



**DEVELOPING
RENEWABLES**
Renewable Energy that benefits all

Amsterdam, February 2007

RENEWABLE ENERGY MARKET POTENTIAL IN EMERGING AND DEVELOPING COUNTRIES

SIXTH FRAMEWORK PROGRAMME PRIORITY 3
Underpinning the economic potential and cohesion of a larger and more integrated EU

SPECIFIC SUPPORT ACTION

Project Acronym: RECIPES
Project full title: Renewable Energy in emerging and developing countries: Current situation, market Potential and recommendations for a win-win-win for EU industry, the Environment and local Socio-economic development
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Recipes for the implementation of renewable energy sources
that benefit the local and global environment, the socio-economic situation
in emerging and developing countries and the European industry

Project summary



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Abbreviations and definitions

CO ₂	Carbon dioxide: a greenhouse gas that contributes to the greenhouse effect. Greenhouse gas emissions are expressed in carbon dioxide equivalents.
EC	European Commission
EDCs	Emerging and Developing Countries
EDI	Energy Development Index
EIA	Energy Information Administration of the US Department of Energy
EU	European Union
GJ	Giga Joule = 10 ⁹ Joule. The unit of energy
HEGC	High Economic Growth Case
IEA	International Energy Agency
IEO	International Energy Outlook
kton	Kilo ton = 10 ⁶ kg
LEGC	Low Economic Growth Case
MDG	Millennium Development Goals. The eight Millennium Development Goals (MDGs) – which range from halving extreme poverty to halting the spread of HIV/AIDS and providing universal primary education, all by the target date of 2015 – form a blueprint agreed to by all the world’s countries and all the world’s leading development institutions. They have galvanized unprecedented efforts to meet the needs of the worlds poorest.
Mtoe	Mega Tonnes Oil Equivalent. Unit of energy quantity, worldwide use as unit for the energy consumption of a country
Mton	Mega ton = 10 ⁹ kg
MW	Megawatt. Unit of power generation capacity used for fossil plants as well as for wind-energy, hydro and other RE sources.
RE %	Percentage of RE as part of the total energy supply or electricity supply. We indicate where RE includes or excludes large hydro. The RE-percentage in relation to the total primary energy consumption relates to the countries total Total Primary Energy Supply including traditional biomass. Where this is not the case it is indicated. The RE-percentage in relation to the total electricity supply: this relates to the total electricity produced, not to the primary energy needed to produce the electricity.
RE	Renewable Energy. There is no universally accepted definition of renewable energy. Especially some techniques like large hydro or energy from waste are disputable. We use the definition of each country if it relates directly to the targets set. In the reports of the in-depth country studies and the extrapolation to the 99 other

countries we state what definitions are used. Traditional biomass is not regarded to be RE.

RECIPES	Renewable Energy in emerging and developing countries: Current situation, market Potential and recommendations for a win-win-win for EU industry, the Environment and local Socio-economic development
REMP	RE Market Potential. The amount of renewable energy which, given all possible restrictions (practical, economical, juridical, etc.) is likely to be produced.
RES	Renewable Energy Sources (see also RE)
RET	Renewable Energy Technologies (see also RE)
TP	Technical Renewable Energy Potential; the amount of renewable energy which, based on the best available renewable energy technologies, can be produced. (i.e. for solar and wind energy this is in almost every country unlimited while geothermal and hydro can have a certain maximum)
TWh	Terra Watt hour = 10^9 kWh
TPES	Total Primary Energy Supply, includes all RE and fossil fuels including those used to generate electricity. Also includes traditional biomass.
TREMP	Theoretical Renewable Energy Market Potential, based on the energy demand as a consequence of growth in energy, a market due to the introduction of RE energy and a market due to (the possible) replacement of old energy equipment
UN	United Nations
UNDP	United Nations Development Program
US	United States
WEC	World Energy Council
Wp	Watt peak also kWp and MWp. Unit of power generation capacity especially used for photovoltaic systems (solar cells). The energy output depends on the quantity of solar energy on the solar cells.

Preface

This report describes the renewable energy (RE) market potential for 114 developing and emerging countries (INCO list). It is based on a set of indicators for the 114 countries and detailed case studies for 15 countries.

RECIPES is a study into the implementation of renewable energy sources (RES) in emerging and developing countries (EDCs), funded by the European Commission. Main aim of the project is to provide all stakeholders involved with information and insights to be able to contribute to the implementation of renewable energy in emerging and developing countries.

More detailed information on the above issues and background information on the methodologies and data used is available at the RECIPES project website www.energyrecipes.org.



Table: RECIPES consortium, local experts and Advisory Board

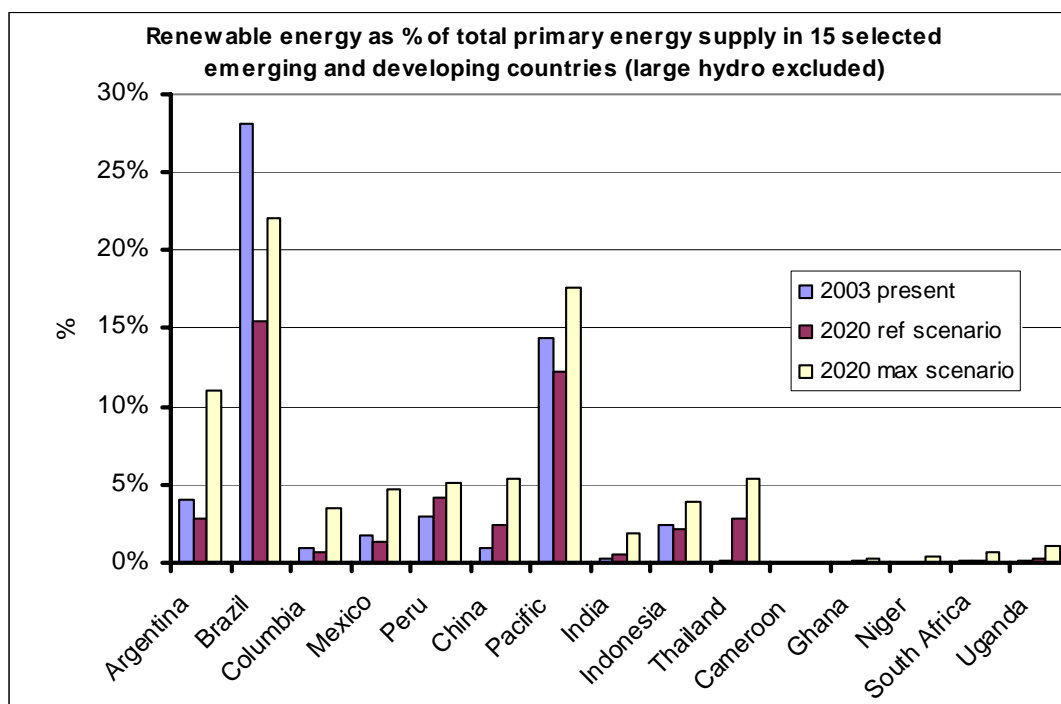
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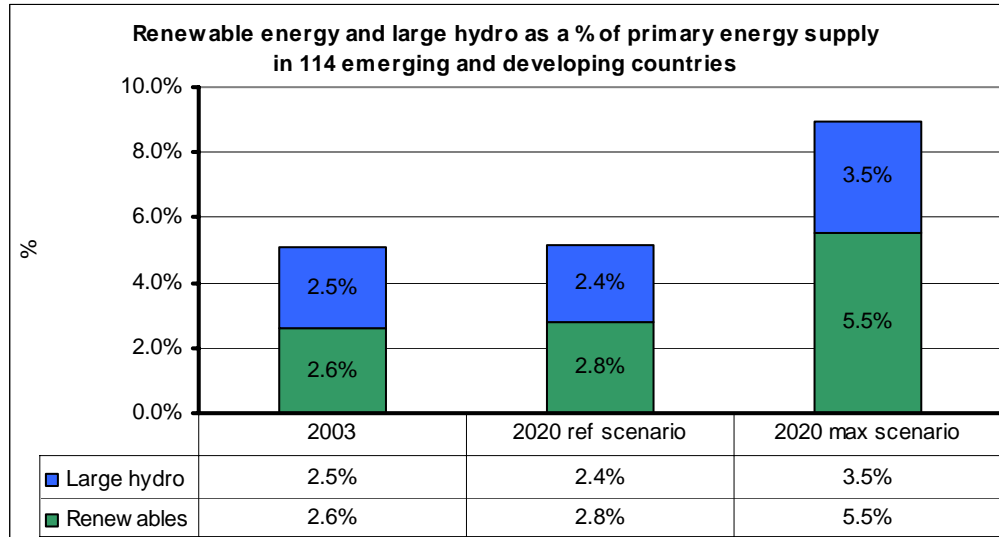
Executive Summary

RECIPES has assessed the market potential of renewable energy for 114 developing countries listed by INCO. In-depth studies for 15 developing and emerging countries concerning the market potential for different market technology combinations form the basis for this assessment.

The RE-potential in 2020 for the 15 countries (5 from Africa, 5 from Latin America and 5 from Asia) is assessed based on information gathered by local experts in each country. The data collected includes the present energy situation, the present use of RE, the targets set as well as qualitative information on the energy policy and implementation. After defining the main drivers and barriers for the various RE technologies, scenarios for further market implementation were developed. A reference scenario describes the future development of the respective market technology combination if the present situation remains unchanged including the estimated impact of existing policy measures by 2020. The scenario described as the 'maximum scenario' leads to the largest RE output per technology by 2020.

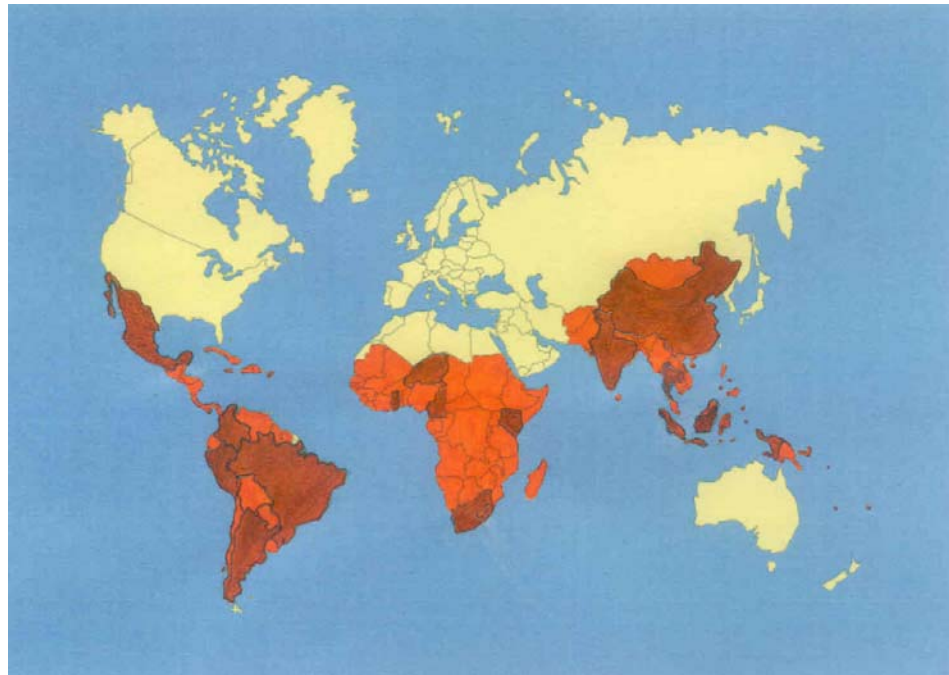
The outcome for all 15 countries is presented in the figures below.





It is important to note that the RECIPES maximum scenario may well be higher than the above estimations. Especially possible developments in the bio-fuels sector and in the use of waste from agro industry (although waste as a source is not always regarded as RE), can increase the above figures. We could not assess a reliable market potential for 2020 for these RE options in all the countries because we lacked information on present situation and technical potential. Furthermore most countries studied have at present no policy for these sectors and in many countries there is discussion on the land-use for energy production instead of food production.

The map below shows the 114 countries (red and deep red colored) and the 15 selected countries (deep red colored). In Latin America the 5 countries of the in depth studies covers almost all the region, in Asia they cover more than 70% and in Africa they represent only a small part.

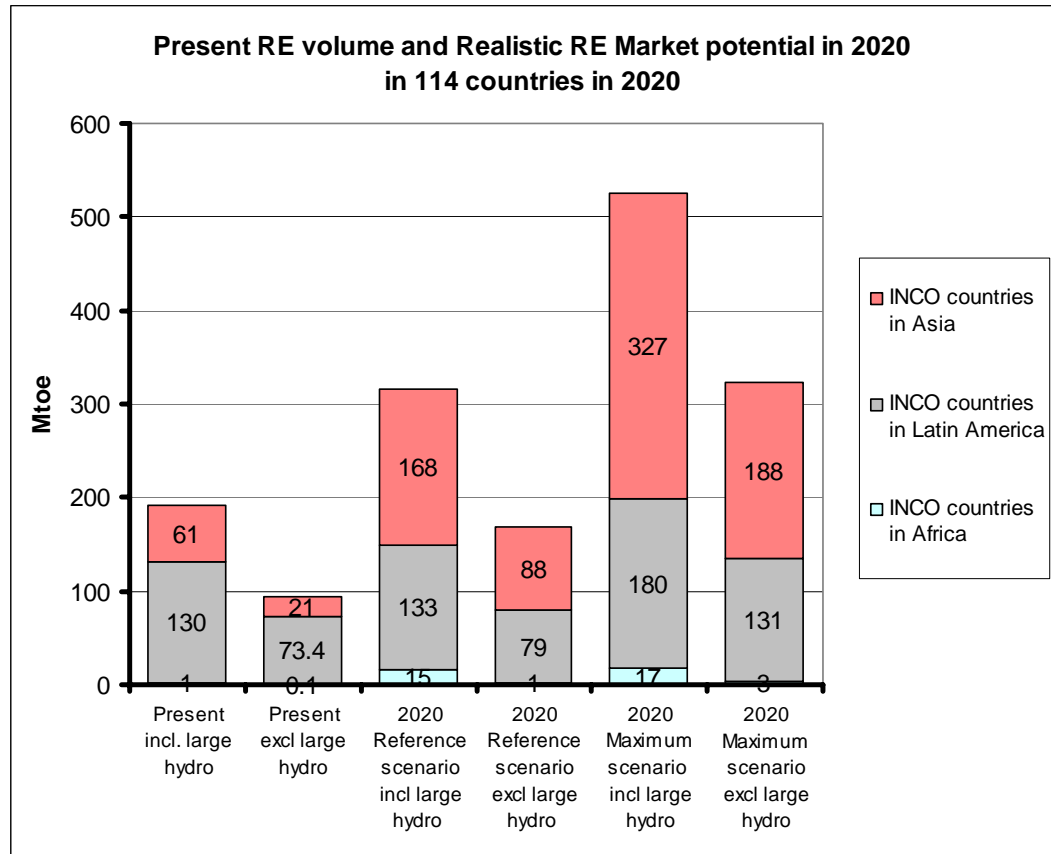


For the 99 countries of the 114 INCO list, the numerical information is deciphered through more than 70 aspects. Information on the present economic and energy situation was gathered from publicly accessible sources. Some of the 99 countries don't have policy or energy structure information available.

For extrapolation of the results of the 15 in-depth studies to the 99 countries four economic groups of countries were defined. The existing (large)hydro over all the countries were taking into account to assess the RE market potential. Large hydro is in the Recipes project not regarded as RE. This is in line with other RE potential studies where large hydro is not considered as an RE source, because of its environmental and social impact. So we did not assess the situation of large hydro in detail and did not create scenarios for its future development. We only took into account the already planned new large hydro plants and the targets set. From the 15 countries we then extrapolated to the 114 countries as we did for RE technologies.

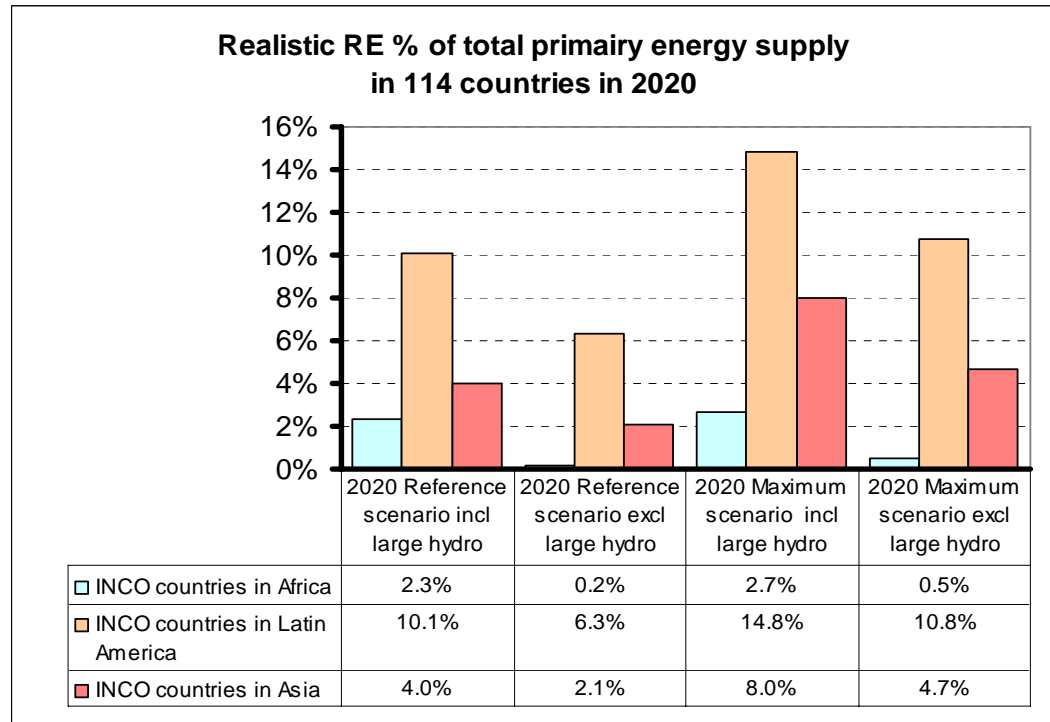
The existing RE volume excluding large hydro is, due to a lack of information, the volume for the 15 countries of the in depth study extrapolated to the 114 countries. We estimate that in reality it can be 8 to 15 Mtoe and have used 11 Mtoe.

The outcome of the assessment is presented here below in RE volume and in the percentages of the total primary energy supply.



The present RE volume, excluding large hydro, can be tripled in 2020. In Asia this volume growth is even higher. In Latin America this growth is smaller due to their present already high volume. In Africa this difference is even larger where energy consumption is low and the effect of increased RE capacity higher. For poor countries the effort to bring modern and renewable energy to the people costs much more per energy unit produced than larger installations in more industrialized countries. This effect slows down their RE volume growth compared with other countries.

If large hydro is included, the maximum scenario shows that RE production in the 114 countries is more than twice as high as in the reference scenario.



The continent with the greatest RE percentage is Latin America, due to the fact that this continent is generally more developed. And many countries in Latin America have or are developing a definite policy towards RE.

Asia has the largest absolute RE contribution in all the scenarios, but in % of the energy supply it remains at almost 5% when large hydro is excluded. This in spite of the ambitions of China and India which are responsible for 50% (China) and 25% (India) of the TPES in 2020 of the Asian countries studied,.

The research shows that from the present situation there is a long way to go for the RE technologies other than large hydro to realise the maximum scenario potential. There is a clear need for ambitious targets for these technologies, supported by reliable measures in order to nurture sustainable RE industry and create the situation where RE could make a real impact on security of supply and imported fuel dependency. We emphasise that in this study a realistic market potential is assessed, we did not define scenarios on just the technical potential nor did we aim at a political or environmental desirable potential.

For all the countries, effective market drivers are important to realise the market potential. These market drivers are finance availability, prioritised access to the grid, cost effectiveness, capacity building factors such as local knowledge and skills on a technical level and skills for effective contracting for example, down to awareness building. These drivers all rely on the effectiveness of the underlying energy policy and organisational structure of the energy companies.



1. Introduction

1.1. The RECIPES project

The RECIPES project aims to contribute to the implementation of renewable energy in emerging and developing countries. The RECIPES project is financed under the 6th Framework Programme for Research and Technological Development of the European Commission.

The main objective of the RECIPES project is to provide the European Commission and other stakeholders with a comprehensive data basis and pragmatic recommendations facilitating appropriate action to further the implementation of renewable energy in emerging and developing countries, taking into account:

- The effects on the local socio-economic situation.
- The competitive position of European renewable energy industry.
- The impacts on the local and global environment.

Data collection on the situation and potential of renewable energy in emerging and developing countries is the core of the RECIPES project.

An identification of the RE market potential is carried out for 15 developing and emerging countries. Local experts gathered data for all of these countries. The results of these in-depth studies are extrapolated to 99 other developing countries for which data is gathered through desk research. These 99 countries are categorised on relevant indicators and main regions (Africa, Asia and the Pacific, Americas and the Caribbean) to assess the cumulative total market potential for the entire group of developing countries.

1.2. This document

This document contains the results of the RE potential studies for all the 114 developing countries by extrapolation of the results of 15 in depth country studies and basic indicators for the 99 other countries.

1.3. Other RECIPES documents

On the RECIPES website (www.energyrecipes.org) we publish relevant data collected and reports produced. The following information will be available on the website:

1. *Database with collected data for the 114 emerging and developing countries.* The website will have reporting tools for extracting this data and comparing countries.
2. *Information collected by our experts in the 15 selected countries.* This includes the 15 country study reports as well as part A (questionnaire - accessible via the online database), part B (energy and policy) and part D (RE projects) (B and D both available for downloading). Part C (maps) will

also be downloadable from the website when developed. Part E (interviews with stakeholders) will remain in a restricted area for privacy reasons.

3. *Country studies*

15 reports contain the results of the RE potential studies for

- | | | |
|--------------|-----------------|---------------------|
| 1. Argentina | 6. Cameroon | 11. China |
| 2. Brazil | 7. Ghana | 12. Pacific Islands |
| 3. Colombia | 8. Niger | 13. India |
| 4. Mexico | 9. South Africa | 14. Indonesia |
| 5. Peru | 10. Uganda | 15. Thailand |

4. *Overall project reports:*

- Methodology and Model explanation report
- Results of 15 country studies including extrapolation to 114 emerging and developing countries
- Report on socio-economic aspects, environmental effects and costs / benefits for the EU RE industry of RES in the countries
- Comparison of the results of the study with other relevant studies and information sources
- Final report and pragmatic recommendations for the implementation of RE in developing countries

2. Summary of the results from the 15 in-depth country studies

2.1. Introduction to the 15 country potential studies

Based on the data collected by the local expert we calculated the RE potential for the following eleven market technology combinations:

- Solar thermal for residential and public services
- Photovoltaic
- Wind on-shore and off-shore
- Geothermal
- Small and medium size hydro
- Large hydro (see also next page)
- Biomass, electricity and heat production
- Bio fuels
- Small RE systems
- RE used in industry
- Water desalination

The methodology to assess this realistic market potential consists of 3 steps:

- Description of the present market situation
- Estimation of Theoretical RE Market Potential (TREMPE)
- Estimation of the realistic RE Market Potential (REMP)

A detailed description of approach and results is presented in the country potential reports. Underneath a summary is given.

The existing market for a specific renewable energy technology is an important starting point for future possible developments for a market. We have described the existing market asking ourselves the question: *'why is this RE-technology implemented in the present quantity?'* To answer this question we looked at nine decisive factors or market aspects. Based on the information gathered by our local country experts we have described these. See the Country Potential Reports for information on the present situation.

The Theoretical RE Market Potential TREMP is calculated for each market-technology combination and depends mostly on the market. For every market technology combination there are some restrictions, due to the environmental possibilities (e.g. for solar water, is there enough space for the technology near or on the dwellings in a city?).

This TREMP is only used as input for the assessment of the realistic market potential and not used in the extrapolation to the 99 other developing countries. So we will not use it further in this report.

The realistic Renewable Energy Market Potential (REMP) is, given all possible restrictions and stimuli, the most likely market potential. The REMPE will vary due to various drivers and barriers; we have used scenarios to show the different possible results. Drivers and barriers we have distinguished are:

- cost effectiveness
- finance availability
- energy policy
- other policies
- knowledge and skills and
- awareness.

For each market technology combination we present up to 4 scenarios (depending on the number of important drivers or barriers) one of them is the **reference scenario**. This reference scenario describes the future development of the respective market technology combinations if the present situation remains unchanged including the estimated impact of existing policy measures. The only changes that are included are:

- National income growth;
- Global energy cost increase (expected);
- Global price decrease of some RE technologies (expected).

The scenarios that lead to the highest consumption of RE in 2020 is called the **maximum scenario**. A scenario can be based on changes in all above drivers and barriers including policy concerning industry, environment, health or poverty reduction. The change in drivers that will give the maximum result can be different for each market technology combination and for each country:

Large hydro is not considered as a renewable energy technology in the RECIPES project (for more info we refer to the methodology report on our website www.energyrecipes.org). This is in line with other RE potential studies where large hydro is not considered as an RE source, because of its environmental and social impact. So we did not assess the situation of large hydro in detail and did not create scenarios for its future development. Many countries however include large hydro in the RE contribution for their country energy balance. To be in line with the presentation in these countries we present the RE contribution both with and without large hydro.

For the present situation and the scenarios for 2020 we take into account large hydro as describe below

1. In the present situation we utilize the existing large hydro production, The definition of large hydro varies in the countries (between 10 and 50 MW as lowest boundary). We respect the boundaries that are used in the various country also we also use varies boundaries.
2. In the reference scenario we also take into account the planned large hydro plants.
3. In the maximum scenario we also take in account the ambition for new large hydro, often these are plans where not yet an exact time frame is yet available or the investment is not yet arranged.

The summation of the capacity of the various technologies and the RE production which can be reached under a reference scenario (continuing present situation and present policy) and a maximum scenario (positive change of most important market drivers) are used as lower and upper boundaries for the RE-potential.

For some countries and some technologies the reference scenario may lead to an optimistic estimation of the RE potential; setting a policy target will not automatically mean this target will be reached. So in the in-depth study for some countries and technologies we have assessed a scenario which will lead to lower implementation than that in the reference scenario. For reasons of comparability however we will not use these in our extrapolation to the 114 countries.

2.2. Present policy in the 15 countries

Establishment of transparent, consistent long-term targets is an important driver for stakeholders in the public and private sectors and attracts both national and international energy investors. Targets need to be supported with regulatory-frameworks in order to be really effective. We learned in the in-depth studies that the opinion of the stakeholders on whether the regulations are considered effective varies considerably. In the following overview we mention the policy targets but not the extent to which these targets are supported by regulation.

The target for grid connection is also included in our research. It is important to note that it is not always clear what a country means by ‘grid connection’, as it can be confused with electrification. It sometimes includes stand alone or small local grid systems. Some countries have a target for the percentage of people who will have access to only a basic quantity of electricity, including small stand-alone systems for lighting and communications for example. Thus the reader is advised to take an impression from these figures only.

Biofuels are, for many countries, a relatively new type of energy. Targets are often quite low, to be reached within some years or a special quantity (for example 5 % of all the transport fuel in cities with more than 0,5 million people). We consider it more important to show that a country has a policy and target for biofuel than describing the target in detail which is likely to be out of date rather soon. So if the target can not be transformed into a simple % we state ‘yes’ or ‘no’ where there is/is not a biofuel target.

Targets for RE and grid connection

	RE- electricity		biofuels	total primary energy		grid connection	
	% of total electricity production	year		% of total primary energy use	year	% of poeple connected	year
Argentina	40	2015	5	no		100	
Brazil	70	2020	yes	10	2025	100	2008
Colombia	no		10	no		no	
Mexico	11	2010	5	no		98	2030
Peru	no		yes	no		91	2013
China	20	2020	yes	15	2020	100	
Fiji	80		no	no		yes	
India	25	2012-2020	yes	no		100	2012
Indonesia	no		no	10	2020	90	2020
Kiribati	10		no	no		no	
Thailand	8	2011	1	8	2011	99-100	
Vanuatu	no		no	no		no	
Cameroon	no		no	no		no	
Ghana	no		no	10	2020	yes	
Niger	no		no	10	2020	no	
South Africa	13	2020	no	1	2013	yes	
Uganda	no		no	no		no	

2.3. Market potential for the market technology combinations

The results of the scenario assessments for the 15 countries are presented here per market technology combination. We will add some comments relevant to these results. Also we will give details on the most important factors related to the specific market technology but will not explain in detail why there are differences between the scenarios and the countries (some factors are well known). We will also not mention the most common drivers and barriers which occur in almost all the countries like finance availability. See for this information the reports of the 15 in-depth countries studies. The three islands in the Pacific are combined under the name Pacific Islands.

Solar thermal	Present		Present	Scenarios 2020		Scenarios 2020	
	number installation	m2	m2/1000 inhabitants	Ref	Max	Ref	Max
Argentina	12.000	24.000	0,7	15.000	31.000	0,4	1
Brazil	500.000	2.100.000	11,4	1.2 mil	3.5 mil	7	19
Colombia	na	na	na	9.000	115.000	0,2	3
Mexico	na	600.000	5,7	750.000	1.300.000	7	12
Peru	8.000	na	0,6	26.000	181.000	1	7
China	40 million	80 million	61,9	150 mil	150 mil	116	116
Pacific Islands	>1000	na	1,8	pm	pm	pm	pm
India	700.000	1.000.000	0,9	1.3 mil	2 mil	1	2
Indonesia	150.000	400.000	1,8	350.000	2.8 mil	2	13
Thailand	50.000	na	1,5	58.000	165.000	1	3
Cameroon	pm	pm	pm	300	3.700	0,0	0,2
Ghana	750	na	0,0	1.200	2.200	0,1	0,1
Niger	pm	pm	pm	250	700	0,0	0,1
South Africa	na	750.000	16,0	1 mil	1.5 mil	21	32
Uganda	165	4.900	0,0	300	650	0,0	0,0

In the reference scenario the present quantity solar installations will in many countries be two folded in 2020. These countries support RE programmes and/or fiscal regulations for this technology. China is the only country with a target for the number of solar thermal installations.

Under the maximum scenario the installed number in 2020 will be substantial higher; up to ten folded the present quantity.

There is a great variation in the m2 of installation per 1000 capita.

Important factors for these variation are for example, whether it is common practice in a particular country to use hot water, the nuisance to use fossil energy and whether people in a climate without constant sunshine throughout the year accept variable-unreliable supply over the year (wealthier people in the cities will sometimes not accept unreliability and demand a backup system for example).

Another important factor is the present energy source for hot water preparation, especially when this is electricity where price and guarantee availability are under pressure.

Photo voltaic	Present		Scenarios 2020	
	MWp	Target	Ref MWp	Max MWp
Argentina	4.7	No	15	26
Brazil	5.2	No	50	130
Colombia	2.0	No	4	40
Mexico	15	No	16	55
Peru	3.7	Yes	10	31
China	70	Yes	300	1000
Pacific Islands	0.3	0	1.7	3.8
India	83	Yes	105	145
Indonesia	4.2	No	6	85
Thailand	24	Yes	275	575
Cameroon	0	Yes	0.0	0.4
Ghana	0.9	No	1.4	6.7
Niger	1.0	Yes	1.5	5.6
South Africa	6.5	No	14	115
Uganda	0.23	No	0.7	2.6

The present capacity photovoltaic in a country is directly related to the activities to bring electricity to areas at present not connected to the grid. The present capacity is less related to the percentage of household already connected to the grid; Brazil and Thailand for example have already a high grid connection.

For the reference scenario the achievable capacity is positively influenced if countries have a specific target for photovoltaic or have targets for rural electrification to be realized within RE systems, photovoltaic being one of them.

Very important for the further implementation of photovoltaic is the capacity in a country to organise service and maintenance. Furthermore the information of the local expert for the in-depth study showed that there are regions where small solar home systems do not fulfil the energy demands of the people. Photovoltaic will then be regarded as second best compared with grid connected or small fossil fueled power systems.

Wind

	Present		Scenarios 2020	
	MW	Target	Ref MW	Max MW
Argentina	27	Yes	315	7,500
Brazil	28	Yes	3,300	20,000
Colombia	19.5	No	90	1,250
Mexico	2.6	No	105	9,400
Peru	0.7	Yes	6	65
China	570	No	7,000	30,000
Pacific Islands	0.0	na	0	0
India	4500	Yes	12,500	20,000
Indonesia	0.4	na	1,4	100
Thailand	0.7	Yes	135	330
Cameroon	pm	Yes	pm	pm
Ghana	0.3	na	0.3	0.3
Niger	pm	No	pm	0.8
South Africa	3.2	No	18	200
Uganda	pm	No	pm	pm

Apart from India and China the present capacity is rather low, although many countries have small wind systems, but they do not contribute much in the total MW capacity

Some countries have a specific target for wind, others have targets for rural electrification to be realised through RE systems, part of which includes wind. Countries that have a large potential for hydro and countries where industrialisation and skills are low, have a smaller realistic potential for wind energy than other countries.

Small and medium hydro	Present		Scenarios 2020	
	MW	Target	Ref	Max
Argentina	280	No	350	550
Brazil	2500	Yes	3,250	12,300
Colombia	84	No	165	650
Mexico	134	No	230	1,900
Peru	39	Yes	46	60
China	34,000	No	69,000	80,000
Pacific Islands	0.6	na	1.2	1.2
India	1694	Yes	4,650	15,000
Indonesia	210	No	360	770
Thailand	200	Yes	560	900
Cameroon	na	Yes	0.2	5.0
Ghana	na	No	0.2	2.0
Niger	na	na	0.2	2.2
South Africa	68	No	100	1700
Uganda	0.01	No	30	115

As stated before the countries do not have the same definition of small and medium hydro, we respect the definition a country determines. The present capacity in the 15 countries varies a lot, not only caused by the natural conditions as can be deduced from the growth of the capacity in the reference scenario.

Some countries have a specific target for small and medium hydro, others have targets for rural electrification to be realized through RE systems, part of which includes hydro (small, large and refurbishments). It is obvious that countries that don't have many rivers suitable for hydro have lower realistic potential. Where there is greater theoretic potential, a policy to develop new local grids and/or facilitative regulation to deliver the electricity to the grid positively influences the realistic potential the most.

Large hydro

Large hydro is not considered as a renewable energy technology in the RECIPES project and we did not assess the situation of large hydro in detail and did not create scenarios for its future development. (see chapter 2.1).

Only existing large hydro, planned new hydro (reference scenario) and targets or ambition (maximum scenario) are taken into account.

- The present capacity is 68MW
- Included in the reference scenario is the planned large hydro in 12 of the 15 countries; the countries without plans are Argentina, Ghana and South Africa. The total capacity in the reference scenario is 110 MW
- In the maximum scenario we also take in account the ambition for new large hydro, China, India Indonesia, Cameroon, Ghana and Cameroon. The total capacity in the is 152 MW

Geo thermal	Present		
	MW	kind of energy	Target
Argentina	150	heat	No
Brazil	16	heat	No
Colombia	0		No
Mexico	960	electricity	No
Peru	0		No
China	32	electricity	No
Pacific Islands	0		Yes
India	0		No
Indonesia	812	electricity	yes
Thailand	0.3	electricity	No
Cameroon	0		No
Ghana	0		No
Niger	0		No
South Africa	0		No
Uganda	0		Yes

Three countries have set a target for geothermal use;

- Vanautu in the Pacific has some projects
- Uganda intends to produce 143 GWh yearly
- Indonesia has atarget of 6000 MWe in 2020.

Potential studies are available for four more countries (Brazil, India, Mexico and Thailand) In Brazil and Argentina geothermal energy is only used for heat in small industries or tourist accommodations.

The information we received from our local experts included some perceived barriers for further development (eg. geographic site, drilling cost), which was unfortunately not substantial enough to be able to calculate scenarios according to the method RECIPES is using.

Biomass

wood and
plantation

Present	
MW	Target

Argentina	20	No
Brazil	3049	Yes
Colombia	1340	No
Mexico	0	No
Peru	0	No

China	na	No
Pacific Islands	19	No
India	260	No
Indonesia	0	No
Thailand	0	No

Cameroon	790	na
Ghana	5	No
Niger	0	No
South Africa	0	No
Uganda	na	No

Biomass

waste (industry
and households)

Present	
numbers industries	yearly energy production TWh

Argentina	5	0
Brazil	354	14
Colombia	no information	0
Mexico	59	0
Peru	3	0

China	yes unknwon	20 billion m3 gas
Pacific Islands	5	2
India	yes, unknown	0
Indonesia	2	0
Thailand	600	na

Cameroon	no information	0
Ghana	yes, unknown	0
Niger	no information	0
South Africa	4	0
Uganda	0	0

There is not a unique, globally accepted definition concerning RE biomass or biomass non renewable. Even traditional biomass is sometimes regarded renewable though the real sources are often unknown. The Recipes project distinguishes 'traditional biomass' (which most countries have estimated), 'biomass from wood and plantation' and 'biomass from waste, mostly used by industry'.

The two latter categories are often mixed by different parties.

Only one third of the RECIPE's countries give an impression of the energy quantity produced by wood biomass and waste. That is not so remarkable considering that many industries only produce this type of energy for their own consumption (due to lack of surplus or that independent private producers are unable to integrate into the energy supply system). The lack of information about the present situation implies that there is no use in defining various scenarios. The variables are too diverse. For the relevant countries we estimated potential growth which is incorporated in the maximum scenario.

Biofuels

Biofuels are, for many countries, a relatively new type of energy. Targets are set for the short-medium term (2007, 2010 or 2012) and energy policy for biofuel is generally in a development stage. We indicate the present production of the fuels for transport means and whether a country has set a target or not. In the figures belows ethanol is presented in billion litres and biodiesel in million liters.

Ethanol	Present		Scenarios 2020	
	billion l / year	Target	Ref	Max
Argentina	pm	No	pm	1
Brazil	15	Yes	25	54
Colombia	0	Yes	0.3	0.7
Mexico	No	No	na	na
Peru	No	No	0.4	0.6
China	0.9	Yes	10	10
Pacific Islands	No	No	0	0
India	0.3	Yes	10	15
Indonesia	pm	Yes	1.5	3
Thailand	na	Yes	1.1	4
Cameroon	pm	Yes	0	0
Ghana	No	No	0	0
Niger	No	No	0	0
South Africa	pm	No	0	**
Uganda	No	No	0	0

**= combined with biodiesel

Biodiesel	Present		Scenarios 2020	
	million l / year	Target	Ref	Max
Argentina	pm	No	pm	3,300
Brazil	8	Yes	2,500	11,500
Colombia	na	Yes	na	**
Mexico	No	No	na	na
Peru	No	No	0	**
China	0.04	Yes	1,000	1,000
Pacific Islands	No	No	pm	0.02
India	2	Yes	15	34
Indonesia	pm	Yes	2,300	3,100
Thailand	128	Yes	900	3,100
Cameroon	pm	Yes	0.0	0.0
Ghana	No	No	0.0	0.0
Niger	0.0	No	0.0	0.0
South Africa	pm	No	na	na
Uganda	No	No	pm	0

** = combined with ethanol

The potentials we assessed in the scenario studies could in fact be higher due to 1.improvements in technology, 2. opportunities to use new sources like other agro-waste and 3. changes in policy.

2.4. RE contribution Total Primary Energy Supply for 15 countries

The following tables illustrate the present and possible future total RE Supply and the percentage of it used to generate electricity relative to the Total Primary Energy Source (TPES) over 15 countries in 3 continents.

The tables show for each country the primary energy supply and the renewable energy contribution in this supply. The renewable energy is shown including and excluding large hydro. The amount RE excluding large hydro stands is the summation of the RE production for generating electricity (except with large hydro), for transportation and heating and cooling. The renewable electricity percentages based on the total electricity production, also not on the (fossil) energy needed to produce the electricity. The lower parts of the tables give the summation of the 15 countries and the summation of the five countries for each continent.

RE contribution

	Present						
	Total primary energy MTOE	Renewable total energy				Renewable electricity	
		incl large hydro MTOE	%	excl. large hydro MTOE	%	incl large hydro %	excl. large hydro %
Argentina	69	6	8%	2.8	4%	43%	1.6%
Brasil	207	84	41%	58.3	28%	74%	5.1%
Columbia	28	4	13%	0.2	1%	81%	3.4%
Mexico	163	5	3%	2.8	2%	11%	2.4%
Peru	12	1.9	15%	0.4	2.9%	83%	2.8%
China	1326	37	2.8%	13.3	1.0%	20%	5.4%
Pacific	1	0.2	19%	0.1	14%	61%	3.1%
India	578	8	1%	1.7	0.3%	19%	4.0%
Indonesia	182	5	3%	4.3	2%	13%	3.4%
Thailand	92	0.7	1%	0.1	0.1%	6%	0%
Cameroon	7	0.3	4.5%	0	0%	96%	0%
Ghana	9	0.5	5.3%	0	0%	85%	0%
Niger	2	0.0	0.0%	0	0%	0%	0%
South Africa	112	0.2	0.2%	0.1	0.1%	1%	0%
Uganda	9	0.1	1.2%	0	0%	82%	8.7%
15 countries	2796	152	5.4%	84	3.0%	26%	4%
total 5 countries in Latin America	479	100	21%	65	13%	52%	4%
Asia	2179	51	2%	20	1%	19%	5%
Africa	138	1	1%	0.1	0.1%	6%	0.3%

The present situation across the continents shows that large hydro produces almost 50% of the present RE production (3 of the 5.4% RE contribution) In Latin America large hydro produces even 65% of all the RE production. The important issue for



developing countries to consider is whether these large hydro power plants and also the medium and small hydro power plants, afford better management, better maintenance, improved skills and resources in order to capitalise from the existing investment for the longer term. These cost effective measures can benefit communities in the shorter term compared with less market ready technologies. Assessments for the need for refurbishment should be calculated using local expertise as well as national experts. In many countries hydro is suffering from lack of constant water supply and countries which rely heavily on hydro for electricity production are emphasising the need for diversification of sources.

The present RE production in the five African countries is the lowest, both in quantity and in percentage.

At country level, it is Brazil which has the largest RE production excluding large hydro, both in quantity and in percentage. The use of biofuel is debit on this. In the Pacific Island the % RE is rather high because of the use of biomass waste. Of course the quantity is not so high, these Island are relatively small compared to the other countries in the Recipes study.

**RE
contribution**

2020 reference scenario							
Total primary energy MTOE	Renewable total energy					Renewable electricity	
	incl large hydro		excl. large hydro		incl large hydro %	excl. large hydro %	
	MTOE	%	MTOE	%			

Argentina	111	6	5%	3.2	3%	24%	1.7%
Brasil	423	96	23%	65.7	16%	47%	5.5%
Columbia	46	4	9%	0.3	1%	84%	4.4%
Mexico	229	5	2.4%	3.0	1.3%	9%	2.2%
Peru	15	2.3	16%	0.6	4.1%	62%	2.9%
China	2181	103	4.7%	52.2	2.4%	23%	5.7%
Pacific	1	0.2	18%	0.1	12%	76%	6.1%
India	935	17	2%	5.1	0.5%	18%	4.2%
Indonesia	263	9	3.5%	5.8	2.2%	20%	2.3%
Thailand	161	5.7	4%	4.6	2.9%	10%	3%
Cameroon	8	0.4	4.8%	0	0.0%	65%	0%
Ghana	15	0.5	3.2%	0	0.1%	18%	1%
Niger	4	0.1	1.4%	0	0.0%	54%	0%
South Africa	199	0.5	0.2%	0.3	0.2%	1%	0%
Uganda	11	0.2	1.7%	0	0.2%	26%	3.4%
15 countries total	4600	251	5.5%	141	3.1%	24%	5%
5 countries in Latin America	823	113	14%	73	9%	36%	4%
Asia	3541	136	4%	68	2%	21%	5%
Africa	236	2	1%	0.4	0.2%	5%	0.3%

The reference scenario is based upon a continuation of the present situation including the estimated impact of existing policy measures. In the Recipes study large hydro was not studied as one of the RE technologies, only the already planned new large hydro power stations are including in the scenarios. The RE contribution in 2020 including large hydro can therefore, in some countries, be higher than is presented here.

The RE-contribution excluding large hydro in the 15 countries together increases from 84 to 141 Mtoe. Due to the growth of the energy demand the % RE contribution remains the same, 3 %. In the five Latin America countries this percentage even drops from 13 to 9%. In Asia the quantity RE technologies produce increases from 19 to 68 Mtoe, the percentage however only increase from 1 to 2 %. In the five African countries the absolute contribution five folded the percentage RE remains low 0.1 %

Brazil is, as it was in the present situation, also in this reference scenario the country with absolute and in % the country with the highest RE contribution, due to the present RE situation and the energy policy of Brazil.

Other countries with a RE target (China, Indonesia, Thailand, Ghana and South Africa) do not reach their targets set. There is a clear need that these targets need to be supported by reliable regulations including finance support from the country or abroad and measures in order to nurture sustainable RE industry.

RE contribution

	2020 maximum scenario						
	Total primary energy MTOE	Renewable total energy				Renewable electricity	
		incl large hydro MTOE	%	excl. large hydro MTOE	%	incl large hydro %	excl. large hydro %
Argentina	101	14	14%	11	11%	48%	26.8%
Brazil	414	121	29%	91	22%	64%	22.7%
Columbia	45	5	11.5%	1.6	3.6%	89%	13.9%
Mexico	226	13	5.8%	11	4.7%	15%	9.1%
Peru	15	2.4	16%	0.7	5.1%	62%	3.0%
China	2031	190	9.3%	110	5.4%	42%	14.8%
Pacific	1	0.2	24%	0.2	18%	79%	15.9%
India	931	39	4%	17	1.8%	30%	8.9%
Indonesia	263	17	6.6%	10	4.0%	38%	10.0%
Thailand	161	10	6%	9	5.4%	10%	4%
Cameroon	8	0.6	7.7%	0	0.0%	95%	0%
Ghana	14	0.6	4.5%	0	0.2%	25%	1%
Niger	4	0.1	2.5%	0	0.4%	94%	14%
South Africa	196	1.4	0.7%	1.3	0.6%	5%	4%
Uganda	10	0.6	5.9%	0	1.0%	81%	12.3%
15 countries	4419	415	9%	263	5.9%	39%	13%
total 5 countries in Latin America	801	156	19%	115	14%	49%	17%
Asia	3386	256	8%	146	4%	38%	13%
Africa	232	3	1%	1.4	0.6%	11%	3.9%

The maximum scenario is based upon positive but realistic changes in drivers and barriers. In this scenario the increase of large hydro is limited to the already planned large hydro power stations and the targets or ambition in five countries.¹

The RE-contribution excluding large hydro in the 15 countries together increases from 84 to 263 Mtoe. Due to the growth of the energy demand the % RE contribution excluding large hydro is not three folded but increases from 3 to 6%. In the five Latin America countries this percentage remains almost the same 13-14%. In Asia the quantity RE technologies produce increases from 19 to 146 Mtoe, the percentage however increase from 1 to 4%.

In the five African countries the absolute contribution ten folded, the percentage RE increases from 0.1 to 0.6%

China is the country with the largest absolute RE contribution followed by Brazil which has the largest RE percentage 22% compared with the 5% in China.

¹ Please Note:

TPES total primary energy supply can be less in the maximum scenario than the reference scenario due to the fact that in the reference scenario more fossil energy is needed to fulfil the demand of electricity and because of the losses by transformation from fossil fuel to electricity the total energy supply is higher than where RE is producing the electricity.



Latin America

The total for the five countries in Latin America, the continent with the highest percentage RE part of TPES in the maximum scenario, is buoyed by the strong present position of Brazil. However the reference scenario and the maximum scenario for Brazil show significant dips, highlighting the need for continuing ambitious RE policy backed up by robust and reliable measures to be able to sustain RE industry growth for the longer term. Argentina sustains constant growth through the scenarios with a significant increase in RE electricity in the maximum max scenario 2020 at 26.8% excl. large hydro.

Asia

The five Asian countries have the largest absolute RE contribution in the maximum scenario. The pressing need for reliability of supply and increase in capacity in order to keep up with fast paced economic growth in China and India provides the greatest incentive for these countries to implement sustainable RE policy and measures. Volatile imported fuel costs also stimulate RE development. The incentives are undeniable and acknowledged. The maximum scenarios show a potential increase of RE in TPES from 2-5 % by 2020.

China's RE % electricity production increases from 5 to 15%, even if the electricity demand is rising in the period till 2020. This percentage increase from 20 to 42% when including large hydro. For India this growth is 3% including and 6% excluding large hydro. Notably, India suffers at the reference scenario if no change is implemented towards longer term development.

Thailand which has a firm policy and target towards RE reaches also a high RE percentage; 5.4% excluding large hydro. In the Pacific Islands it is possible that some countries could produce biofuels from agro waste leading to a higher RE percentage of 17%.

Africa

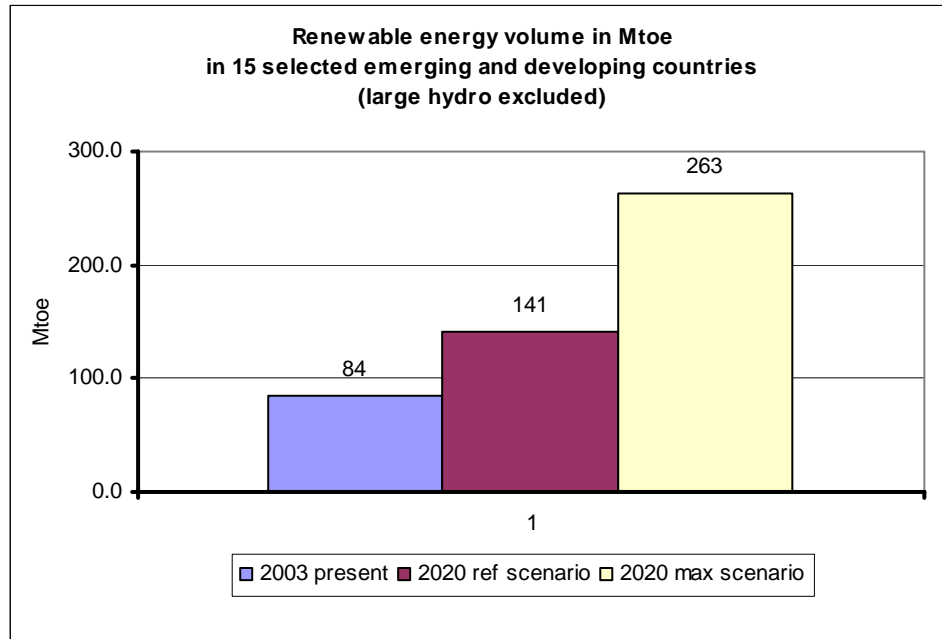
The five countries in Africa improve by only around 1 percentage point of RE in TPES in the maximum scenario 2020, which is still relatively low. The RE increases only marginally over that 14-year term.. The influence of some large hydro dams (eg in Niger) is obvious as the major contributor of RE electricity.

Results for South Africa, the biggest RE contributor of the five countries in the continent, show most important benefits from implementing measures towards the maximum scenario only. Its present position however leads to no significant progress in development at the reference scenario. Uganda shows promising results in the max scenario for RE electricity excl. large hydro, 3.6 percentage points from the present scenario. Although this percentage dips significantly in the reference scenario.

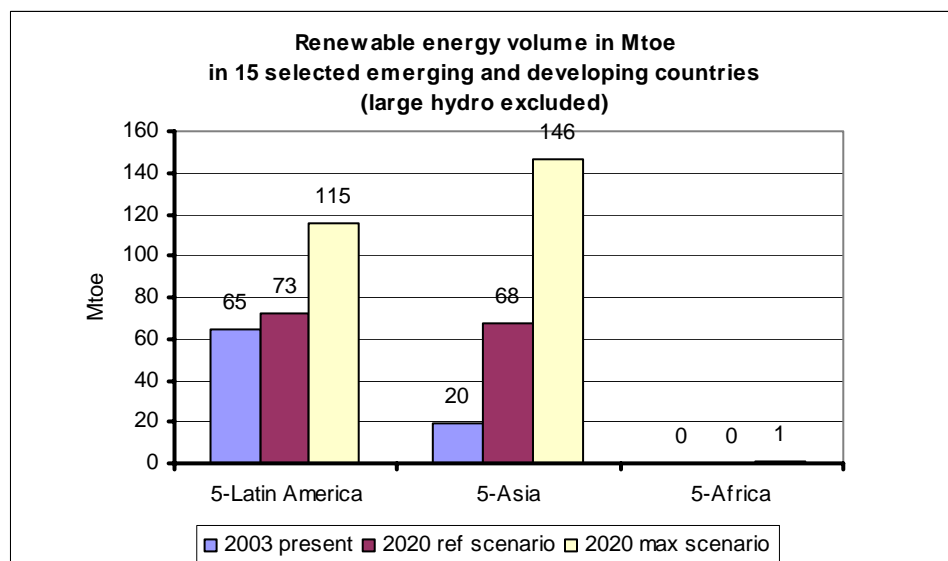
These results highlight the critical need for RE development support from developed nations, especially for infrastructure, grid connections, market development etc. Climactic and political volatility and economical instability provide stimulants and deterrents for the development of RE in Africa today.

The total RE volume (excluding large hydro) in Mtoe in the present situation and in the scenarios is given in the figure below.

The RE volume in 2020 can increase with 75 % in 2020 in the reference scenario. In the maximum scenario the RE production is almost twice as high as in the reference scenario.



The RE volume per region in the present situation and in 2020 is given in the figure below.

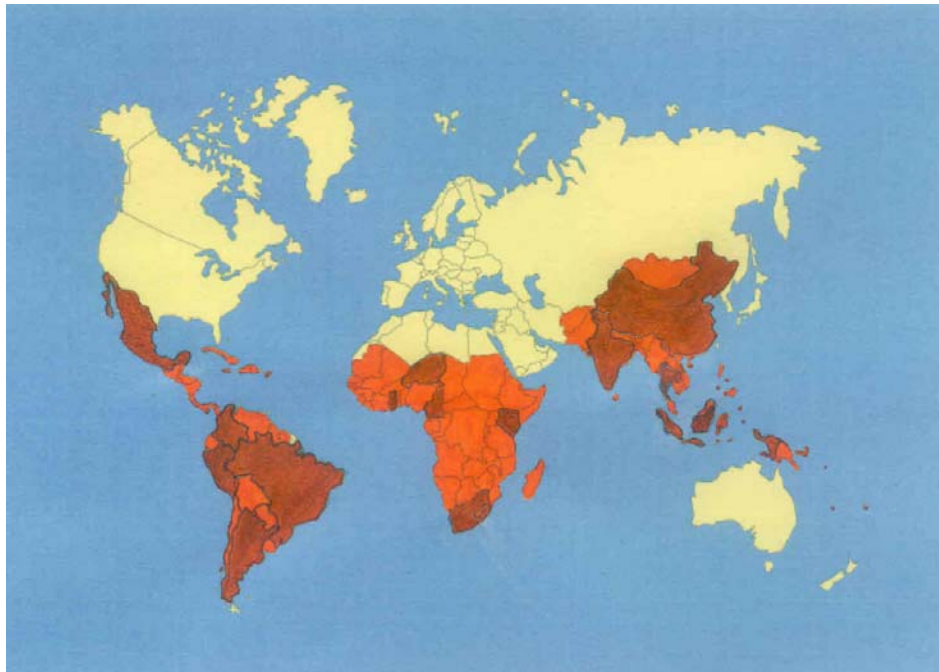


3. Indicators for 114 developing and emerging countries

3.1. Methodology for assessing potentials for all 114 countries

To assess the RE market potential of the 114 countries we first present an overview of the existing energy situation. Using the results of 15 in-depth studies for selected countries, we then give an impression of the potential and the drivers and barriers for the implementation of renewable energy.

The map below shows the 114 countries (red and deep red colored) and the 15 selected countries (deep red colored). In Latin America the 5 countries of the in depth studies covers almost all the region, in Asia they cover more than 70% and in Africa they represent only a small part.



The information on the 99 countries was gathered from publicly accessible sources, like surveys, statistical data from the internet, books and other publications, freely available. This information is available at the RECIPES website with reporting tools for extracting this data and comparing countries; an overview of the data can also be found in annex to this report.

The information consists of:

1. indicators and indices
2. description of the relevant energy items/subjects /themes



Indicators and indices

This concerns basic information on the general situation in a country, the economy, relevant social factors, energy development and the use, production and consumption of energy. The more than 70 indicators (mostly gathered in the second part of 2005) can for some countries be outdated due to important changes like a boost of the economy, war and other instability in a country.

Two comments on this data

- The data set includes the data of the 15 countries for which an in-depth study has been carried out. This data sometimes deviates from that provided by the local expert. The basic information for the 15 countries is then substitute in the database for the 114 country list by the information from local experts.
- For a number of countries the available energy information is limited and data at the level RECIPES requires could not be supplied. Other organisations including the IEA and EIA do not have this data either.

Description of the relevant energy items/subjects /themes

As it is quite difficult to present an overview of the energy situation in a country by using only indicators and numbers, for each country short descriptions of the major energy issues are gathered. The themes are:

- Environmental issues
- Energy situation
- Energy sector organization
- Renewable energy potential
- Renewable energy.

Naturally the level and the amount of information available differ per country, just as it is the case with indicators and numbers.

3.2. Clusters of countries

We grouped the countries not on geographic basis but on their present economic and energy development. We then compared this group of countries with the characteristics of the 15 countries for which we carried out the in-depth studies.

The groups based on the economic development. The main factor the form the groups is the income/capita followed by the energy development

We distinguish four groups.

Poorest - Poor - Modest - Richest countries

The characteristics of these groups are shown in the following pages. Some countries energy statistics were not available. For the extrapolation of the results from the in-depth studies we have averaged the uses of similar countries.

Characteristics of the groups

The information of the four groups of countries given below is a segment of all the information gathered for the 114 countries. The countries accentuated yellow are part of the in-depth study.

The group 'Poorest countries'

Income per capita	< \$ 1500 / capita
Energy development index	< 0.2
Population below poverty line	More than half of the countries have >50% of the population below the poverty line
Grid connection	2-50 %
Average TPES/capita	0.45 toe/capita

		People connected to the grid (electricity)	Traditional fuel consumption	Energy production	Net Imports	TPES primary energy supply
unit		%	(% of total energy requirements)	Mtoe	Mtoe	Mtoe
East Timor	Pacific					
Burundi	Africa		96.6			
Malawi	Africa	5.8	86.6			
Sierra Leone	Africa	0	92			
Somalia	Africa	0	0			
Comoros	Africa					
Congo (D R.)	Africa	19.6	65.6	12.11	-11.08	1.03
Guinea-Bissau	Africa	0	66.7			
Tanzania	Africa	9.2	92.8	16.03	1.15	17.15
Afghanistan	Asia	2				
Congo (Republic)	Africa	8.3	94.6	16.55	-0.66	15.88
Ethiopia	Africa	2.6	95.2	18.9	1.33	20.51
Kiribati	Pacific		23	0	0.03	0.03
Madagascar	Africa	8.3	84.4			
Eritrea	Africa	18.4	77.8	0.56	0.27	0.81
Liberia	Africa	0	0			
Mali	Africa		88.3			
Niger	Africa	0	77.3	0.12	na	1.7
Zambia	Africa	18.4	87.1	6.35	0.39	6.69
Nigeria	Africa	44.9	82.3	214.58	-116.22	97.79
Central African R.	Africa		87.5			
Kenya	Africa	9.1	70.6	13.49	2.69	16.17
Tuvalu	Pacific	0	0			
Benin	Africa	24.8	81.9	1.58	0.75	2.31
Burkina-Faso	Africa	10	91.7			
Mozambique	Africa	8.7	90.5	7.99	0.28	8.2
Sao Tome and P.	Africa					
Djibouti	Africa	0	0			
Rwanda	Africa	0	92.8			
Bhutan	Asia	0	84.1			
Cape Verde	Africa					
Côte d'Ivoire	Africa	50.7	75.1	6.69	-0.02	6.58
Haiti	Caribbean	33.5	54	1.67	0.56	2.24
Nepal	Asia	25.9	88	7.79	0.96	8.75
Uganda	Africa	5	95	0	0.4	8.7
Chad	Africa	2	97.8			
Marshall Islands	Pacific					
Togo	Africa	17	88.6	1.87	0.73	2.6



**DEVELOPING
RENEWABLES**
Renewable Energy that benefits all



This group of countries contains many countries for which not much information on public sources is available. Government and/or energy experts in these countries however can have more information available as we learned in our in depth study for Kiribati, Niger and Uganda.

In this group of 37 countries, only one belongs to Latin America (and the Caribbean) and 7 to Asia, the rest is part of Africa.

The group 'Poor countries'

Income per capita	Between \$1500 and \$ 3000 /capita
Energy development index	Between 0.15 and 0.4
Population below poverty line	A quarter of countries have >50% of the population below the poverty line
Grid connection	2-80 %
Average TPES/capita	0.5 toe/capita

		People connected to the grid (electricity)	Traditional fuel consumption	Energy production	Net Imports	TPES primary energy supply
		%	(% of total energy requirements)	Mtoe	Mtoe	Mtoe
Chad	Africa	2	97.8			
Marshall Islands	Pacific					
Togo	Africa	17	88.6	1.87	0.73	2.6
Senegal	Africa	31.4	72.5	1.74	1.53	3.19
Solomon Islands	Pacific		66.7			
Gambia	Africa		71.4			
Mauritania	Africa	0	36.9			
Cameroon	Africa	40.7	71.6	12.13	-5.49	6.75
Laos	Asia	0				
Mongolia	Asia	90				
Sudan	Africa	31	80.1	26.97	-10.21	16.62
Zimbabwe	Africa	40.9	68.6	8.53	1.03	9.67
Bangladesh	Asia	26.3	63.6	17.53	4.33	21.68
Cambodia	Asia	18.3	95.1			
Micronesia	Pacific		80			
Angola	Africa	5	79.2	50.73	-41.78	9.12
Guinea	Africa		90.6			
Pakistan	Asia	53	26.6	55.49	14.22	69.31
Papua New Guinea	Pacific	0	68.6			
Ghana	Africa	48.5	84.5	5.99	2.5	8.49
Nicaragua	Latin America	46.6	54.6	1.8	1.31	3.1
Tonga	Pacific		85			
Bolivia	Latin America	65.1	23.6	7.73	-3.44	4.45
Equatorial Guinea	Africa	0	75			
Vietnam	Asia	79.6	32.5	54.53	-10.27	44.26
Honduras	Latin America	60.1	62.1	1.66	2.2	3.6
Saint Vincent and Grenadines	Caribbean					
Vanuatu	Pacific		50			

This group of countries also contains many countries for which not much information on public sources is available.

In this group of 28 countries, only 4 belong to Latin America (and the Caribbean), 12 to Asia and 12 to Africa.

The group 'Modest countries'

Income per capita	Between \$ 3000 and \$ 7500 /capita
Energy development index	Between 0.3 and 0.7
Population below poverty line	A third of the countries have >50% of the population below the poverty line
Grid connection	5-99 %
Average TPES/capita	0.8 toe/capita

		People connected to the grid (electricity)	Traditional fuel consumption	Energy production	Net Imports	TPES primary energy supply
		%	(% of total energy requirements)	Mtoe	Mtoe	Mtoe
Cuba	Carribbean	95.8	24.5	6.66	4.63	11.22
India	Asia	44.4	24.3	455.29	99.51	553.39
Lesotho	Africa	5	0			
Indonesia	Asia	52.5	24.8	249.96	-88.04	161.55
Niue	Pacific	0	0			
Ecuador	Latin America	89.7	22.5	23.62	-13.26	9.1
Guyana	Carribbean	0	47.6			
Maldives	Asia		0			
Sri Lanka	Asia	65.5	34.8	4.29	3.82	8.11
Jamaica	Carribbean	87	8.5	0.47	3.66	4.06
Guatemala	Latin America	84.4	65.3	5.47	1.95	7.29
Suriname	Carribbean	0	6.7			
Paraguay	Latin America	85.3	28.7	6.62	-2.7	3.99
El Salvador	Latin America	76.9	39.9	2.39	2.1	4.49
Cook Islands	Pacific	0	0			
Grenada	Carribbean		0			
Nauru	Pacific					
Philippines	Asia	89.1	33.4	22.5	19.96	42.12
Swaziland	Africa	0	0			
Saint Lucia	Carribbean					
Dominica	Carribbean					
China	Asia	99	7.8	1,380.79	39.82	1,409.38
Peru	Latin America	75.7	25.4	9.44	3.27	12
Samoa	Pacific	0	33.3			
Venezuela	Latin America	94	2.6	179.62	-124.73	54.23
Fiji	Pacific	0	32.1			
Gabon	Africa	47.9	21.3	12.42	-10.75	1.68
Dominican Rep.	Carribbean	92.3	11.3	1.55	6.42	7.97
Belize	Carribbean	0	31.3			
Colombia	Latin America	90.2	19.1	74.36	-44.87	28.37
Panama	Latin America	85.1	20.2	0.69	1.9	2.61
Namibia	Africa	34.7	0	0.31	0.95	1.26
Seychelles	Africa					

This group of countries contains some small countries for which not much information on public sources is available.

In this group of 32 countries, only 4 belong to Africa, 11 to Asia, and 17 to Latin America (and the Caribbean)

The group 'Richest countries'

Income per capita	More than \$ 7500 /capita
Energy development index	More than 0.6
Population below poverty line	Only a few countries have >50% of the population below the poverty line and 40% of the countries has less than 20% of the population below poverty line
Grid connection	90-99 %
Average TPES/capita	1.5 toe/capita

		People connected to the grid (electricity) %	Traditional fuel consumption (% of total energy requirements)	Energy production	Net Imports	TPES primary energy supply
				Mtoe	Mtoe	Mtoe
Brazil	Latin America	94.6	35.7	171.14	25.63	193.24
Thailand	Asia	91.1	15.9	48	42	88
Saint Kitts and Nevis	Caribbean		50			
Palau	Pacific					
Botswana	Africa	26.4	0			
Costa Rica	Latin America	97	30.1	1.63	2.06	3.67
Mexico	Latin America	0	15	242.51	-82.61	159.94
Malaysia	Asia	97.1	2.3	83.84	-27.81	56.65
Trinidad and Tobago	Caribbean	99	0.7	28.84	-16.67	11.1
Chile	Latin America	97	16.2	8.34	18.75	26.27
Antigua and Barbuda	Caribbean					
South Africa	Africa	67.1	12.95	154.48	-32.6	118.57
Argentina	Latin America	95	3.9	84.32	-23.96	59.85
Mauritius	Africa	0	30.4			
Uruguay	Latin America	99	39.1	1.16	1.84	2.52
Barbados	Caribbean	0	5.9			
Bahamas	Caribbean	0	0			
Brunei	Asia	99.2	0	21.22	-18.52	2.68
Singapore	Asia	100	0.1	0.14	39.3	22.43

This group of countries contains some small countries for which not much information on public sources is available.

In this group of 18 countries, only 3 belong to Africa, 5 to Asia, and 10 to Latin America (and the Caribbean)

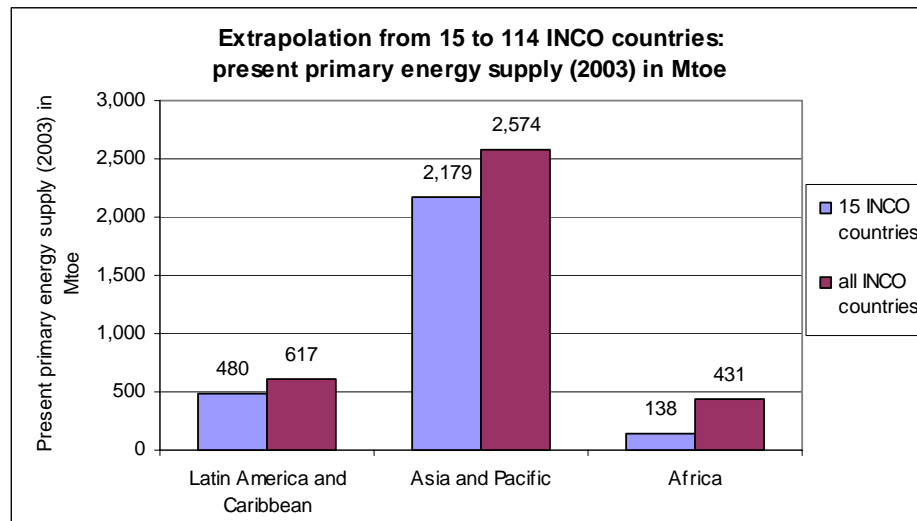
4. Renewable energy market potential for 114 countries in 2020

The potential in 2020 is based on the characteristics of the present situation and the realistic market potential assessed for the 15 countries of the in-depth study. The potential in this study is in generally given as a percentage of RE within the total primary energy supply (TPES), the same indicator as is often used for a RE target.

4.1. Assessment of the present energy demand

The total primary energy demand is available for most countries. In case this figure is not available it is assessed on base of the mean energy demand per capita in the group. The present RE contribution is only available for a small group of countries (except for the 15 countries of the in dept study). The electricity production of hydro power plants however is available for many countries. This number contains the production of all hydro plants, a partition of large hydro production, as was carried out for the 15 in depth studies is not possible.

The figure below shows the present energy supply of the 114 countries per region. This figure clearly shows that the in depth studies for the 15 countries covers a great large part of the total energy supply of the 114 countries; in percentage it is 75%.



4.2. Assessment of the present RE volume

The present volume of RE in the 114 countries is not available. The percentage RE in the total primary energy supply is only known for 60% of the countries and often includes a part traditional biomass. So it is impossible to give a solid figure for the present RE volume in the 114 countries. Instead we use the figure for the RE volume excluding large hydro for the 15 countries, this is 84 Mtoe. We estimate that in reality this amount can be 5 till 20 Mtoe higher, so we added 12 Mtoe for the other countries. The total electricity production by hydro is more accurate; we add this to the volume RE excluding large hydro.

4.3. Assessment of the energy demand in 2020.

Firstly the TPES in 2020 has to be estimated. In order to do this we distinguished the fossil fuel energy use, the use of traditional biomass and the present use of RE (mostly large hydro). We assume that the traditional biomass use will remain the same despite the growth of the population; the relative decrease of traditional biomass use will be the result of more efficient use of the biomass and substitution with fossil energy.

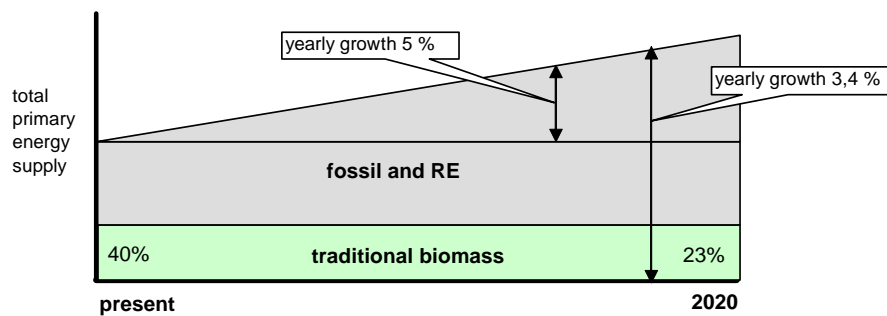


Figure: Fictive example of the growth of primary energy supply in relation to the use of traditional biomass

The fossil energy growth of the various countries till 2020 depends on their present and future economic development. The presence of fossil energy reserves seems for the underdeveloped countries of less importance for the energy growth. Fossil energy is just one of the riches of any given country as are minerals, vegetation, agricultural conditions; the extent to which a country can enjoy these riches is influenced by many factors. In the more developed countries the presence of fossil fuel reserves is not a leading factor for energy growth; the reserves influence the energy policy to a great extent.

The yearly energy growth is derived from the energy growth of the countries for which an in-depth study was carried out. The yearly energy growth as is used in other studies like the IEA is only available for whole regions and continents.

The energy growth of the clusters of countries is shown in the table below.

Energy growth

	Total primary energy supply MTOE Present situation (mostly 2003)	Yearly growth fossil part	Yearly growth including fossil and traditional biomass
Poorest countries	330	5 %	1%
Poor countries	400	5 %	1.9 %
Modest countries	3700	3.5 %	2.8 %
Richest countries	1400	4.5 %	3.9 %

4.4. Assessment of the realistic market potential

The realistic market potential for renewable energy is based upon the results of the in-depth studies. This RE potential is assessed for different scenarios, based on the present situation including policy (the reference scenario) and variations of various market drivers and barriers. For the extrapolation to all the countries we use the reference scenario and the scenario that lead to the largest contribution of RE, ie the maximum scenario.

The potential is first calculated for the four groups of countries (poorest, poor, modest and richest) with a weighted RE contribution per capita. We do not present here these results but give the results after clustering the countries in the three regions. Some corrections have been made;

- Due to the present amount of large hydro and the growth of large hydro in some specific countries the calculation was carried out without large hydro. Large hydro per region was added later on. So a possible growth of large hydro in the 99 countries is not taken into account.
- The 15 countries involved in the in-depth studies compared to the 114 countries show relatively more large hydro. Hydro is an important energy source for the countries in this study; the 114 countries have 280 MW hydro installed being 40% of the present world capacity, the electricity production numbers we have gathered for these 114 countries show that the electricity production is also around 40% of the present world hydro production
- The influence of some countries in a group was so large that with a simple extrapolation the RE volume in some countries of the in depth studies would change too much if the same extrapolation was used.(for example the outcome for South Africa with relative low RE volume was influence by the large RE amount of some Latin American countries). This was corrected for the specific countries.

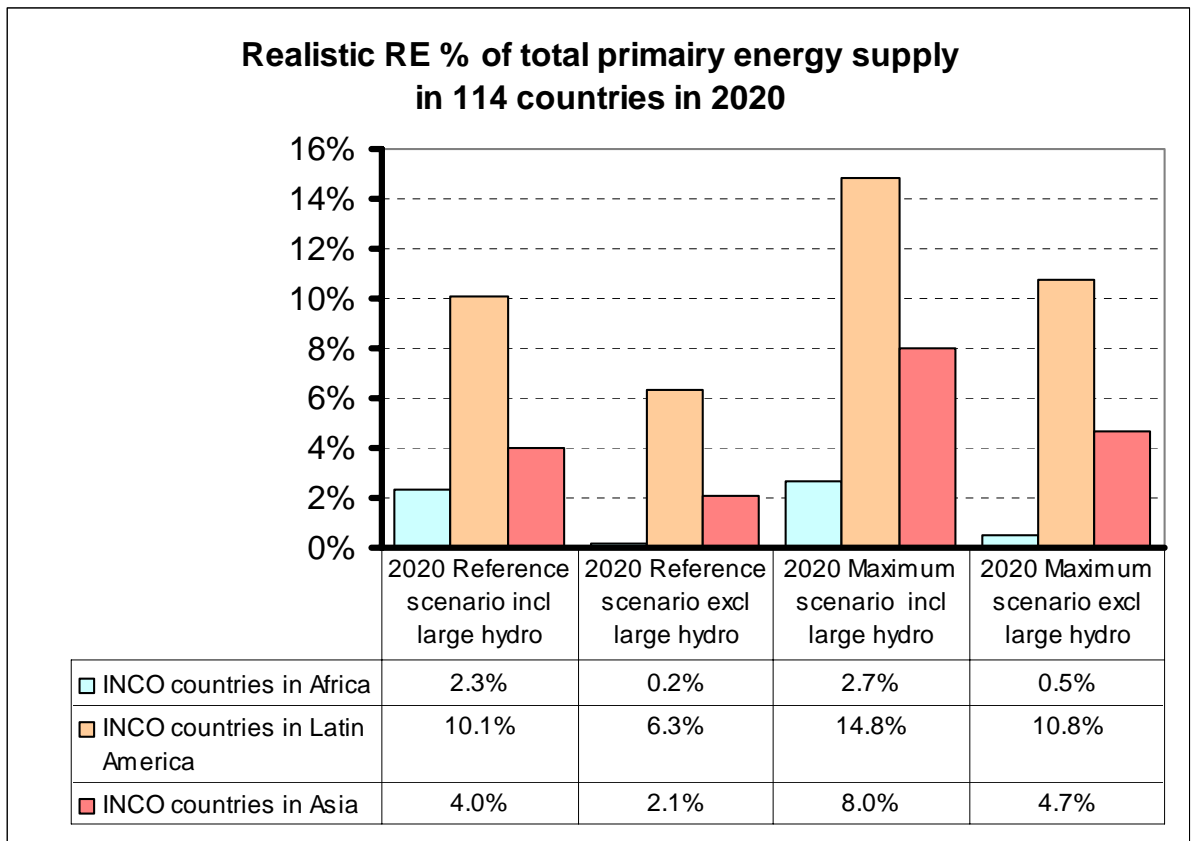


There are however two RE sources that may be underestimated in our realistic market potential.

- The production of biofuels is in many countries just starting, as the technology advances and especially as the use of agro waste for biofuels instead of agro production will improve, the share of biofuels could be higher the maximum scenarios.
- The use of (agro) waste for energy production is not always regarded as RE, but nowadays often referred as to 'RE and waste'. As stated before, we lack the information on the present situation in many countries to assess the scenarios. Therefore the potential use of waste could be larger than we assumed for the maximum scenario, especially in the poor and modest developed countries.

4.5. Realistic market potential for RE in 114 countries over 3 continents

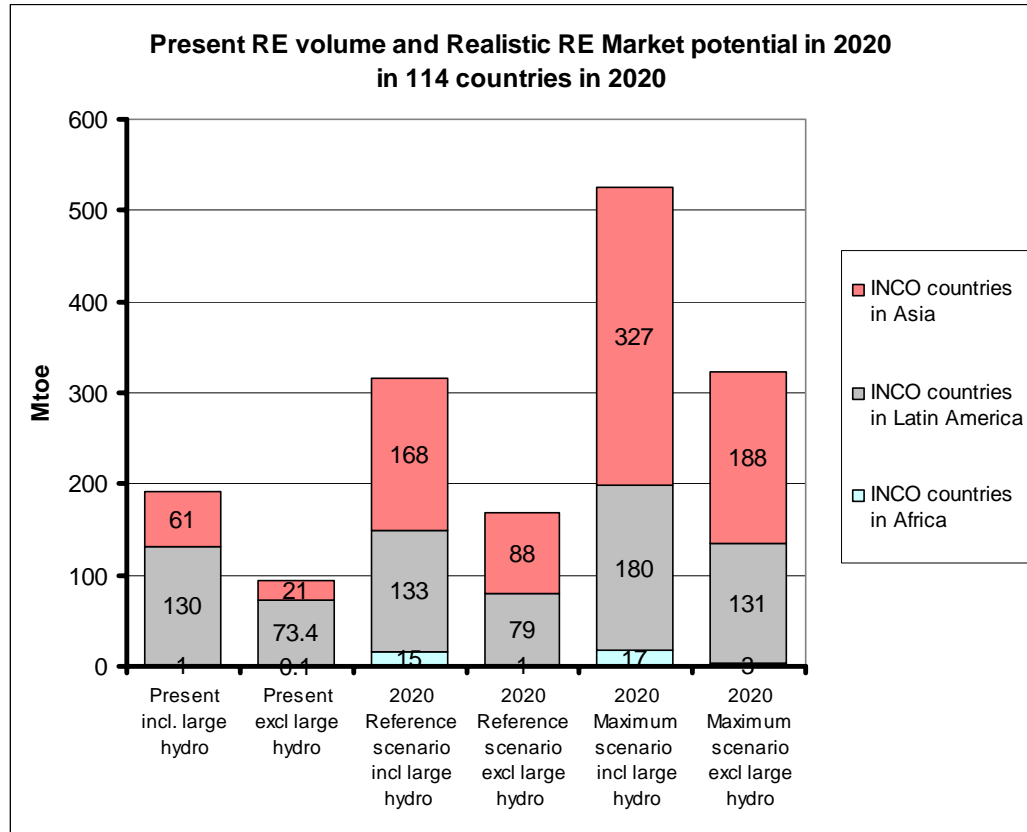
The 114 countries of the INCO list are clustered to the continent they belong to. The market potential for each group in the countries is based upon the present energy demand, the energy demand in 2020 (assessed as stated in 4.1) and the RE contribution for the reference and maximum scenario (see 4.2).



The continent with the greatest contribution of RE in percentage is Latin America, due to the fact that this continent is generally more developed, there are almost no countries in our defined groups ‘poorest’ and ‘poor’ here. Many countries in Latin America have or are developing a definite policy towards RE.

Note:

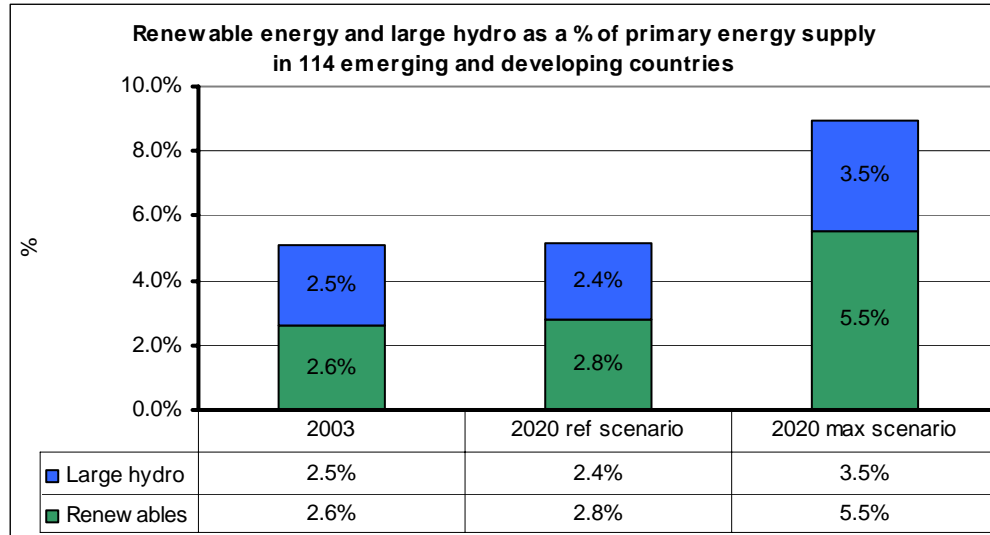
- Traditional biomass is included in the Total Primary Energy Supply, not in the RE %.
- The RE volume for the 114 countries in the present situation excluding large hydro is extrapolated on the 15 countries of the in depth study, the volume can be 5-15 Mtoe higher (see 4.2 for explanation)
- The possible new large hydro other than those already planned in the 15 countries of the in depth study are not taken into account (see 4.2 for explanation)



The present RE volume, excluding large hydro, can be tripled in 2020. In Asia this volume growth is even higher.

The maximum scenario shows RE production excluding large hydro, in the 114 countries, is almost twice as high as in the reference scenario. In Africa this difference is even greater where energy consumption is low and the effect of increased RE capacity greater.

Asia has the largest absolute RE volume in all the scenarios, due to the dimension of the INCO countries in this continent. Only the larger countries in Asia have defined RE policies.



The RE % for the total of the 114 countries is shown in the figure above. Without large hydro it increases from 2.6 to 5.5 %. Under the reference scenario the growth of the RE contribution may seem small, but the volume of the production almost doubles. The growth of the energy demand for all the 114 countries in this period is 70%.

Some remarks on the results of the 114 countries assessment

- It is deemed inadvisable and unreliable by the RECIPES team to calculate either a RE percentage or Mtoe for the various technologies we have researched. The outcome of the in-depth studies shows a great range in potential per technology and there is too little background data for the 99 other countries.
- The great range in RE contribution in the countries is not only caused by the economic development but also the effect of energy policy in the past and in the future. The extrapolation of the results of the 15 countries to 114 countries show that calculation only on basis of economic development (income per capita) and present energy use can give a result that is very different from the result of an in depth study for this country. However, the 15 countries from our in depth study covers a great area of the 115 countries and their present energy use is 75% of the total energy use in the 114 countries. So the outcome of our study is rather sound. To present more reliable figures in depth studies for more countries taken into account the present policy of these countries, are indispensable.