IRENA
International Renewable Energy Agency

Doubling the Share of Renewables:

A Roadmap to 2030

in the context of the UN Secretary General's
"Sustainable Energy for All" (SE4ALL) Initiative

2nd Workshop (Abu Dhabi, 14 November 2012)

Context

The International Renewable Energy Agency (IRENA) is developing a global Renewable Energy Roadmap (REMAP 2030) to double the share of renewable energy in the global energy mix by 2030. The work is carried out in the context of the United Nations Secretary-General's "*Sustainable Energy for All"* (SE4ALL) initiative, which was launched in November 2011.. The IRENA Director General Adnan Z. Amin was Member of the SE4ALL High Level Group between November 2011 and September 2012, which was established to guide the initiative.

The IRENA work in the context of the SE4ALL initiative is carried out in support of IRENA Member Countries, based on IRENA's 2012 Work Programme. REMAP 2030 is part of this work, and is expected to continue in 2013. First results are to be presented at IRENA's third Assembly in January 2013.

The SE4ALL initiative[1] aims to achieve three objectives by 2030:

1) Universal access to modern energy services;
2) Doubling the rate of improvement of energy efficiency (EE); and
3) Doubling the share of renewable energy (RE) in the global energy mix.

The initiative involves a number of public and private organisations at both national and international level, including most active international institutions in the energy field such as the International Energy Agency (IEA), the International Institute for Applied Systems Analysis (IIASA), the Renewable Energy Policy Network for the 21st Century (REN21), the UN Environmental Program (UNEP), the World Bank.

At the third IRENA Council (Abu Dhabi, June 2012), Council Members endorsed the use of the 3rd SE4ALL objective as an aspirational target for IRENA's roadmap activities. The aim of REMAP 2030 is to *identify and operationalize viable pathways to achieve the 3rd SE4ALL objective* (i.e. doubling the RE share), taking into account the interactions with the other two SE4ALL objectives.

To start the Roadmap process, it is therefore of key importance to

a) Select appropriate ***indicators*** to measure the RE share and progress toward the SE4ALL target;
b) Establish the ***baseline*** (where we are today) and the reference database to build the Roadmap;
c) Assess the ***level of challenge*** associated with the 3rd SE4ALL objective (how much ambitious it is, e.g. how much it exceeds current energy projections to 2030); and
d) Build a close ***cooperation framework with Member Countries*** to capture the national/regional dimension of the SE4ALL objective, and make the roadmap effort a useful contribution to Countries' policy rather than an Agency's exercise.

IRENA has been working on these items since June 2012 and first results have been tabled and discussed with Member Countries at the 1st workshop held in Malta on 5 September 2012.

At present, a joint *Global Tracking Report* for the renewables objective of the SE4ALL initiative is being prepared by the IEA, IRENA, REN21, UNEP and the World Bank, to address more specifically the items a) and b), which will have a significant impact on the Roadmap. Further valuable

[1] SE4ALL background documents include "*A Framework for Action*" and "*A Global Action Agenda*" by the SE4ALL High Level Group

contributions that may have an impact on the Roadmap process include the recent release of the Global Energy Assessment by IIASA and the upcoming IEA World Energy Outlook 2012 (12 November 2012).

This report is intended to provide a basis for discussion of the items a) to d) mentioned above and prepare for the 2nd workshop on the IRENA Roadmap (Abu Dhabi, 14 November 2012) aimed to update Member Countries on recent developments, discuss criticalities and ask for Member Countries guidance and involvement in the Roadmap process.

1. Indicators and Targets

The RE share in the global energy mix can be measured with respect to the total primary energy demand (TPED) or to the total final energy consumption (TFEC):

- TPED refers to primary energy, i.e. the form of energy that first appears in the energy balance, before conversion processes and related losses (e.g. crude oil, coal, natural gas, biomass);
- TFEC[2] refers to secondary energy, i.e. the form of energy after the conversion processes and related losses, and the form in which energy is made available for final consumption (e.g. electricity, heat, biofuels, gasoline and diesel, but also coal, natural gas and biomass if they are used for heating or other direct uses).

Since most renewable energy sources (e.g. solar, wind and hydro electricity, solar heat, biofuels) appear directly as secondary energy, it is clear that, in principle, measuring the RE share in the TPED tends to underestimate the role of renewables in the energy mix. Furthermore, the RE share in the TPED is highly dependent on the accounting method used to convert renewable commodities into primary energy equivalents[3]. Assuming an accounting method with a high efficiency for renewables will reduce the RE share in TPED, while an accounting method with a low efficiency will increase the RE share in TPED.

As a consequence, the RE share in TFEC seems to be the most suited indicator to represent the actual role that renewables play in providing final energy services, as compared with fossil energy

[2] Note that TFEC differs from total final consumption (TFC) because it does not include non-energy uses of fossil and biomass resources such as the feedstock to chemical industry for plastics and bioplastics production. Therefore, if the RE share in TFEC is used as an indicator, the role of biomass for non-energy is not taken into account. Whether this can penalise in absolute terms the RE share depends on the relative role that fossil and biomass feedstock will play in chemical industry. It should also noted that neither TFC nor TEFC represents so-called *useful energy*, that is the energy actually used for final energy services, e.g. the net energy used to move a car or for space heating, after the energy losses associated with the end-use device (car or boiler). Useful energy is indeed difficult to measure and it is not considered in energy statistics.

[3] Actually, different organisations use different methods to estimate the RE share in the TPED:

- in the *Physical Energy Content* method used by IEA and EUROSTAT, renewable electricity (e.g. wind, PV and hydro power) and biofuels are counted in TPED as they appear in form of secondary energy (that means using a 100% efficiency to convert them into primary energy equivalents) while geothermal, CSP electricity and nuclear electricity are counted using average process efficiencies (e.g. 10% to 33%) to convert them into primary energy equivalents;
- in the *Direct Equivalent* method used by the IPCC, all non-combustible energy sources (renewables, nuclear) are converted into primary energy equivalent as they appear in the TFEC (that means using a 100% efficiency to convert them into primary energy equivalents.)
- in the *Substitution* method used by the US Energy Information Administration (EIA), renewable electricity and heat are converted into primary energy using the average efficiency of fossil fuel power plants.

sources. The use of this indicator to track progress toward the 3rd SE4ALL objective is recommended in the "*A Framework for Action*" document and in the draft Global Tracking Report. It should also be noted that using the RE share in TFEC as an indicator, the contribution of individual renewable technologies to the total renewable electricity and heat production has to be allocated to each technology based on production proportions, and that this process can somewhat penalise the renewable sources in terms of energy losses.

A comparison of different indicators to estimate current and 2030 RE share in the global energy mix is given in Table 1, based on the IEA energy balances and the IEA 2030 energy scenarios, notably the New Policy Scenario (NPS) and the 450 Scenario as described in the IEA World Energy Outlook 2011[4].

Table 1. Share of RE in the global energy mix using different indicators, based on IEA energy statistics and scenarios.

Indicators	IEA balance 2009		IEA Balance 2010		IEA NPS 2030		IEA 450 2030		Greenpeace Energy [r]evolution	
	%	EJ	%	EJ	%	EJ	%	EJ	%	EJ
RE share in TPED - substitution	~16		~17	91	~22		~29	192		
RE share in TPED - phys en. cont.	~13		~13	69	~17		~23	141	~41	214
RE share in TPED dir. Equivalent	~13		~13	68	~16		~23	129		
RE share in TFEC	~18		~18	61	~21		~28	109	~45	153

Based on the 2010 IEA Energy Balances and depending on the indicators used, a doubling of the RE share would result in a 2030 target ranging between 26% and 36%. Considering that the High Level Group has mentioned a target of around 30% in 2030 and the TFEC methodology proposed by the Global Tracking report would result in a 2030 target of 36%, REMAP 2030 will explore a range of pathways resulting in a RE share in 2030 between 30% and 36%.

Furthermore, to explore the implications of doubling the RE share at both primary and final energy level, IRENA proposes to use in its Roadmap both the RE share in TPED (substitution method) and the RE share in TFEC. The use of further indicators is under consideration to track the evolution of the renewable energy market in terms of policy targets, technology costs, investment, economic implications and regional diversity.

1.1 The Role of Traditional Biomass

According to the IEA energy statistics, renewable energy currently accounts for about 17% of the world total primary energy demand (TPED, substitution method), with around 14% biomass and 3% other renewable energy sources. However, about 70% of this biomass consists of *traditional* biomass (e.g. woody biomass, animal manure, etc.) mostly used in developing countries as a fuel for inefficient open fires and stoves for cooking and heating purposes.

[4]The IEA New Policy Scenario takes into account energy policies and measures, and technology deployment either in place, ongoing and planned worldwide to mitigate energy-related emissions and climate change. The IEA 450 Scenario includes an additional set of policy measures, and technology development and deployment aimed to keep the CO2 concentration in the atmosphere below 450 ppm, in order for the global warming not to exceed the limit of 2°C

In the current energy projections to 2030 the share of traditional biomass is not expected to reduce significantly. Even most ambitious energy scenarios aimed to reduce energy-related emissions and climate change (e.g. the IEA's World Energy Outlook 450 scenario) rely on a significant, continued role of traditional biomass.

In contrast, the first two objectives of the SE4ALL initiative aim to provide universal access to modern energy services (electricity, modern and more efficient heating and cooking devices) and to increase significantly the overall efficiency in energy use. Both these objectives lead to phase out the use of inefficient traditional biomass and the associate environmental concerns such as deforestation and pollution. This has two important consequences for achieving the SE4ALL target. One the one hand, the higher efficiency of modern renewables would lead to reduce the energy (and biomass) demand for heating and cooking in developing regions, thus reducing the RE share in the global energy mix. On the other hand, increased efficiency will free up biomass resources to be used in other applications, most notably in the manufacturing and agricultural sectors.

Either way, doubling the current RE share (which today includes a significant proportion of traditional biomass) whilst phasing out in parallel (by 2030) the use of traditional biomass would imply an increase of the share of modern renewables (currently around 7%) by a factor of more than 4 in less than 20 years. This is indeed an ambitious target, which would require a significant transition in the global energy system.

The use of traditional biomass also poses a statistical issue because it is currently difficult to distinguish between the use of "modern" and "traditional" biomass, particularly in the residential sector. For example, in the IEA scenarios, the bioenergy used in OECD countries is accounted for as modern biomass while the biomass used in non-OECD countries is accounted for as traditional biomass. Obviously, this is a simplification because even in OECD countries there is an informal use of wood fuels in low-efficiency appliances, which is very difficult to measure with any precision. The draft Global TrackingReport suggests that improving energy statistics to distinguish between traditional and modern use of biomass could take significant time and efforts. IRENA and UNEP are carrying out a joint effort to collect and improve information and data on this topic, based on their numerous developing countries' membership.

1.2 Other Statistic Issues

The draft *Global Tracking report* identifies other statistic issues that may have a growing impact on tracking progress to the SE4ALL objective as soon as the share of renewables will increase over time. Current statistics do not fully reflect or capture:

- Small distributed, grid-connected power generation such as small-scale PV or wind,
- Off-grid and mini-grid power generation,
- Direct production of solar heat (e.g. solar water heaters),
- Difference between renewable (biogenic) waste-based fuels and other waste resources,
- A reduction of transmission and distribution losses due to decentralised electricity production,
- The renewable ambient heat that heat pumps capture/transfer using small amount of electricity.

Some of these issues can be addressed by ongoing IRENA efforts and analysis in projects other than the SE4ALL initiative.

2. Baseline and Reference Data Base

Given the current availability of 2010 energy statistics, the Global Tracking report suggests that 2010 could be the baseline year for SE4ALL initiative, thus providing a 20-year period to achieve the three SE4ALL goals. It also recommends the use of the IEA energy statistics as the main source of data. In areas such as traditional biomass as well as in areas concerning policy, technology costs, investment, and the economic implications of the transition to renewable technologies, the IEA statistics could be supplemented by the use of other leading data repositories (e.g. IRENA, REN21, UNEP, Bloomberg, the World Bank)

The Global Tracking report also reviews trends and developments of renewable over the period 2000-2010. While the global TFEC has been growing at a compounded annual growth rate (CAGR) of 2.0%, the RE consumption grew at 2.4% annually, but the RE growth includes a declining trend in the first half of the decade and a strong acceleration in the second half due to policy incentives for renewable technology deployment in many countries. As these policies are currently under revision following significant price reduction of renewable technologies, it is not clear at the moment how this trend will develop over the next years. The RE share in TFEC in 2010 was 18.0%, including 9.6% of traditional biomass, 3.7% modern biomass, 0.8% biofuels, 0.2% each for biogas, solar and geothermal energy, 3.1% hydro, 0.3% wind, and 0.1% waste, all of them increasing (modern biomass, hydro) or strongly increasing (e.g. wind, solar, biofuels) over the second half of the decade up to an average 5.7% CAGR, except for traditional biomass which has been slowly declining over the entire decade. Indeed, over the past years, modern renewables almost quadrupled at a global level, with wind, solar and biofuels soaring at almost 27%, 19%, and 13% CAGR, respectively, driven by policy incentives and reducing technology costs.

In terms of final applications, RE use has been quickly increasing in electricity generation and in transport and slightly declining in heating applications presumably due to the slow reduction of traditional biomass use. Biofuels grew from 1% to almost 4% of the total transport fuels while the RE share in electricity generation reached 19.4%, with 16% hydro, 1.6% wind, 0.9% biomass, 0.3% geothermal, and 0.2% each for solar, waste and biogas.

3. The Level of Challenge

As a preparatory work for the Roadmap, in the past months IRENA has been working to assess the level of challenge involved in doubling the RE share in the global energy mix by 2030 (in other words, the *plausibility* of the objective) as well as the mutual interaction with the other two 2030 SE4ALL objectives, i.e. universal access to modern energy, and the doubling of the energy efficiency (EE) improvement rate.

Data from Table 1 show that even most ambitious 2030 scenarios aimed to drastically mitigate emissions and climate change leave significant gaps if compared to SE4ALL objectives. For example, in the IEA 450 Scenario, the RE share in TPED increases from today's 17% to 29% in 2030, and the RE share in TFEC increases from today's 18% to 28% in 2030. In addition, the EE improvement rate is

expected to increase from today's 1.6%[5] to 2.5% by 2030 (but does not double), and the number of individuals with no access to electricity and modern cooking and heating services will decline, but remain significant.

The IRENA exercise to assess the level of challenge has been based on the IEA 2009 energy balances and the energy projections to 2030 as described in the IEA New Policy Scenario (NPS) of the IEA World Energy Outlook 2011[6]. The analysis builds on a range of ongoing IRENA activities (IRENA Sectoral Roadmaps for RE implementation in industries, cities and power grids; IRENA Technology Briefs; IRENA Cost Analysis Series) and has been developed at the global level, based on global assumptions for all regions.

The methodology used is based on global assumptions for all regions and includes the following steps:

- Evaluate the current RE share based on IEA 2009 data;
- Develop an ***Access Scenario*** **(AS)** building on the IEA NPS and achieving the universal access to modern energy services;
- Analyse the impact of AS on the global RE share;
- Develop an ***Access and Efficiency Scenario*** **(AES)** building on AS and achieving both universal access and double energy efficiency growth rate;
- Analyse the impact of AES on global RE share;
- Develop a ***Renewables, Access and Efficiency Scenario*** **(RAES)** building on AES and using different combinations of renewable technology options to double the RE share.

While the simple addition of effects and global assumptions for all regions does not capture the complexity of the energy market transition that is needed to achieve the SE4ALL targets (e.g. steps to get there, regional dimensions, impact on energy trading, economic implications, etc.) this approach can provide information on whether the SE4ALL objectives are achievable and their mutual interaction.

The key results of the IRENA analysis are summarised in Figures 1 and 2, which show respectively the renewable share in the total final consumption and the renewable share in the total primary energy demand (substitution method) for the three scenarios AS, AES and RAES.

Building on the IEA NPS, the first **Access Scenario (AS)** assumes an additional effort in deploying modern renewable technologies in order to provide access to electricity to about 1.3 bln people and modern heating-cooking facilities to some 2.7 bln who currently have not[7]. Of course, the impact of this transformation on the RE share depends on the role that renewable energy sources and technologies play in providing universal access to modern energy services. If only renewable-based power generation is used for electricity access (an additional 92 GW of RE power generation would be required on top of the additional 1879 GW of RE power generation assumed in the NPS), and

[5] Energy intensity improvements is used as a proxy for energy efficiency improvements. These results are based on IEA energy statistics and Worldbank GDP data (in PPP) between 1971 and 2008. Similarly, a 40-year period (from 1990 to 2030) is assumed to calculate the energy intensity improvements in 2030.

[6] Results can be easily updated considering 2010 IEA energy balances and most ambitious energy scenarios which will be included in the IEA World Energy Outlook 2012.

[7] According to the IEA NPS, the number of persons with no access to electricity will decline from today's 1.3 bln to about 1 bln in 2030 while the number of person with no modern cooking and heating facilities will remain levelled around 2.7 bln from now to 2030.

renewables-based cooking facilities are used to replace traditional biomass, the RE share in total final consumption will decline from 19% in the NPS 2030 to 17% in AS 2030. This is basically due to the higher efficiency of modern renewable technologies (even modern biomass-based technologies) which would drastically reduce the renewable energy consumption in comparison with the current use of traditional biomass. Obviously, if not only renewables are used to provide universal access to modern energy, the RE share in total final consumption can decline even more (under realistic but still renewable-friendly assumptions, Figure 1 shows that the RE share in 2030 declines to 16%,). Similarly, the RE share in

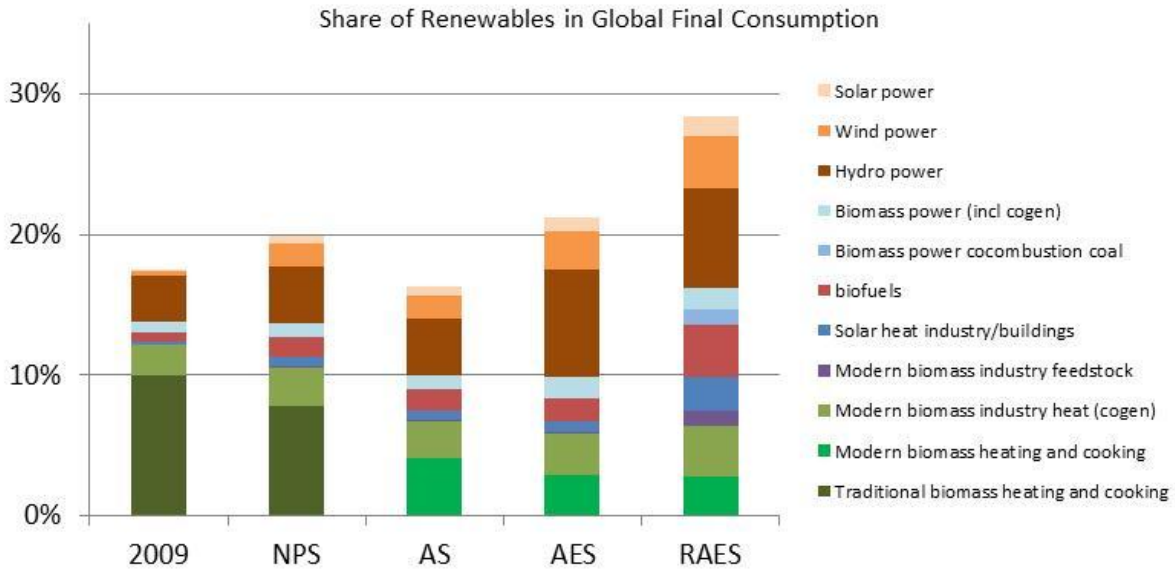

Figure 1. RE share in total final consumption in different scenarios.

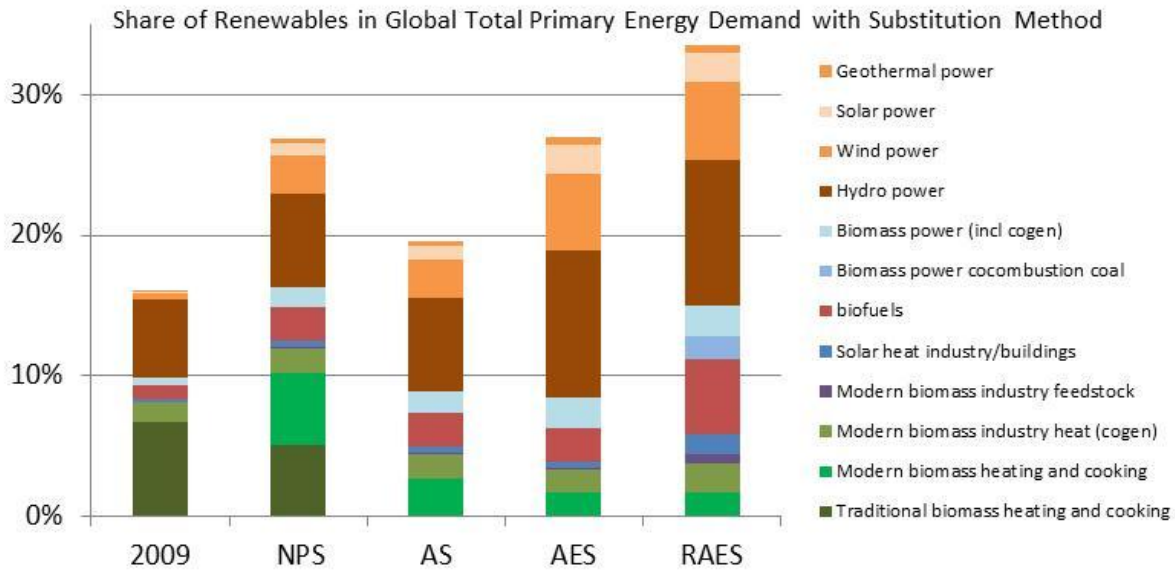

Figure 2. RE share in total primary energy demand (substitution method) in different scenarios.

the total primary energy demand (substitution method) will decline from 22% in NPS 2030 to 20% in AS 2030 if only renewables are used to provide universal access, and even more under more realistic

assumptions (19%, see Figure 2). Comparing NPS and AS 2030, it should also be noted that the use of traditional biomass (around 8% in NPS 2030, Figure 1) is replaced by a 4% modern biomass for heating and cooking. Therefore, the key finding of the AS is that providing universal access to modern energy services to all will reduce the RE share in the global energy mix due to the phase out of traditional biomass. The level of this reduction depends on which technologies and energy sources are used to replace traditional biomass.

The second **Access and Efficiency Scenario (AES)** builds on AS and explores the contribution that an increased electrification based on renewable power (increased use of renewable power generation) can make to energy efficiency. It should be noted that AES does not assume efficiency improvement in power generation and in end-use sectors compared to AS. The results (Figure 1 and 2) show that the increased electrification in the transport sector (electric vehicles), in the building sector (e.g. heat pumps) and in the industry sector (e.g. heat pumps and innovative electricity-based process technologies) lead to a significant increase of the energy efficiency improvement rate, as well as an increase of the RE share. The share of renewable power in the electricity sector would increase from 29% in AS to 35% in AES, and electricity would displace up to 9% of gasoline and diesel consumption in the transport sector, the use of fossil fuels in industry, as well as fossil fuels and biomass in the buildings sector. As a consequence, the RE share in the total final consumption increases from 17% in AS to 23% in AES 2030. Similarly, the share of renewables in TPED (substitution method) increases from 20% in AS to 27% in AES 2030. The main finding of the AES is that an increased electrification contributes significantly the achievement of the SE4ALL renewable energy targets. Of course, more energy efficiency policy measures in power generation and end-use sectors are needed, and the level of additional renewable power capacity to be installed worldwide for this to happen is in the order of 3693 GW. This is 1815 GW more than projected under IEA NPS. In comparison, around 100 GW of renewable energy power generation was added in the year 2011.

The third scenario, **Renewables, Access, and Efficiency Scenarios (RAES),** builds on AES and explores how to achieve the aspirational target of doubling the RE share in the global energy mix using several renewable technology options to displace additional amounts of fossil fuels in power generation and end-use sectors compared to AES. Several ranges of displacement have been analysed, including:

- Displace an additional 1-4% of fossil-fuels in power generation using renewable power technologies through hydro (0-40 GW), wind (300—480 GW), solar PV (200-250 GW), CSP (20-30 GW) , biomass, including co-firing (200-500 GW), geothermal (11-18GW), and ocean energy (2-3GW);
- Co-firing 10-20% of biomass in coal-fired power stations;
- Displace 5-20% of fossil fuels feedstock in chemical industry with biomass feedstock;
- Displace an additional 5-7% of gasoline and diesel fuels in transport by bio-ethanol and biodiesel;
- Displace 5-10% of fossil fuels for heating and cooling in industry by biomass;
- Displace 5-20% of fossil fuels for heating and cooling in industry by solar heating and cooling;
- Displace 5-30% of fossil fuels for heating and cooling in buildings by solar heating and cooling.

The final step in this *plausibility study* is a consistency check based on global and regional availability of renewable energy resources, including the possibility of trading, and the levels of investments required to achieve the different pathways. The consistency check is based on comparisons with

other scenarios and regional and global resource assessments, as well as Country Member data to be collected within IRENA's Cooperation Framework for REMAP (see Section 4).

This list of options is a preliminary selection based on the IRENA analysis of most promising renewable technologies (IRENA Technology Briefs). A discussion is needed on how this list can be expanded or changed, and on priority of technology options.

IRENA has developed two pathways to achieve the renewable energy target in the RAES. One pathway favours efforts to increase the share of renewables in end-use sectors, while the other pathway favours efforts to increase the share of renewables in the electricity sector. The two pathways are based on different combinations of renewable energy options[8], but each pathway uses the same global assumptions in all world regions.

The first finding of RAES is that a significant growth of renewable power generation alone is not sufficient to achieve the SE4ALL objective for the RE share in the global energy mix, and that combined interventions in both power generation and end-use sectors are needed. While even renewable energy options in the end-use sectors have an insufficient individual impact, they can collectively enable the achievement of the SE4ALL objective if combined with a significant increase of renewables in power generation. Under this assumptions, a 30% RE share in the global energy mix is marginally achieved if the RE share is measured with respect to the total final consumption (Figure 1) and is slightly exceeded if the RE share is measured with respect to the total primary energy demand (Figure 2).

Figure 3 provides an overview of the additional contribution that each technology option makes in RAES to achieve the 3rd SE4ALL objective, compared with NPS, AS and AES. Important contributions are provided by the use of renewable energy in building heating and cooling, by the use of biofuels in transport and by biomass co-firing in coal-fired power plants. Smaller but still significant contributions are given by the use of renewables to meet industrial heat demand (including options with growing importance such as renewables-based water desalination) and the use of biomass in chemical industry (bioplastics) instead of fossil fuels.

[8] For example, the "end-use sector" pathway assumed 10% biomass co-firing for coal-fired power stations in 2030, while the "power sector" pathway assumed a 20% biomass co-firing for coal-fired power station in all regions.

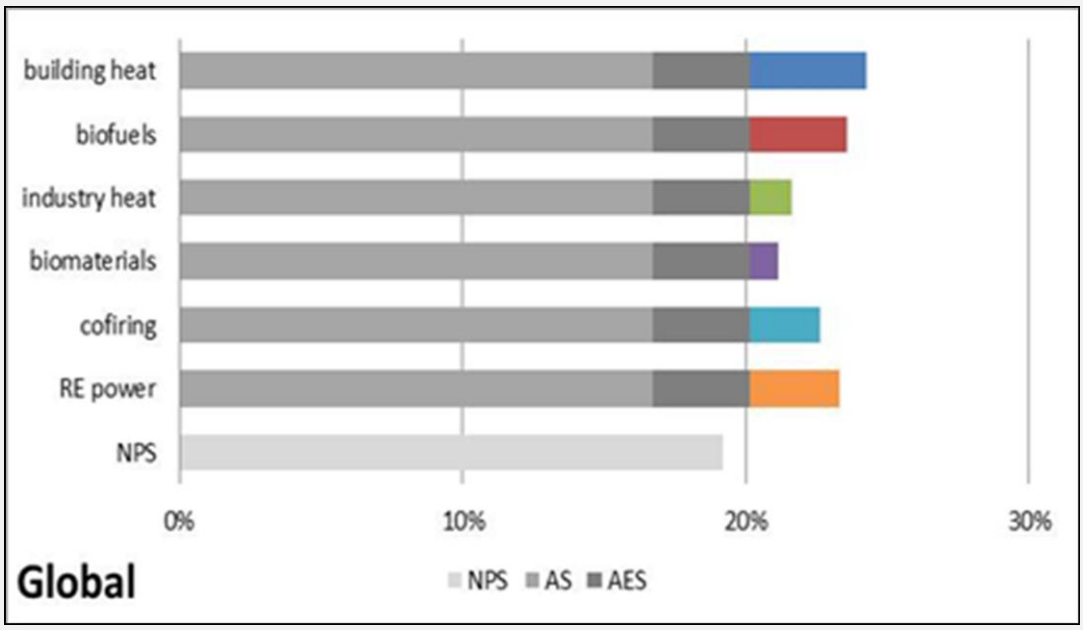

Figure 3. Contribution of different technology options to increase the RE share in total primary energy demand (substitution method) in RAES, compared to NPS, AS and AES.

The conclusion of the IRENA analysis is that the 3rd SE4ALL objective as it is currently defined is technically achievable, but poses unprecedented challenges in terms of development and deployment of renewable technologies and capacity in a relatively short time frame, in particular if it is associated with the phase out of traditional biomass in developing regions.

The present analysis also provides a preliminary exploration of the impact at regional level based on global assumptions. Figure 4 shows the RE share in total primary energy demand (substitution method) for three different regions: the European Union, Africa, and the Middle East. The results show that achieving universal access to modern energy services will significantly reduce the RE share in Africa and have a little impact on the RE share in the European Union and the Middle East. On the other hand, a high growth rate of bio-based plastics has no impact on the RE share in Africa, while it impacts the RE share in the European Union and the Middle East. Similarly, biomass co-firing has a negligible impact in the Middle East due to the limited coal-fired power generation capacity, while it contributes the RE share in the European Union and Africa.

These regional differences are an obvious consequence of different natural endowment and starting point for individual regions and countries[9] and show that the challenges associated with the achievement of the SE4ALL objective vary considerably across regions and countries. The global assumptions considered in the present IRENA analysis - and the analysis itself - need to be specialised at regional and national level to capture the national dimension of the challenge .

[9] The current share of renewable energy is almost 0% in the Middle East, it is 58% in Africa due to the large use of traditional biomass, and 45% in Brazil due to the large use of biofuels and renewable power (large availability of hydropower and sugarcane for biofuel production).

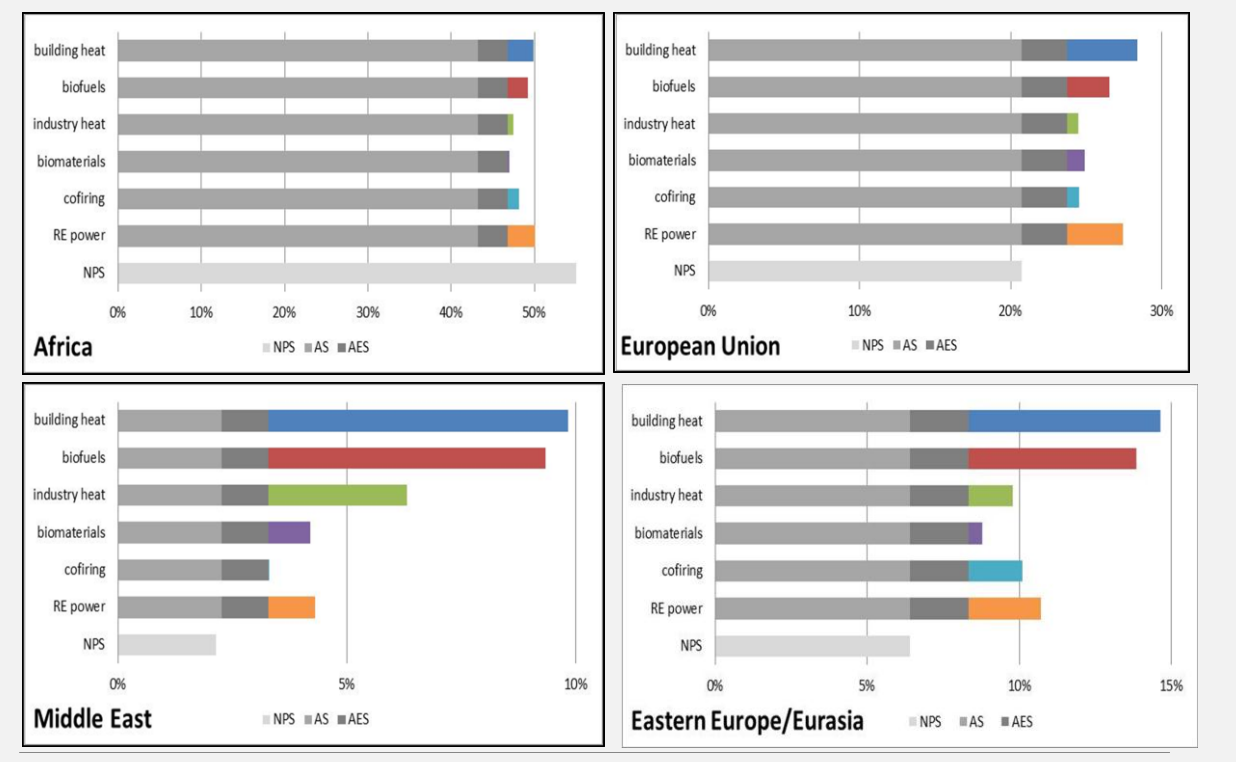

Figure 4. *Contribution of different technology options to the increase of the RE share in total primary energy demand (substitution method) in RAES, in various world regions*

4. The IRENA's Roadmap and Cooperation Framework

At workshop held in Malta on 5 September 2012, participants have discussed the activities required to finalise the current IRENA's analysis to be presented at the IRENA General Assembly in January 2013. These activities include: a) Make available model assumptions and results from the RAES; b) Determine the *gap* between the SE4ALL objective and existing national action plans by collecting additional regional and country data based on simple data sheets, and evaluating the global, regional and national assumptions in the RAES based on Countries' data and comments; c) Translate the *gap analysis* into concrete action items and allow for Countries' and stakeholders' feedback through workshop and reviews of the final draft.

In accordance with the IRENA view, Member Countries' experts have also agreed and suggested that the Roadmap to the 3rd SE4ALL objective that IRENA is going to develop over the next months should include a number of topics and key factors for policy makers' attention. These are broadly listed below:

- Potential pathways and intermediate steps to achieve the SE4ALL objective
- Associated needs for technology deployment
- Associated financial investment
- International energy technology and commodities trade
- Regional economic implications (impact on GDP, economic development and employment)
- Energy security benefits
- Beneficial impact on environment and climate change

- Human (social) development associated with an increasing share of renewables
- Possible technology breakthroughs that could ease the achievement of the objective
- Enabling policies "to get there".

While the present IRENA work (the *plausibility study)* provides an assessment of the technical feasibility (of the 3rd SE4ALL objective and its interaction with the other two goals, a much more in-depth and comprehensive analysis is needed to assess the above-mentioned key factors and develop concrete action items.

Such analysis at a global level would involve a very significant effort for IRENA to carry out alone and could result in just an Agency's exercise if developed only at a global level without dealing with the regional and national dimension. Furthermore, it would require complex models to assess the interaction and feedback loops between global energy demand and supply, technology deployment, economic and social development, technological progress, and policy interventions. More interesting and useful for policymakers is the assessment of regional and national economic implications, opportunities, policies and barriers. This kind of analysis makes only sense taking into account regional diversification and national peculiarities and policies by a direct and active involvement of Member Countries.

For these reasons the IRENA's Roadmap is intended to build on a Cooperation Framework where an increasing number of volunteer Member Countries provides guidance, input, data and direct contributions to assess the *gap,* and to formulate and analyse their own national policies towards the SE4ALL objective. IRENA's role in the *gap analysis* would be:

- Makes available shared, comparable and transparent analytical tools as used in the *plausibility study*,
- Provides information on international costs, performance and sectoral criticalities for renewable technologies,
- Supplements the analytical efforts with global, regional and national analysis for those geographical regions that are not directly represented by participating countries,
- Offers coordination and harmonisation of results in order to ensure the consistency with the global SE4ALL goal.

Based on this *gap analysis*, IRENA will collaborate with Country Members' and other stakeholders to develop concrete action items at a sectoral level to allow for cross-cutting recommendations applicable to multiple regions and countries simultaneously.

During the first REMAP workshop on 5th September in Malta, several Countries have already provided information on national renewable energy plans, key drivers, and sectoral priorities within their own countries. This information is made available at the IRENA website[10].

IRENA's intention is to attract the interest of an increasing number and variety of Member Countries at the second workshop in Abu Dhabi.

Therefore, an important goal of the second workshop is to discuss whether Member Countries may wish to support this IRENA's approach and - if so – ways and means how to build the Cooperation Framework, what kind of analytical tools are to be used to allow easy access, use and input for

[10] http://www.irena.org/menu/index.aspx?mnu=Subcat&PriMenuID=30&CatID=79&SubcatID=211

Countries' experts, and easy comparison of results and assumptions, as well as the limits of the effort, and the national expertise and in-kind resources countries may wish to make available and invest in it. Furthermore, Countries' input is sought on the idea to develop action items based on a sectoral approach.

As suggested by Member Countries at the Malta meeting, IRENA will take a step-by-step approach in dealing with the key factors listed above. Therefore, as a starting point in the Roadmap development, IRENA plans to deal with the energy and technology dimension of the SE4ALL objective (potential pathways and intermediate steps to achieve the SE4ALL objective, related needs for renewable technology deployment, opportunities, barriers and associated financial investment). For this first set of aspects IRENA can make available the simple spreadsheets that have been used to develop the *plausibility study*. These spreadsheets also provide information on the key assumptions for regional and sectoral energy demand projections, the deployment of renewable energy technologies to achieve universal access to modern energy services, electrification rates in the end-use sectors of transport, buildings, and industry, and the displacement of fossil fuels in electricity, heat and plastics production.

The second step of the analysis will be the assessment of the *gap,* and will consist of data collection regarding Member Countries' energy demand projections and national renewable energy plans. If available, IRENA will attempt to collect data on the regional and national economic implications of the transformation of the energy system (impact on GDP, economic development and employment). Such information could be based on simple input-output matrix of local economies (I-O matrix) - which basically analyses how an investment can activate the economic sectors of a certain economy, given the interconnection of the economic sectors - or using more complex approaches based on macro-economic models[11]. A possible cooperation with the World Bank can also be considered on this kind of topics. Member Countries' preference is of key importance to guide the choice of tools for the Roadmap analysis.

The third and final step of the development of the Roadmap is the development of action items. IRENA proposes to use a sectoral approach for the development of action items. A sectoral approach will not require allocation of specific renewable energy targets to regions or countries, but instead will allow for cross-cutting recommendations on additional action, which are applicable to multiple regions and countries. Furthermore, a sectoral approach will allow for engagement of non-country stakeholders through sectoral roadmap workshops. Finally, REMAP's sectoral approach will provide insights on potential renewable energy applications that would not be evident from regional or national roadmaps. As such, REMAP will provide complementary insights for those countries that are interested in the development of national roadmaps for renewable energy deployment.

In summary, in the light of a possible significant involvement of IRENA resources in the UN SG's SE4ALL initiative, and more precisely in the development of a Roadmap to achieve the 3rd SE4ALL objective, it is proposed that a session of the Abu Dhabi workshop be devoted to discuss the following three questions:

- Would Member Countries support the IRENA approach and the establishment of a Co-operation Framework involving direct contributions of Countries' experts to the development of a Roadmap, including regional and national dimensions as described above?
- What kind of tools in terms of easy-access and use, technical transparency or complexity should IRENA use to analyse the first two aspects of the Roadmap (i.e. energy and technology pathways, related investment and associated economic implications) in the light of a closer cooperation with Member Countries' experts. Do Member Countries have any specific recommendations on this matter? Which specific country analysis and tools could IRENA refer to ?
- Do Member Countries consider the proposed approach helpful from their national perspective and expectations? Will the sectoral approach be able to assist Country Members' that are interested in the development of national roadmaps? How can it be improved, upgraded or downsized?
- Which position and priority should the UN SE4ALL initiative and the IRENA Roadmap have within the IRENA Programme of Work for the next year and for the subsequent years to come? Which percentage of its resources should IRENA invested in such an effort?

5. Conclusions

IRENA has almost finalised its assessment of the level of challenge involved in the achievement of 3rd SE4ALL objective, i.e. doubling the share of renewable energy in the global energy mix by 2030. The results of this effort are summarised in the present report and are going to be discussed with Member Countries at the next workshop in Abu Dhabi on November 14, 2012. Member Countries' comments will be incorporated in the final report to be presented at the IRENA General Assembly in January 2013. In this analysis, indicators to track progress towards the SE4ALL objective and the baseline to developed the IRENA Roadmap towards the 3rd SE4ALL objective have been discussed and identified. A Baseline Report is currently being finalised in cooperation with other international organisations involved in the SE4ALL initiative.

The main conclusion of the IRENA analysis is that the 3rd SE4ALL objective, as it is currently defined, is technically achievable, but poses unprecedented global challenges in terms of development and deployment of renewable technologies and capacity in a relatively short time frame, in particular if it is associated with the phase out of traditional biomass in developing regions. The deployment of modern renewable technologies that is needed to achieve the objective goes well beyond some of the more ambitious scenarios to mitigate emissions and climate change, which still rely on continuous use of traditional biomass.

The regional dimension of this effort varies considerably across world regions and from country to country. It depends on natural endowment, current use of traditional biomass and other regional and national characteristics such as the level of industrial development and national policies. The level of investment and the economic implications of this important transformation of the energy system also need to be better addressed at national and regional level.

The next step of the IRENA work in the SE4ALL context will be the development of a Roadmap to define and assess potential pathways to achieve the SE4ALL objective and to measure progress towards the objective. Member Countries' suggestions as discussed at the first workshop (Malta, 5 September 2012) as well as considerations emerging from the IRENA analysis suggest that the Roadmap IRENA is going to develop needs to address the regional and national dimension in order to make the effort a useful contribution to Countries' policy rather than an Agency's exercise.

For these reason and to deal with the limited available resources, IRENA is proposing to establish a Cooperation Framework where Member Countries provides guidance, input, data and direct contributions to formulate and analyse their own national policies and roadmaps, and IRENA provides shared and transparent analytical tools, information on international costs and criticalities of renewable technologies, and supplements analytical efforts for geographical regions that are not represented in the Cooperation Framework, and offer coordination and harmonisation of results to ensure the consistency with the global SE4ALL goal. Subsequently, IRENA will, through Country Member and other stakeholders' engagement, translate the gap analysis into concrete action items at a sectoral level.

As the IRENA Roadmap is expected to require a significant part of the IRENA resources in the years to come, Member Countries are also asked to consider the level of priority they attribute to the IRENA Roadmap and the IRENA contribution to the UN SE4ALL initiative.