURE 3: STATUS OF IDENTIFIED RENEWABLE ENERGY USES IN CURRENT ENERGY BALANCES



Source: IRENA

activity that is necessary in many areas of the world. Renewable energy-based water pumps are often powered by wind but can also use solar energy. Wind-powered pumps are typically mechanical, but can also be electric, while solar PV-powered pumps generate electricity to drive the water pump. These pumping methods, though widespread, are typically not accounted for statistically. Wind and solar PV pumps that produce electricity to run a water pump should be included in energy statistics.

Similarly, communication devices, such as communication towers, are stand-alone appliances that need power for their operation but are not connected to any grid, so their production of power is not measured. Solar PV-powered communication towers, complemented with batteries or diesel back-up, are common in many developing countries, and efforts should be made to estimate how much power these devices produce and consume.

Other common applications of stand-alone solar PV, including public lights, traffic sings and a wide range of solar chargers, are likewise not typically recorded in statistics. In the heat sector, the use of waste heat (*e.g.* from a geothermal power plant) for the drying of food does not enter the energy balance; nor does direct solar heat (*e.g.* for salt production).

NON-ENERGY USES OF RENEWABLE SOURCES

Not all uses of fuels involve combustion or transformation into another energy commodity. Fossil fuels, *i.e.* coal, natural gas, oil and their derived products, are also used for non-energy purposes: as a raw material for the petrochemical and refining industries (such as natural gas used for the production of ammonia), because of their physical properties (bitumen as a waterproofing material for roads), or as solvents (white spirit).

In 2010, non-energy uses represented 6% of world TPES; coal accounted for 5% of the total non-energy use, natural gas 19% and oil 76%. Since electricity and heat only go to energy uses, none of the renewable energy sources that appear in the energy balance directly as heat or electricity (*i.e.* hydro, wind, solar, geothermal, ocean energy) has any non-energy use. The remaining renewable energy source, bioenergy, has proven, and partially measured, non-energy uses, such as wood being split between roundwood and firewood in Food and Agriculture Organization (FAO) statistics.

Even so, current methodologies do not allow reporting of the non-energy uses of biomass. Reasons for this include the question of boundaries with biomass for non-energy uses, and differences between the energy and agriculture systems. However, the order of magnitude of the non-energy use of biomass is estimated to be greater than the current non-energy use of fossil fuels. The convention of accounting for non-energy use only with fossils, and not with biomass, introduces a distortion for all measures comparing the respective TPES or TFC of fossils and renewables. Current energy accounting methods will also prove deficient for new renewable energy uses likely to emerge in the future, such as bioenergy feedstock in the petrochemical industry.

PROPOSED IMPROVEMENTS IN RENEWABLE ENERGY DATA

In order to improve bioenergy measurements and reporting, several steps need to be taken. At the country level, surveys of bioenergy use need to be performed regularly, and their results critically assessed by both bioenergy experts and energy statisticians. Joint agreed methodologies for the estimation of bioenergy use must be put forward by international organisations active in energy statistics and must be suitable to capture a wide array of sources and applications, which would vary considerably from one region to another.

For the reporting process to succeed, the data questionnaires would need to offer the possibility to report bioenergy using the measurements and terminology already familiar in the sub-sector. The scope of errors and omissions at country level can be reduced if the questionnaires include several different categories of bioenergy sources and allow reporting in physical units. However, countries should also be able to report calorific values for various bioenergy sources and uses, which would need to be checked against standard values before being used to calculate the energy balance.

For the IRENA annual statistical questionnaire, the following bioenergy categories will be used:

- Renewable municipal waste
- Wood and straw pellets/briquettes
- Fuel wood
- Wood waste
- Bagasse
- Rice husks
- Straw
- Other vegetal and agricultural waste
- Other primary solid biomass
- Charcoal
- Black liquor
- Landfill gas
- Sewage sludge gas
- Other biogases from anaerobic fermentation
- Biogases from thermal processes
- Conventional bioethanol
- Advanced bioethanol
- Conventional biodiesel
- Vegetable oil
- Advanced biodiesel

While this list is long, only a few countries possess such diverse bioenergy sources, so the reporting burden should not be overwhelming. The categories are intentionally exhaustive, in order to accommodate the diversity existing in bioenergy and increase the precision of reporting.

To stimulate a process of improvement in the accounting of stand-alone and other decentralised renewable energy applications, efforts should be made to account for standard and potentially larger applications, such as desalination, heat pumps and water pumps. While the methods may not currently exist to incorporate some of these applications into the energy balance, knowing the extent of such omissions ought to help with setting priorities and developing the appropriate methods. The IRENA annual statistical questionnaire will also use the following categories for renewable energy technologies and applications:

- Capacity of solar water heaters
- Capacity of biogas digesters
- Desalination
    - Solar thermal
    - Solar PV
    - Wind
    - Geothermal
- Heat pumps
    - Ground-source
    - Air-source
    - Water-source (natural water)
- Water pumps
    - Solar PV
    - Wind
- Communication towers
    - Solar PV with batteries
    - Hybrid solar PV/diesel
    - Other (specify)
- Solar PV streetlights and traffic signs

NEXT STEPS IN RENEWABLE ENERGY REPORTING

The proposed structure of data to track over time would be a substantial improvement compared to existing datasets with global coverage. Still, this structure should not be considered final. While it resolves some issues related to bioenergy and distributed generation accounting, more efforts will be needed to fully account for sustainable renewable energy sources, in particular with further methodology work on renewable wastes, as well as better measurement of improvements in access to modern energy services.

The Sustainable Energy for All *Global Tracking Framework* discusses five tiers of energy access, for access to both power and clean cooking. To track energy uses so closely, to the extent that assignment to a particular tier is possible, will require the international organisations in the energy statistics arena to conduct further methodological work, as well as statistical capacity building in developing countries. For the moment, the medium-term goal is to achieve the tracking of two broad access

Figure 4: Candidate framework for multi-tier measurement of household electricity access

ACCESS TO ELECTRICITY SUPPLY

Attributes	Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Peak available capacity (W)	-	>1	>500	>2,000	>2,000	>2,000
Duration (hours)	-	≥4	≥4	≥8	≥16	≥22
Evening supply (hours)	-	≥2	≥2	≥2	≥4	≥4
Affordability	-		√	√	√	√
Legality	-			√	√	√
Quality (voltage)	-			√	√	√

- Five-tier framework.
- Based on six attributes of electricity supply.
- As electricity supply improves, an increasing number of electricity services become possible.

Index of access to electricity supply = $\Sigma(P_T \times T)$

with PT = Proportion of households at tier T

T = tier number {0, 1, 2, 3, 4, 5}

USE OF ELECTRICITY SERVICES

Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
-	Task lighting AND phone charging (OR radio)	General lighting AND television AND fan (if needed)	Tier 2 AND any low-power appliances	Tier 3 AND any medium-power appliances	Tier 4 AND any high-power appliances

- Five-tier framework.
- Based on appliances

Index of access to electricity supply = $\Sigma(P_T \times T)$

with P_T = Proportion of households at tier T

T = tier number {0, 1, 2, 3, 4, 5}

Source: Sustainable Energy For All, 2013

categories, basic (including Tier 1 for electricity and Tiers 1-3 for clean cooking); and advanced (Tiers 2-5 for electricity and Tiers 4-5 for clean cooking), without details about specific tiers.

The issue of sustainability will need to be addressed, too. Not all renewable energy sources are sustainably sourced, in the case of bioenergy, or managed, in the case of hydropower or geothermal energy. Unsustainable uses, in principle, should not be counted as renewable. Efforts are advancing to precisely define the sustainability criteria for all types of renewable energy. The Global Bioenergy Partnership (GBEP) has developed 24 sustainability indicators, addressing all 3 pillars of sustainability (environmental, social and economic), and the International Hydropower Association (IHA) has developed the Hydropower Sustainability Assessment Protocol.

In practice, tracking the sustainability of every single installation, or indeed every bioenergy input, does not seem feasible. However, widely accepted harmonised international sustainability criteria, applicable in a practical manner, which are not yet developed, would undoubtedly help to improve measurement of and therefore our knowledge about sustainable renewable energy uses.

Figure 5: Candidate framework for multi-tier measurement of household cooking solutions

STEP 1: TECHNICAL PERFORMANCE

- Multi-tier technical measurement of the primary cooking solution in two steps:
    1. Three-level measurement based on the direct observation of the cookstove and fuel.
    2. Manufactured non-BLEN cookstoves (medium grade) are further categorised into four grades based on technical attributes. This grade categorisation would only be possible for cookstoves that have undergone third-party testing. Non-BLEN manufactured cookstoves that have not been tested are assumed to be Grade D.

LOW GRADE	MEDIUM GRADE	HIGH GRADE
Self-made[1] cookstove	Manufactured[2] non-BLEN cookstoves	BLEN[3] cookstove

	LOW GRADE	MEDIUM GRADE			HIGH GRADE
Attributes	Grade-E	Grade-D	Grade-C	Grade-B	Grade-A
Efficiency Indoor pollution Overall pollution Safety	Self-made cookstoves or equivalent	Uncertified Non-BLEN manufactured cookstoves	Certified Non-BLEN manufactured cookstoves		BLEN cookstoves or equivalent

1 A self-made cookstove refers to a three-stone fire or equivalent, typically made by an untrained person without the use of premanufactured parts.

2 A manufactured cookstove refers to any cookstove available in the market (including cookstoves from artisans and small local producers trained under a cookstove programme).

3 BLEN cookstove refers to stove-independent fuels (such as biogas, LPG, electricity, natural gas). BLEN equivalence of more fuels (such as ethanol) would be examined going forward. Non-BLEN cookstoves include most solid and liquid fuels for which performance is stove dependent.

STEP 2: ACTUAL USE

- Measurement of additional aspects of access beyond technical performance.
- Three types of attributes, as listed below:

- Multi-tier measurement is based on technical performance adjusted for the three attributes.

Conformity	• Chimney/hood/pot skirt used (as required). • Stove regularly cleaned and maintained (as required).
Convenience	• Household spends less than 12 hours per week on fuel collection/preparation. • Household spends less than 15 minutes per meal for stove preparation. • Ease of cooking is satisfactory.
Adequacy	• Primary stove fulfills most cooking needs of the household, and it is not constrained by availability or affordability of fuel, cultural fit, or number of burners. • If multiple cooking solutions are used (stacking), other stoves are not of a lower technical grade.

Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
				Grade-A w/o CCA	Grade-A w/ CCA
			Grade-B w/o CCA	Grade-B w/ CCA	
		Grade-C w/o CCA	Grade-C w/ CCA		
	Grade-D w/o CCA	Grade-D w/ CCA			
Grade-E w/o CCA	Grade-E w/ CCA				

Index of access to clean cooking = $\Sigma(P_T \times T)$

with P_T = Proportion of households at tier T; T = tier number {0, 1, 2, 3, 4, 5}

Source: Sustainable Energy For All, 2013

** The proposed multi-tier framework (above) is complementary to the multi-tiered technical standards for cookstove performance proposed by the International Workshop Agreement (IWA) led by the Global Alliance for Clean Cookstoves. The IWA multi-tier standards provide the basis for measurement of cookstove performance on the four technical attributes—efficiency, indoor pollution, overall pollution, and safety. Laboratory measurements based on the IWA standards would be used by the multi-tier framework (above) to determine the overall technical performance of the primary cookstove in step-1. The objective of the multi-tier framework (above) is to measure the level of household access to cooking solutions. It builds upon the technical performance of each of the multiple cooking solutions being used in the household (including the use of non-solid fuels), while also taking into account CCA attributes.*

Note: BLEN = Biogas-LPG-Electricity-Natural gas; CCA = Conformity, Convenience and Adequacy

References

IEA (International Energy Agency) (2011), "Technology Roadmap – Biofuels for Transport"

IEA (2012a), "Technology Roadmap – Bioenergy for Heat and Power"

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Sustainable Energy For All (2013), "Global Tracking Framework"

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