



DEVELOPING RENEWABLES

Renewable Energy that benefits all

Brussels, March 2007

Renewable energy in emerging and developing countries

**An increase by a factor of 3
can be achieved by 2020**

Final report RECIPES project

EUROPEAN UNION SIXTH RTD FRAMEWORK PROGRAMME
Scientific support to Policy Programme
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
Contract number: 513733
Duration: January 2005 – December 2006

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

Table of contents

Abbreviations and definitions	4
Foreword	6
Executive summary	8
Introduction	16
Tripling the volume of renewable energy in emerging and developing countries in 2020 is possible in a maximum scenario, with a positive socio-economic impact and continued opportunities for EU industry	21
<i>1. With present policy the volume of renewable energy in emerging and developing countries will double in 2020, with extra effort this volume can triple.....</i>	<i>22</i>
1.1. At the overall level, RE volume increases with a factor 2 in the reference scenario and with a factor 3 in the maximum scenario. The percentage of RE within the TPES remains stable in the reference scenario and doubles in the maximum scenario.	22
1.2. At continent level, large differences occur: RE is well established in Latin America, grows quickly in Asia and also shows growth in Africa although levels remain low	26
1.3. At country level, the RE market potential varies even more and is predominantly related to establishing strong policy for RE, except for the poorest countries where providing access to energy primes	29
1.4. Large hydro is considered RE in many countries and accounts for 2 to 3 % of TPES	39
1.5. RE accounts for 13% of the total electricity production in 2020 under the maximum scenario, large hydro for 26%	43
1.6. Other studies are in line with RECIPES although the ranges of uncertainty differ	46
<i>2. An increased volume of renewable energy has a positive socio-economic impact in emerging and developing countries, but further work is required to substantiate and quantify this.....</i>	<i>51</i>
2.1. Experts indicate that RE technologies contribute more to socio-economic development in emerging and developing countries, than non RE technologies;.....	52
2.2. Solar, hydro, bio-energy and wind technologies contribute most, fossil based and nuclear technologies least	54
2.3. RE technologies have a significant CO ₂ reduction potential	56

2.4. Other studies confirm the potential of RE technology for job creation but provide a confused picture on the overall socio-economic impact of RE in emerging and developing countries; thorough analysis does not exist.....	57
3. <i>An increased volume of renewable energy in emerging and developing countries presents a highly interesting market for EU industry but competition is fierce and risks are higher than in the domestic market</i>	61
3.1. The volume of the RE market in emerging and developing countries is significant and interesting for EU industry	61
3.2. Country and RE sector specific barriers and risks show that the investigated Asian and Latin American countries are most attractive for doing business in RE. This is more difficult in the African countries except in South Africa.....	62
3.3. Market opportunities for EU industry vary per RE technology but are generally best in the investigated Asian and Latin American countries, and small in the African countries, except in South Africa	63
3.4. This is in line with and complementary to other studies.....	85
4. <i>Further actions: recommendations for main stakeholders</i>	88
4.1. For the EC (DG ENV, DG TREN, DG RTD, EuropeAid)	88
4.2. For energy actors in emerging and developing countries.....	90
4.3. For the EU RE industry	91
4.4. Follow-up: how to put RECIPES into practice	92
Annexes	93
<i>Annex A – Outcome stakeholder validation workshop</i>	93
<i>Annex B – Selected references</i>	97
<i>Annex C – Emerging and developing countries (INCO list)</i>	100
<i>Annex D – Reports available on www.energyrecipes.org</i>	101

Abbreviations and definitions

CDM	Clean Development Mechanism
CSD	Commission on Sustainable Development of the United Nations
CO ₂	Carbon dioxide: a 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. Energy unit.
HEGC	High Economic Growth Case
IEA	International Energy Agency
IEO	International Energy Outlook
JREC	Johannesburg Renewable Energy Coalition
INCO	A dedicated programme for international scientific cooperation (INCO) within the EU Framework Programmes for Research, Technological Development and Demonstration Activities. The EU has elaborated a list of 114 countries that are the so-called INCO target countries. This list is included in annex C
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, used worldwide as the 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 primary energy supply or electricity supply. The RE volume used to calculate the RE% is the output of a RE technology without any hypothetical substitution or calculation of equivalence, so in RECIPES the RE volume is not expressed in avoided primary fossil energy use. IEA, Eurostat and UN use the same method. REN21 and BP use the ‘ <i>substitute method</i> ’ that expresses RE in avoided use of fossil fuels, and that leads to higher RE percentages especially for electricity production. The RE% in relation to the TPES relates to the countries’ total TPES including traditional biomass. Where this is not the case it is

indicated. The RE% in relation to the total electricity supply relates to the total electricity produced, not to the primary energy needed to produce the electricity. We indicate where RE includes or excludes large hydro.

RE	Renewable Energy. There is no universally accepted definition of renewable energy. Some technologies like large hydro or energy from waste are included in some countries and excluded in others. IEA separates large hydro from RE. We used the definition of RE 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	Tera Watt hour = 10^9 kWh
TPES	Total Primary Energy Supply: includes all RE, traditional biomass and fossil fuels including those used to generate electricity.
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.

Foreword

The RECIPES project was named this way because the project team had the ambition to look for recipes that could improve the implementation of renewable energy technologies in emerging and developing countries.

The team's basic idea was to look for the market potentials for renewables in emerging and developing countries. Based on the potentials that were calculated, the possibilities for the European renewables industry and the local social-economic and environmental effects of implementing the different technologies were analysed. The calculation of market potentials is based on detailed country studies performed by local experts.

The European Commission funded the project in order to obtain results to be used for policy support. However, we also identified other potential (non-paying) clients for the results of the project:

- European renewables industry;
- Energy actors like governments and energy producing companies, in emerging and developing countries;
- Financial organisations investing in renewables.

When setting up and carrying out the project we tried to address their needs as well.

Both the wealth of data and information gathered during the project and the results of the analysis of this information can be interesting and useful for these 'clients'.

The project team has been working intensively the last two years to gather all information and to come up with meaningful results. We are aware of the limited span of influence of this project considering all other activities taking place in this area. However we feel we have added something new: no other study has so far provided data on the RE situation in emerging and developing countries at such a level of detail and in such a comprehensive and standardised way.

The project team would like to thank everyone involved (either directly or by providing information or opinions) in the RECIPES project for his or her cooperation. All inputs and information received were of crucial importance for the quality and relevance of the project results.

Brussels, March 2007

Table: RECIPES consortium, local experts and Advisory Board

<u>Expert</u>	<u>Organisation</u>	<u>Location</u>
Project consortium		
Els Sonnemans	EBM Consult	Netherlands
Emiel Hanekamp	Partners for Innovation	Netherlands
Eric Evrard	Prospect C&S	Belgium
Paul Cognaud	Partners for Innovation	Belgium
Peter Karsch	Partners for Innovation	Netherlands
Peter Vissers	Partners for Innovation	Belgium
Richard Oomen	EBM Consult	Netherlands
Victorio Oxilia Dávalos	ESENERG	Paraguay
Wolfgang Lutz	ESENERG / AES	Paraguay / Netherlands
Local experts		
Sven Dervedde	Energy Foundation	Ghana
Chayun Budiono	PT CGI	Indonesia
Dieudonné Goudou	EDER	Niger
François Serneels	Kosmos	Belgium / Thailand
Liu Ying	CREIA	China
Jean Koueda	Global Village Cameroon	Cameroon
Henry García Bustamante	ESENERG	Peru
Jason Schäffler	Nano Energy Ltd	South Africa
Luis A. Vega	Vega Consultants	Hawaii / Pacific Islands
Odón de Buen Rodríguez	ESENERG	Mexico
Omar Prias Caicedo	ESENERG	Colombia
Srikanth Subbarao	IT Power India Ltd	India
Timothy Byakola	Climate & Dev. Initiatives	Uganda
Advisory Board		
Celio Bermann	PIPGE	Brazil
Christine Lins	EREC	EU
Claude Turmes	European Parliament	EU
Emil Bédi	INFORSE Europe	Slovakia
Emilia Van Egmond	Eindhoven University	Netherlands
Eric Martinot	Tsinghua University	China
Jean Marc Jossart	AEBIOM	EU
Eleni Despotou	EPIA	EU
Narendra Kumar Bansal	SMV Devi University	India
Secou Sarr	ENDA	Senegal
Sven Harmeling	Germanwatch	Germany
European Commission		
Domenico Rossetti	DG Research	EU
Barry Robertson	DG Research	EU

Executive summary

Introduction

Emerging and developing countries have 80% of the world's population but consume only 30% of global commercial energy. As energy consumption rises with increases in population and living standards, the need to expand access to energy in new ways is growing as well as the awareness of the environmental costs. Increased recognition of the contribution that renewable energy (RE) can make to energy independence, climate change mitigation, rural development, improved health and lower health costs (linked to air pollution), is shifting RE from the fringe to the mainstream of sustainable development.

The European Commission (EC) identified a need for policy-oriented research leading to a better understanding of the existing and future situation with regard to RE in emerging and developing countries. The EC selected the RECIPES project to provide better insight in the market potential of RE in emerging and developing countries, as well as in the related socio-economic effects and opportunities for EU industry. Main aim of the RECIPES project is to provide all stakeholders with information and insights that will enable them to contribute to the implementation of RE in emerging and developing countries.

The actual implementation of RE technologies varies with its use and users. RECIPES therefore focussed on different market-technology-equipment combinations. The time horizon of the project is 2020, therefore only the market-technology-equipment combinations relevant in view of this time horizon are taken into account.

RE market-technology-equipment combinations considered in RECIPES

RE	RE market-technology-equipment combination
Solar thermal	<ul style="list-style-type: none"> ▪ Hot water for residential, commercial and public use in all areas ▪ Solar thermal processes for industrial use
Photo voltaic	<ul style="list-style-type: none"> ▪ Electricity for grid connected single users and large fields ▪ Electricity for rural areas as stand alone or for local grid
Wind	<ul style="list-style-type: none"> ▪ Grid connected electricity from on shore and off-shore wind parks ▪ Electricity from single turbines, grid connected ▪ Electricity for rural residential and public services as stand alone or local grid ▪ Mechanical power (water pumping, milling)
Geothermal	<ul style="list-style-type: none"> ▪ Electricity grid connected ▪ Heat for local industry or public services
Small and medium size hydro power	<ul style="list-style-type: none"> ▪ Grid connected electricity (medium size) ▪ Stand alone or local grid electricity for rural residential and public services ▪ Mechanical power for milling (small)
Bio-energy	<ul style="list-style-type: none"> ▪ Cooking and heat for rural residential ▪ Bio gas for cooking and heating for rural residential ▪ Stand alone wood and agro waste combustion/waste digestion for cogeneration ▪ Grid connected electricity with wood combustion and gasification ▪ Grid connected electricity with agro digesters or incineration of city waste ▪ Bio fuels from energy crops

When appropriate for a country (and data was available) also attention was paid to RE used in industry and water desalination. Large hydro was dealt with separately as a technology that is considered RE in some countries.

The study includes the 114 emerging and developing countries that are on the INCO list (see Annex C), of which 15 countries were studied in more detail. These 15 countries will be referred to in this report as “RECIPES countries”:

<u>Latin America</u>	<u>Asia and Pacific</u>	<u>Africa</u>
Argentina	China	Cameroon
Brazil	India	Ghana
Colombia	Indonesia	Niger
Mexico	Pacific Islands	South Africa
Peru	Thailand	Uganda

Approach and results

Starting point of the project was the identification of the potential¹ of RE in developing countries. The calculation of the market potentials for 2020 for different RE technologies are based on the technical potential, the effects of different barriers, national policy, practical feasibility, energy market development and economic restrictions. Detailed country studies based on a combination of desk research and interviews provided the necessary information for this exercise.

Based on this potential, quantitative and qualitative assessments are made for the socio-economic and environmental implications and the opportunities for the EU industry. As a last step a comparison was made with other studies, and different validation mechanisms of data and results were carried out.

RECIPES generated a wealth of (recent) data on: existing renewable situation, the technical potential of renewables; the costs and benefits of increased shares of RE; market potentials for renewables; actual attitudes towards renewables, local socio-economic and environmental impacts of renewables, and barriers and drivers for implementation. For all 114 emerging and developing countries available basic data has been gathered. For the 15 RECIPES countries detailed data and information has been made available.

Besides the underlying final report, the following reports are available:

- Detailed country reports: detailed studies of the 15 RECIPES countries;
- Country reports: 114 reports of all countries included on the INCO list;
- A report on opportunities and barriers for EU industry;
- A report on social, economic and environmental performance of energy technologies in emerging and developing countries;
- A report on RE market potential in emerging and developing countries;
- A report describing the RECIPES methodology.

¹ ‘Potential’ can be market potential, technical potential or other. We have used the following definition: RE Market Potential - the amount of RE which, given all possible restrictions (practical, economical, juridical, etc.) is likely to be produced.

On the RECIPES website (www.energyrecipes.org) all the relevant data collected and reports produced are freely accessible.

Conclusions

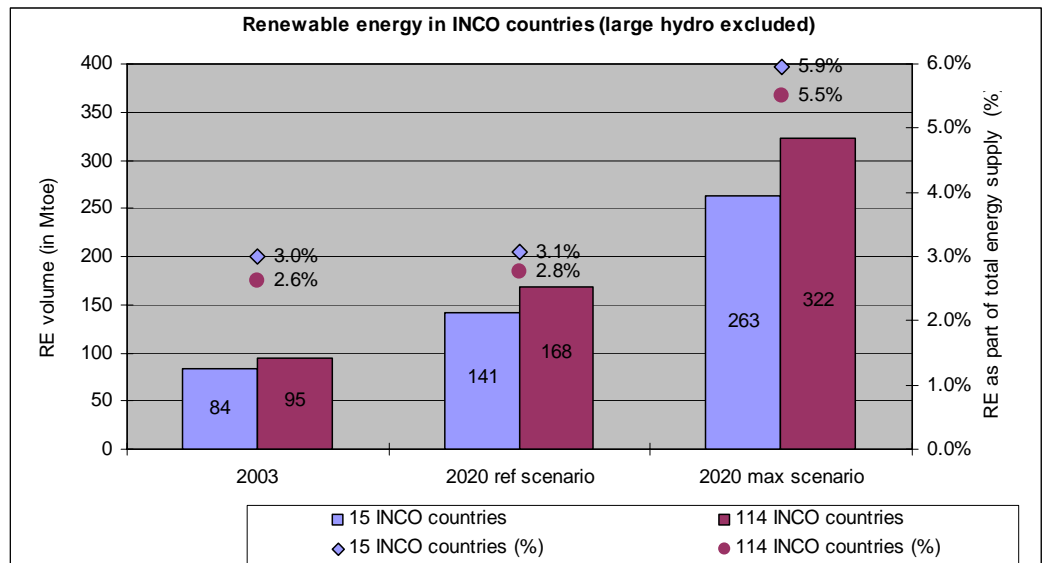
The overall conclusion for the RECIPES project is:

Tripling the volume of renewable energy in emerging and developing countries in 2020 is possible in a maximum scenario, with a positive socio-economic impact and continued opportunities for EU industry.

More detailed conclusions are given below.

At the overall level, the RE volume increases with a factor 2 in the reference scenario and with a factor 3 in the maximum scenario. The percentage of RE within the TPES remains stable in the reference scenario and doubles in the maximum scenario.

RE in 114 INCO countries



In order to achieve this maximum scenario there is however still a long way to go for all RE technologies. Ambitious targets for RE technologies, supported by reliable measures, are needed in order to nurture sustainable RE industry and to create the situation in which RE could make a real impact on security of supply and imported fuel dependency. The RE technologies that contribute most to these objectives are small / medium hydro, bio fuels, bio energy and wind. Other RE technologies contribute to a much lesser extent, however, the local socio-economic impact of these systems can be very positive.

At continent level, large differences occur: RE is well established in Latin America, grows quickly in Asia and also shows growth in Africa although levels remain low.

Latin America and Caribbean (33 INCO countries)

Latin America has the largest present RE volume (73 Mtoe) and the highest RE percentage of TPES (12%). This is mainly the result of Brazil (58 Mtoe) with its energy policy focused on bio fuels and energy independency. However, also the other Latin American and Caribbean countries have developed or are developing a policy towards RE. Under the 2020 reference scenario, the RE volume in Latin America grows slightly to 79 Mtoe but not at the pace of growth of the TPES. The RE percentage of TPES therefore goes down from 12 to 6%, highlighting the need to continue ambitious RE policies backed up by robust and reliable measures aimed at maintaining RE industry growth in the longer run. In the 2020 maximum scenario, the RE volume in Latin America almost doubles compared with the present situation (131 Mtoe instead of 73) while the percentage of RE within the TPES remains almost stable (it drops 1 percentage point to 11%).

Asia and Pacific (33 INCO countries)

Under both the reference (88 Mtoe) and maximum (188 Mtoe) scenario, the RE volume in INCO Asia will surpass the RE volumes in Latin America in 2020, because of the strong RE policies put in place, and the strong growth in energy demand and the large size of the economies in INCO Asia. China and India have a large impact on the energy figures of INCO Asia; they account for $\frac{3}{4}$ of the TPES of the Asia INCO countries in the current situation as well as in 2020.

Africa (48 INCO countries)

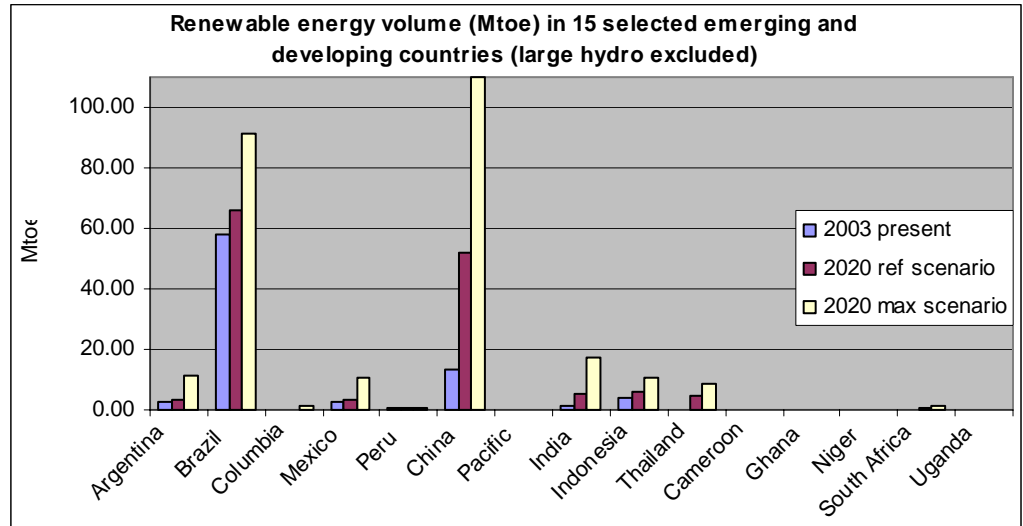
The present RE production in the African INCO countries, is low in absolute figures (0.1 Mtoe) and in percentage of TPES (<0.1%). The reference and maximum scenarios show that RE production will grow in African INCO countries in 2020 but that the levels will remain low. These results highlight the critical need for RE development support for the poorest countries, especially for policy formulation, infrastructure, grid connections, and market development. Climatic and political volatility, and economical instability provide stimulants and deterrents for the development of RE in Africa today. South Africa is different as it is the only emerging economy in INCO Africa.

At country level, the RE market potential varies even more and is predominantly related to establishing strong policy for RE, except for the poorest countries where providing access to energy primes

At present Brazil has the largest RE volume of the emerging and developing countries, especially due to its high use of biomass and bio-fuels. China has the second largest volume, followed by Indonesia.

In the 2020 reference and maximum scenarios, Brazil and China still have the largest RE volumes but other countries also grow to substantial volumes, notably Argentina, Mexico, India, Indonesia and Thailand.

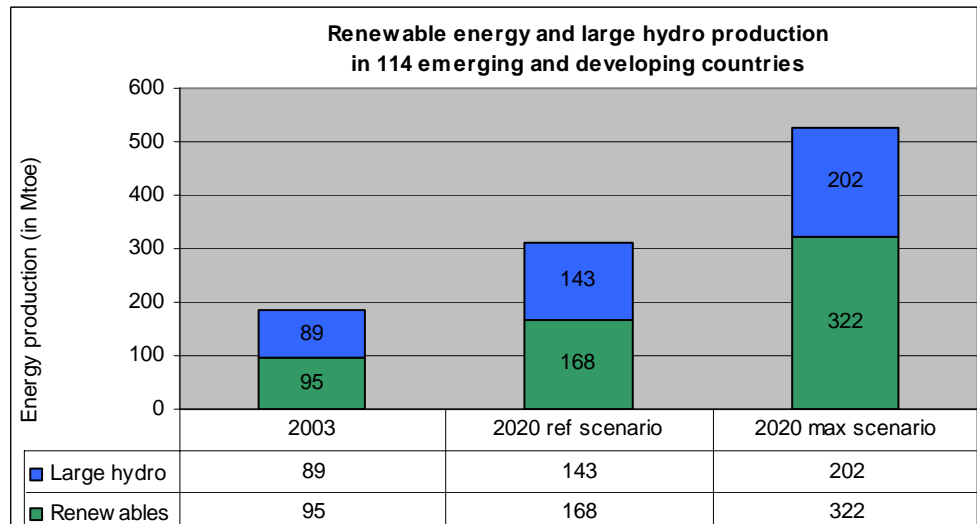
RE in 15 selected emerging and developing countries



Large hydro is considered RE in many countries and accounts for 2 to 3% of TPES

Large hydro is an important energy technology in emerging and developing countries and a zero-carbon energy technology. Many countries include large hydro as RE in their national energy balances. Some countries, however, consider large hydro not RE because of its environmental and social impacts.

RE and large hydro volumes in 114 INCO countries



All Asian and African countries plan significant investments in large hydro, except South Africa. Under the 2020 reference scenario, seven out of ten Asian and African countries observe that large hydro grows at a higher pace than

TPES. These countries try to mitigate the environmental and social impacts of large hydro but consider that large hydro is crucial for their national energy balance and decided to invest in it.

An increased volume of renewable energy has a positive socio-economic impact in emerging and developing countries, but further work is required to substantiate and quantify this.

Part of the RECIPES research was directed towards assessing the socio-economic and environmental impact of RE technologies in emerging and developing countries. Three activities were undertaken for this purpose:

- a. A survey on socio-economic effects of energy technologies;
- b. An estimation of the CO₂ emission reduction potential;
- c. A comparison with other studies.

From this research, it emerges that RE technologies do have positive socio-economic and environmental effects in emerging and developing countries, but also that further work is required to substantiate and quantify this:

- a. The experts participating in the survey indicate that RE technologies contribute more to local socio-economic development in emerging and developing countries, than non-RE technologies;
- b. Solar, hydro, bio-energy and wind technologies contribute most, fossil based and nuclear technologies least;
- c. Renewable energy technologies have a significant CO₂ reduction potential;
- d. Other studies confirm the potential of RE technology for job creation but give a confused picture on the overall socio-economic impact of RE in emerging and developing countries; thorough analysis does not exist.

An increased volume of renewable energy in emerging and developing countries presents a highly interesting market for EU industry but competition is fierce and risks are higher than in the domestic market.

The market for renewable energy in INCO countries in 2020 varies between 73 (reference) and 227 Mtoe (maximum scenario) and is comparable with the market in the EU-15 (228 Mtoe) as identified in the EREC (2004) study.

A number of restrictive non-technical conditions in emerging and developing countries make it more difficult doing business. We identified the attractiveness of doing business in the RE sector in the 15 RECIPES countries, taking into account: the political and economic country stability, the situation of the local RE industry and import figures, readiness of countries to participate in CDM projects, the availability of import facilities and the openness of a country to import/foreign investments in general:

- a. *Attractive:* Brazil, Mexico, China, India, Thailand, Kiribati and Vanuatu;
- b. *Medium attractive:* Argentina, Colombia, Peru, Indonesia, South Africa and Fiji;
- c. *Not attractive:* Cameroon, Ghana, Niger and Uganda.

Market opportunities for EU industry vary per RE technology but are generally best in the investigated Asian and Latin American countries, and small in the African countries, except in South Africa

Wind power presents, for EU RE industry, the biggest market opportunities in emerging and developing countries, especially China, Brazil, India, Mexico and Argentina. The additional installed capacity in 2020 in the 15 RECIPES countries is estimated at 85 GW under the maximum scenario, with EU wind industry in a leading global position.

Also **small and medium hydro** present high market opportunities for EU RE industry in emerging and developing countries, especially China, India and Brazil. The additional installed capacity in 2020 in the 15 RECIPES countries is estimated at 75 GW (maximum scenario). EU industry is technologically leading with its high yields and low environmental impacts, but facing high competition with well-implanted local industries.

Bio fuels for transport represent potentially high market opportunities for EU industry in emerging and developing countries: the additional volume in 2020 in the 15 RECIPES countries is estimated at 75 billion litres ethanol and 22 billion litres bio-diesel. This presents significant opportunities for EU industry that is leading in bio diesel and increasing its involvement in ethanol. The market is however in a very early stage.

Photovoltaic also presents potentially high market opportunities for EU industry in emerging and developing countries: the additional installed capacity for PV in 2020 in 15 RECIPES countries is estimated at 1.8 GWp (maximum scenario). It is however unsure whether this market will become as attractive as the currently dominating and strongly subsidised markets of the EU, Japan and the US. International competition is high between the top producers in Japan, the EU, China and the US.

Solid biomass and biogas also present potentially high market opportunities for EU industry in emerging and developing countries. The international market for bio-energy is still in a very early stage but is expected to grow considerably in both industrialised and developing countries in the next years. EU industry is composed of many small companies but has valuable experience in the sector and is well positioned to benefit from this.

Solar thermal hot water installations are considered to present low market opportunities for EU industry in emerging and developing countries. Chinese industry is servicing its home market that is by far the biggest in the world; this industry produces installations at a fraction of the costs of those produced in the EU. EU industry may find an opportunity to import this low-cost technology or to produce under licence, and so boost its home market.

For **geothermal energy**, the market opportunity level for EU industry in emerging and developing countries remains unclear. The geothermal power

sector is expected to grow, especially in South East Asia and Latin America, but it is unclear how much. Also there is high competition between the five leading global manufacturers of which one is European.

Further actions and recommendations for main stakeholders

The RECIPES team formulated the following recommendations for the main stakeholders, based upon the observations of the team all along its work:

For the EC (DG ENV, DG TREN, DG RTD and EuropeAid):

- a. Put energy technology cooperation at the heart of cooperation programmes;
- b. Intensify exchange of RE knowledge with EDCs;
- c. Give special attention to the poorest;
- d. Continue to put high focus on R&D and RE;
- e. Create favourable conditions for international RE markets;
- f. Set up information services on high potential RE markets;
- g. Continue to develop the EU domestic market.

For energy actors in emerging and developing countries:

- a. Develop a tailor-made RE policy;
- b. Shift the path of financial flows towards long-term energy solutions;
- c. Create an attractive financial climate for RE;
- d. Support local RE industry;
- e. Make a point of knowledge transfer.

For EU RE industry:

- a. Focus on a number of high potential markets;
- b. Put continuous monitoring of market conditions in place;
- c. Work out and constantly review strategies for leadership and expansion;
- d. Play an active role at the global level;
- e. Create local partnerships;
- f. Consider implementation activities as part of the job.

How to put RECIPES into practice: ideas for follow-up

RECIPES has resulted in a mine of valuable information; key is therefore to make sure that this information is used. Participants to the stakeholder validation workshop identified the need for follow-up. In our view, follow-up should be organised along three lines of action:

- a. Facilitate dialogues about project results;
- b. Extend and update the work;
- c. Feed RECIPES results into existing networks.

Introduction

Background

The Johannesburg conclusions clearly raise the point of increasing the share of renewable energy sources. Developing countries, especially those lacking electricity (about 1.6 billion people), could be prioritised for the installation of renewable energy sources. Recently energy has been identified as enabler for reaching the Millennium Development Goals.

Developing countries have 80% of the world's population but consume only 30% of global commercial energy. As energy consumption rises with increases in population size and living standards, awareness is growing about the environmental costs of energy and the need to expand access to energy in new ways. Increased recognition of the contribution renewable energy makes to rural development, lower health costs (linked to air pollution), energy independence and climate change mitigation is shifting renewable energy from the fringe to the mainstream of sustainable development.

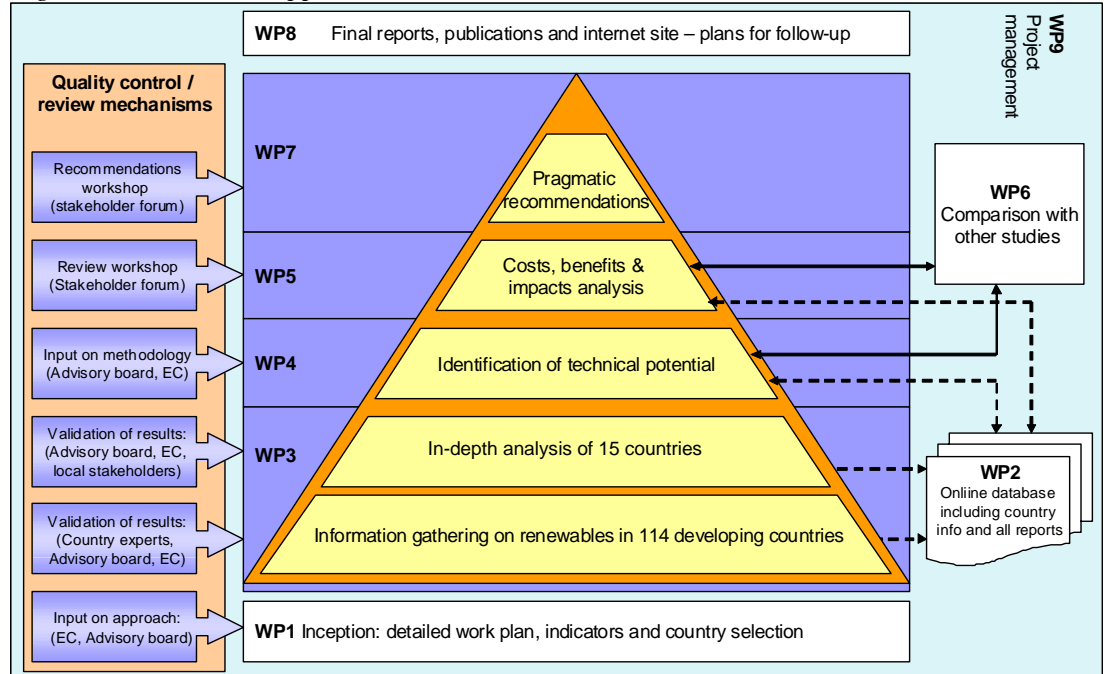
The European Commission (EC) identified a need for policy-oriented research leading to a better understanding of the existing and future situation with regard to renewable energy in emerging and developing countries. The EC selected the RECIPES project to provide better insight in the market potential of renewable energy in emerging and developing countries, as well as in the related socio-economic effects and opportunities for EU industry.

RECIPES approach

'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 with information and insights that will enable them to contribute to the implementation of renewable energy in emerging and developing countries.

The approach is bottom-up (Figure 0.1): the project has started with data and information gathering, detailed country studies, interviews and questionnaires; secondly the analysis of the information, calculations and comparison with other studies took place and thirdly recommendations were formulated. Throughout the project we sought for feedback from stakeholders and validation of data and results.

Figure 0.1: RECIPES approach



Renewable energy technologies

There are many different renewable energy technologies. The actual implementation of these technologies varies with its use and users. We felt that analyses on renewables should be related to specific uses and users (market), and installations (equipment). Therefore we started with identifying different market-technology-equipment combinations. The time horizon of the project is 2020, therefore only the market-technology-equipment combinations that are of importance in view of this time horizon are taken into account. The market-technology-equipment combinations considered are listed below.

Table 0.2: RE market-technology-equipment combinations in RECIPES

RE	RE market-technology-equipment combination
Solar thermal	<ul style="list-style-type: none"> ▪ Hot water for residential, commercial and public use in urban and residential areas ▪ Solar thermal processes for industrial use
Photo voltaic	<ul style="list-style-type: none"> ▪ Electricity for grid connected single users and large fields ▪ Electricity for rural areas as stand alone or for local grid
Wind	<ul style="list-style-type: none"> ▪ Grid connected electricity from on shore and off-shore wind parks ▪ Electricity from single turbines, grid connected ▪ Electricity for rural residential and public services as stand alone or for local grid ▪ Mechanical power (water pumping, milling)
Geothermal	<ul style="list-style-type: none"> ▪ Electricity grid connected ▪ Heat for local industry or public services
Small and medium size hydro power	<ul style="list-style-type: none"> ▪ Grid connected electricity (medium size) ▪ Electricity for rural residential and public services as stand

RE	RE market-technology-equipment combination
	alone or for local grid (small) <ul style="list-style-type: none"> ▪ Mechanical power for milling (small)
Bio-energy	<ul style="list-style-type: none"> ▪ Cooking and heat for rural residential ▪ Bio gas for cooking and heating for rural residential ▪ Stand alone and grid connected, wood and agro waste combustion or agro waste digestion for cogeneration ▪ Grid connected electricity with wood combustion and gasification ▪ Grid connected electricity with agro digesters ▪ Grid connected electricity with incineration of city waste ▪ Bio fuels from energy crops

When appropriate for a country (and data was available) specific attention was paid to small renewable energy systems, renewable energy used in industry and water desalination.

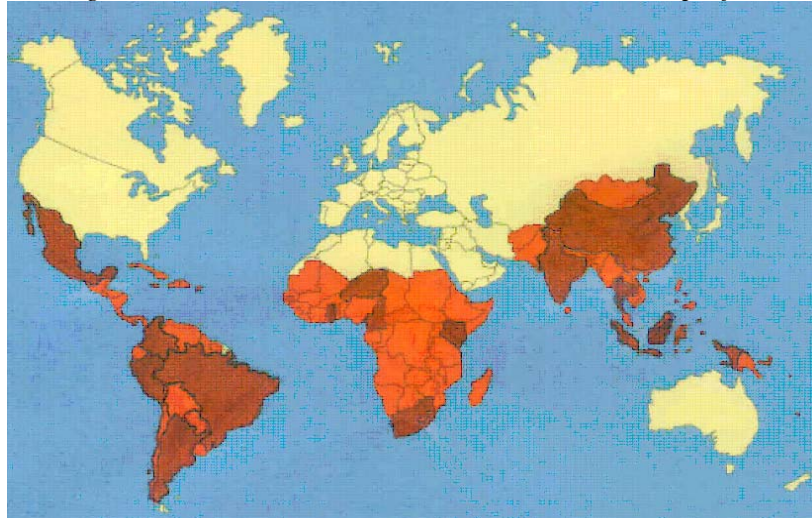
Large hydro

Large hydro is an important energy technology in emerging and developing countries and a zero-carbon energy technology. Many countries include large hydro as RE in their national energy balances but some do not, because of its environmental and social impacts. In order to be able to present comparable figures, and to take account of the not clear-cut status of large hydro as RE technology, we decided to give large hydro a separate status in the RECIPES project. Section 1.4 presents the results for large hydropower.

RECIPES countries

The INCO list consists of 114 emerging and developing countries; these countries are coloured in red on Figure 0.3; they are listed in annex C. The dark red coloured countries on Figure 0.3 are the 15 RECIPES countries for which detailed country studies have been conducted.

Figure 0.3: the countries addressed in the RECIPES project



The 15 countries studied in more detail are:

Latin America

Argentina
Brazil
Colombia
Mexico
Peru

Asia and Pacific

China
India
Indonesia
Pacific Islands
Thailand

Africa

Cameroon
Ghana
Niger
South Africa
Uganda

Data sources

Sources of information for this report and for the underlying country reports are highly diverse. This information was compared with data available in international publications, and was checked with the expert if differences occurred. All sources of information for the country reports are listed in the annexes of the country reports. Key sources of information are listed in annex B; an extensive publication list is available on www.energyrecipes.org.

Results

The project generates a wealth of (recent) data on: existing renewable situation, the technical potential of renewables; the costs and benefits of increased shares of renewable energy; market potentials for renewables; actual attitude towards renewables, local socio-economic and environmental impact of renewables, and barriers and drivers. For all 114 emerging and developing countries available basic data has been gathered. For 15 selected countries detailed data and information has been brought together.

Besides this final report, the following reports are available:

- Detailed country reports: 15 detailed studies of the aforementioned countries;
- Country reports: 114 reports of all the countries included on the INCO list;
- A report on opportunities and barriers for EU industry;

- A report on social, economic and environmental performance of energy technologies in emerging and developing countries;
- A report on RE market potential in emerging and developing countries;
- A report describing the RECIPES methodology.

On the RECIPES website (www.energyrecipes.org) all the relevant data collected and reports produced are freely accessible. This website has an integrated database section including information regarding the current situation and technical potential for renewable energy options in each of the 114 emerging and developing countries. Users can access the database freely and can select their information of choice with the help of reporting and comparison tools.

This report

This report presents the main results of the RECIPES project. It is based upon in-depth case studies for 15 emerging and developing countries, interviews with key stakeholders in these countries, research into the characteristics of the 99 other emerging and developing countries, and a survey on socio-economic effects of renewable energy that includes the input of 123 experts from all over the world. In order to discuss and validate the results and conclusions of the project, a workshop was held with experts on 7 December 2006 in Brussels.

The main results of the project are presented in this report. The central finding is that ‘Tripling the renewable energy volume in emerging and developing countries in 2020 is possible in a maximum scenario, with a positive socio-economic impact and continued opportunities for EU industry’. This is detailed hereafter in chapters 1, 2 and 3.

In chapter 1 the market potential for renewables is further discussed. Chapter 2 describes the local socio-economic and environmental impact of RE technologies in emerging and developing countries. Chapter 3 describes the opportunities and barriers for EU industry associated with the identified market potential.

Chapter 4 contains the recommendations of the RECIPES project that address a variety of stakeholders involved in policy-making, programme management and implementation of renewable energy in emerging and developing countries. Short and long-term recommendations are proposed which would ultimately lead to more coherent and efficient policy making on renewable energy in these countries.

The report contains the following annexes:

Annex A – Outcome stakeholder validation workshop

Annex B – Selected references

Annex C – Emerging and developing countries (INCO list)

Annex D – Reports available on www.energyrecipes.org

Tripling the volume of renewable energy in emerging and developing countries in 2020 is possible in a maximum scenario, with a positive socio-economic impact and continued opportunities for EU industry

1. With present policy the volume of renewable energy in emerging and developing countries will double in 2020, with extra effort this volume can triple.

1.1. At the overall level, RE volume increases with a factor 2 in the reference scenario and with a factor 3 in the maximum scenario. The percentage of RE within the TPES remains stable in the reference scenario and doubles in the maximum scenario.

The RECIPES project includes an assessment of the market potential of renewable energy for the 114 emerging and developing countries of the INCO list. In-depth studies for 15 emerging and developing countries on the market potential for different market technology combinations form the basis of this assessment.

The RE-potential in 2020 for the 15 countries was assessed using information gathered by local experts. The local experts collected this information by means of desk research and contacts (interviews, surveys) with national stakeholders (policy makers, industry experts, other stakeholders). The data was structured in five parts and is annexed to the market potential reports of the 15 countries:

- *A Questionnaire*: data provided by the local expert on the present energy situation, the energy policy and the various market-technology combinations;
- *B Energy and policy*: a description by the local expert of the national energy policy and the characteristics of the energy supply.
- *C Country maps*: these maps contain information on population, (energy) infrastructure, existing RE and available RE sources.
- *D Project description*: description of some RE projects by the local expert with emphasis on non-technical experiences and lessons learned.
- *E Interviews with stakeholders*: interviews with selected local actors in energy and renewable energy (not public).

On the basis of the information gathered by the local experts, the RECIPES team has outlined the *present situation*² and the main drivers and barriers for the various RE technologies, and has developed scenarios for further RE market implementation. The information that was gathered by the local experts, has been compared with data available in international publications, and was checked with the expert if differences occurred.

² The local experts undertook the data gathering in 2005 so most figures on the present energy situation (e.g. the energy balance) are of 2003 or 2004. Mid 2006 the experts were asked to comment on the RECIPES country potential reports. Many experts took the opportunity to provide the newest figures for the RE installed capacity, and we used these figures that are thus of 2004 or 2005. So, if we refer in this final report to '2003' or 'current situation', it can also refer to the RE situation in 2004 or 2005. This has no influence on the figures of the scenarios for 2020. For more information we refer to the potential country reports.

Two scenarios were defined. The *'reference scenario'* describes the future development of a 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 drivers for this maximum scenario can vary per market technology combination and per country. In many cases the maximum scenario was either a strong policy scenario or a finance availability scenario, or a combination of these two. The maximum scenario is based upon positive but realistic changes in drivers and barriers.

The results for the 15 case study countries were extrapolated to the 114 INCO countries. Extrapolation was done on the basis of a categorisation according to the countries' level of development (poorest, poor, average, richest). The extrapolation factor was only 1.3, since all emerging and developing countries with a high TPES are included in the 15 countries.

Figures 1.1 and 1.2 show the results of this extrapolation. Under the *'reference scenario'*, the present RE volume in 114 INCO countries, large hydro excluded, will nearly double in 2020, from 95 to 168 Mtoe. The present TPES in 114 INCO countries will also almost double in this period, from 3,600 Mtoe to 6,000 Mtoe (factor 1.7). Under the reference scenario the RE percentage of TPES³ remains stable at 3%.

Under the *'maximum scenario'*, that combines strong policy at national and international level with finance availability, tripling of the RE volume in 2020 to 322 Mtoe is possible. In this case the RE percentage of TPES will grow to 6% and thus grows at a more rapid pace than TPES.

Large hydro is treated separately, as explained in the introduction; the figures for large hydro are presented in section 1.4.

³ RECIPES calculated the RE percentage of TPES without any hypothetical substitution or calculation of equivalence. For more information: see definition of RE% on page 4. Traditional biomass has been included in the TPES but is not considered to be RE.

Figure 1.1: RE volume in 114 INCO countries, large hydro excluded

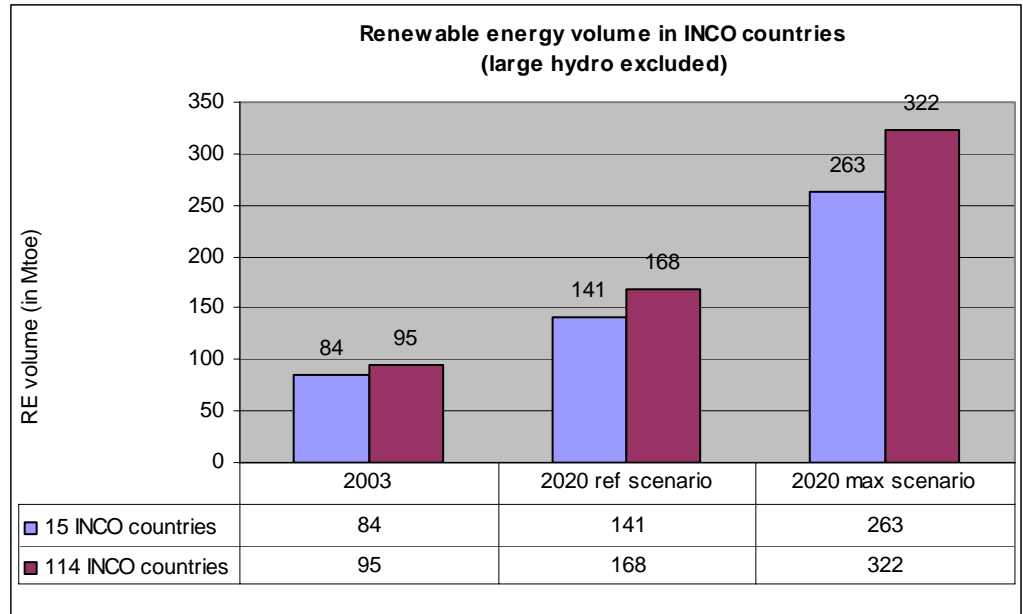
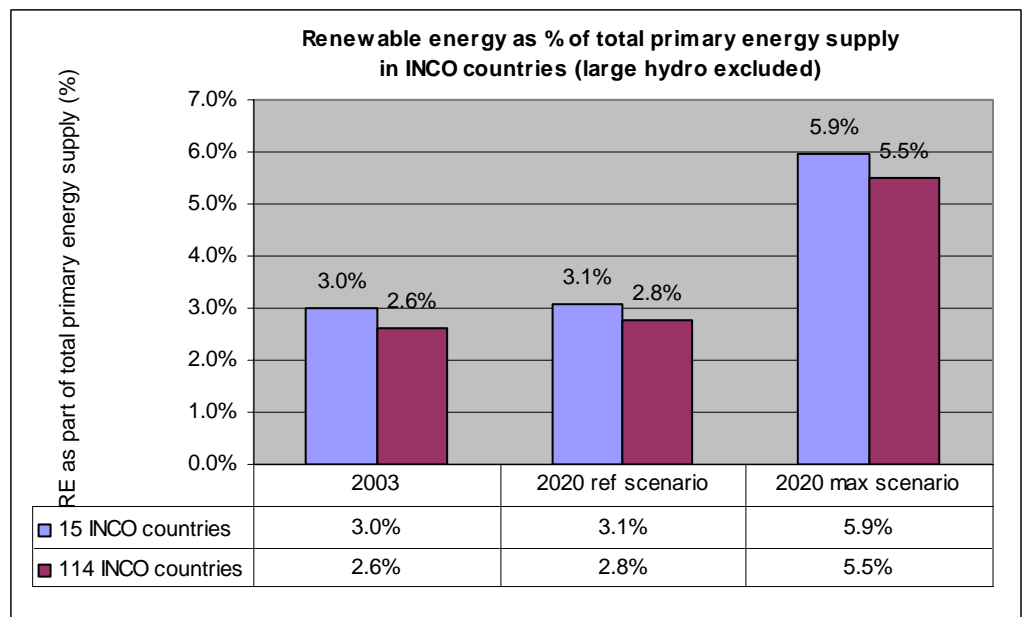


Figure 1.2: RE% of TPES in 114 INCO countries, large hydro excluded



In order to achieve this maximum scenario there is however still a long way to go for all RE technologies. Ambitious targets for RE technologies, supported by reliable measures, are needed in order to nurture sustainable RE industry and create the situation in which RE could make a real impact on security of supply and imported fuel dependency. The RE technologies that contribute most to these objectives are small / medium hydro, bio fuels, bio energy and wind. Other RE technologies contribute to a much lesser extent, however, the local socio-economic impact of these systems can be very positive.

For all the countries, effective market drivers are important to achieve the market potential. These market drivers include finance availability, prioritised access to the grid, cost effectiveness, capacity building factors (such as local knowledge and technical education level and skills for effective contracting) and awareness building. These drivers all rely on the effectiveness of the underlying energy policy and organisation structure of the energy sector.

It must be emphasised that we have assessed a realistic market potential; we did not define scenarios on just the technical potential, nor did we aim at a politically or environmentally desirable potential.

It is also important to note that the actual implementation of RE may well be higher than the RECIPES maximum scenario. Especially possible developments in the bio fuels sector and in the use of waste from the agro industry (although waste is not always regarded as a renewable source) can increase the aforementioned figures. In most countries that were studied, the policy for these energy options is in a developing stage with critical discussions about the claim on land use, competition with food production, and environmental impact.

Leaps in performance and cost effectiveness of technologies, especially in the period until 2010, can also result in higher RE volumes in 2020 than shown in the RECIPES maximum scenario. Solar concentrated (thermal) power may have this potential: a market restart is taking place in this sector; construction of the first utility-scale projects started recently in the US with a 64 MW plant and in Spain with a 10 MW plant. Other 50 MW plants are scheduled in Spain for 2007.

The RECIPES stakeholder validation workshop on 7 December 2006 with participation of REN21 and UNEP, confirmed that the maximum scenario, a tripling of the present RE volume in EDCs in 2020, is a very realistic scenario. Also compared with the pace at which the RE capacity increases, particularly in China and India, and the firm intentions of these countries to continue at this pace.

1.2. At continent level, large differences occur: RE is well established in Latin America, grows quickly in Asia and also shows growth in Africa although levels remain low

Latin America and Caribbean (33 INCO countries)

The continent with the highest present RE volume (73 Mtoe) and the greatest RE percentage of TPES (12%) is Latin America (see Figures 1.3 and 1.4). This is largely due to Brazil with its energy policy focused on bio fuels and energy independency; in the current situation Brazil accounts for 58 of the 73 Mtoe of the RE volume. However, also the other Latin American and Caribbean countries have developed or are developing a policy towards RE.

Under the 2020 reference scenario, the RE volume in Latin America grows slightly to 79 Mtoe but not at the pace of growth of the TPES. The RE percentage of TPES therefore goes down from 12 to 6%, highlighting the need for a continuously ambitious RE policy backed up by robust and reliable measures to be able to sustain RE industry growth for the longer term. This is especially the case in Brazil, where the RE contribution drops from 28% in the current situation to 16% in the 2020 reference scenario, but smaller decreases are also shown in Argentina and Mexico.

In the 2020 maximum scenario, the RE volume in Latin America almost doubles compared with the present situation (131 Mtoe instead of 73) while the percentage of RE within the TPES remains almost stable (it drops 1 percentage point to 11%). In this scenario the RE volumes of Argentina and Mexico grow from 3 to about 11 Mtoe each, while the RE volume in Brazil grows from 58 to 91 Mtoe. This growth is achieved by a continued strong RE policy and is mainly due to installation of wind parks (Argentina, Brazil, Mexico), installation of small/medium hydro plants (Brazil) and an increase of the production of bio fuels (Argentina, Brazil).

Asia and Pacific (33 INCO countries)

Under both the reference and the maximum scenario, the RE volume in INCO Asia will surpass the RE volume in Latin America in 2020, due to the strong RE policies put in place, and the strong growth in energy demand and the large size of the economies in INCO Asia.

China and India have a large impact on the energy figures of INCO Asia; they account for $\frac{3}{4}$ of the TPES of the Asia INCO countries in the current situation as well as in 2020. The pressing need for reliability of supply and increase in capacity in order to keep up with the fast paced economic growth in China and India provides the strongest incentive for these countries to implement sustainable RE policy measures. China also considers the RE sector as a strategic high-technology sector in which it is keen to take a leading position. Volatile costs of imported fuel also stimulate RE development. The incentives are undeniable and acknowledged.

The RE percentage of the TPES grows in China to 2% in the 2020 reference scenario and to 5% in the 2020 maximum scenario. Indonesia and Thailand also grow to these levels. India grows to 1% in the 2020 reference scenario and 2% in the 2020 maximum scenario. This growth is achieved by a strong RE policy in all countries and is mainly due to installation of wind parks (China, India), installation of small/medium hydro plants (China, India), installation of solar thermal installations (China) and to a lesser extent an increase of the production of ethanol (China, India) and bio diesel (Indonesia, Thailand, and China).

Under the reference scenario, the RE volume in the 33 countries in Asia and Pacific grows fourfold (from 22 at present to 88 Mtoe in 2020) and nine fold (to 188 Mtoe) under the maximum scenario of sustained strong policy. The RE percentage of the TPES increases from 1% at present to 2% or 5% in 2020, under the reference and maximum scenario respectively.

Africa (48 INCO countries)

The present RE production in the African INCO countries, is low in absolute figures (0.1 Mtoe) and in percentage of TPES (<0.1%). The reference and maximum scenarios show a substantial growth of RE production; volumes will grow to levels of 1 and 3 Mtoe in 2020, under the reference and maximum scenario respectively. The RE% of TPES will also increase, to 0.2 and 0.5% respectively.

The RE volume and RE% of TPES are significantly lower in INCO Africa than in the other continents. Our country analyses show that there is a combination of factors that make that RE takes off more difficultly in INCO Africa compared to the other continents:

1. *RE policy is in its infancy stage.* In most African INCO countries RE policy is absent or in a very early stage. Most countries have defined or are defining domestic energy policies in order to get a grip on their energy challenges such as low access to modern energy, high use of traditional biomass, frequent power shortages, and high costs of imported fossil fuels. Policies tend to focus on rural electrification, efficient use of traditional biomass and expansion of power production (partly through large hydro); their effectiveness is however still to be demonstrated.
2. *Finance availability is a general problem, also for RE.* The African INCO economies do not have much finance available in general, whether through private investors or governments. Return on investment of large RE projects is typically low or subject to high uncertainty. Smaller RE projects do not have good returns because consumers have difficulties to pay, even at very basic energy prices.
3. *Local industry has no perspective for RE.* Local industry does not really pick up on RE so far, although there is certainly room for local RE services that provide access to energy and increase energy efficiency. There are exceptions, as Uganda, that has a local RE industry which has however difficulties to survive. Stimulation of local RE industry is largely absent.

4. *Costs of RE are considered high.* RE hardware and RE services are considered costly; most of the technology and required know-how has to come from abroad and paid in hard currencies.
5. *RE is not considered a serious option.* This is caused by a combination of factors, among which (i) the reduced complexity of traditional energy technologies and (ii) the negative impact of unsuccessful RE projects in the past, or of RE projects that do not fulfil the energy demand.

This highlights the critical need for RE development support from developed nations in the case of the poorest countries, especially for policy formulation, production infrastructure, grid connections and market development.

The aforementioned factors do not apply to South Africa, the only emerging economy in INCO Africa. South Africa accounts for ¼ of the TPES of INCO Africa, and is the biggest RE contributor of INCO Africa: 0.1 Mtoe in the present situation, 0.3 Mtoe in the reference scenario and 1.3 Mtoe in the maximum scenario. The RE% of TPES increases from 0.1% in the present situation to 0.2% and 0.6% in the reference and maximum scenarios respectively. However, in comparison with countries with a similar average income per capita in other continents, the RE volumes and % of TPES are low. This is mainly because South Africa has not yet developed a strong policy towards RE. There are no signs that such a policy will be adopted in the near future; South Africa strives towards a more sustainable energy mix but is used to cheap coal and has significant reserves of fossil energy.

Figure 1.3: RE volume in 114 INCO countries, large hydro excluded

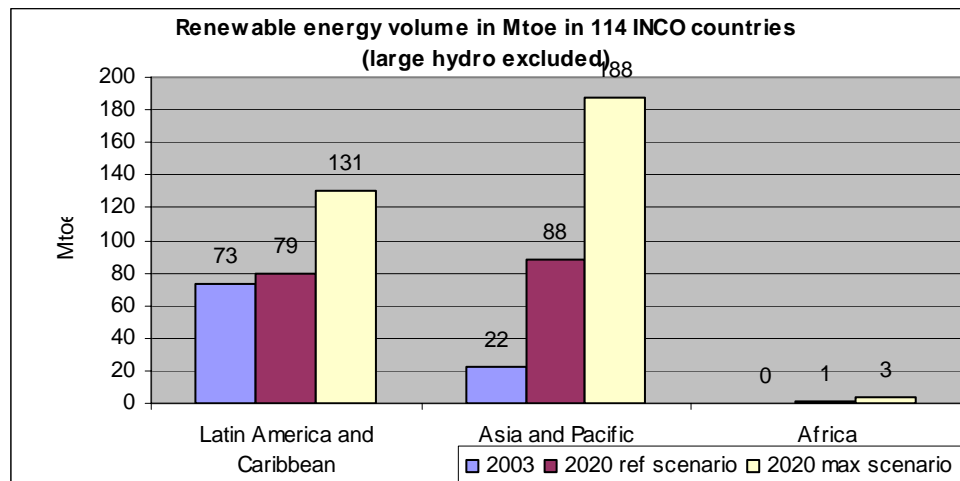
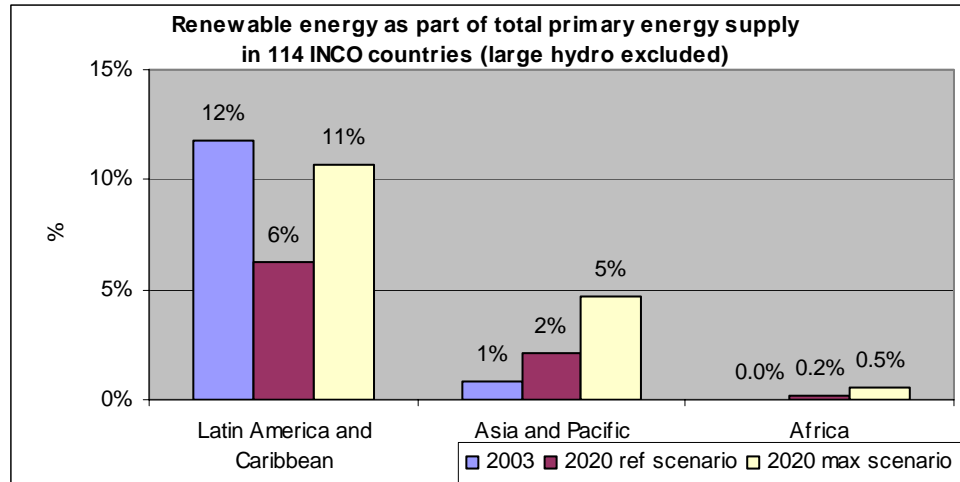


Figure 1.4: RE% of TPES in 114 INCO countries, large hydro excluded



1.3. At country level, the RE market potential varies even more and is predominantly related to establishing strong policy for RE, except for the poorest countries where providing access to energy primes

1.3.1. RE volumes and RE% of TPES

At present Brazil has the largest RE volume of the emerging and developing countries, especially due to its high use of biomass and bio-fuels. China has the second largest volume, followed by Indonesia.

In the 2020 reference and maximum scenarios, Brazil and China still have the largest RE volumes but other countries also grow to substantial volumes, notably Argentina, Mexico, India, Indonesia and Thailand.

In terms of percentage of TPES, Brazil and the Pacific Islands have the highest RE%, respectively 28% and 14% in the current situation. The reference scenario shows that present policy in both countries is not enough to maintain these high levels of RE% of TPES in 2020. The same effect but to a lesser extent is seen in other countries with significant present RE volumes, Argentina, Colombia, Mexico and Indonesia. Only with sustained strong policy the RE% of TPES can further grow in these countries, as the maximum scenario shows. In the Pacific Islands the RE% of TPES grows to 18% mainly as a result of the production of bio fuels from agro waste.

Under the maximum scenario, three groups of countries appear:

- *High RE% of TPES (>10%).* This is the case in three countries which, for historical reasons, either already had a high RE percentage (Brazil, Pacific Islands) or present good conditions for a rapid growth (Argentina);
- *Medium RE% of TPES (between 2 and 5%).* This is the case in seven countries where the RE% grows, under strong RE policy, to still significant

levels in 2020 (Colombia, Mexico, Peru, China, India, Indonesia and Thailand);

- *Low RE% of TPES (<1%).* The African countries Cameroon, Ghana, Niger and Uganda show growth but only in small percentages because of the difficulties related to energy infrastructure, policy formulation and RE market development. These countries are the poorest in this study and focus on access to energy. Growth by a relatively small percentage is also shown in South Africa but for a different reason: it is anticipated that RE will not have the priority that it would need to show strong growth.

Figure 1.5: RE volume in 15 selected INCO countries, large hydro excluded

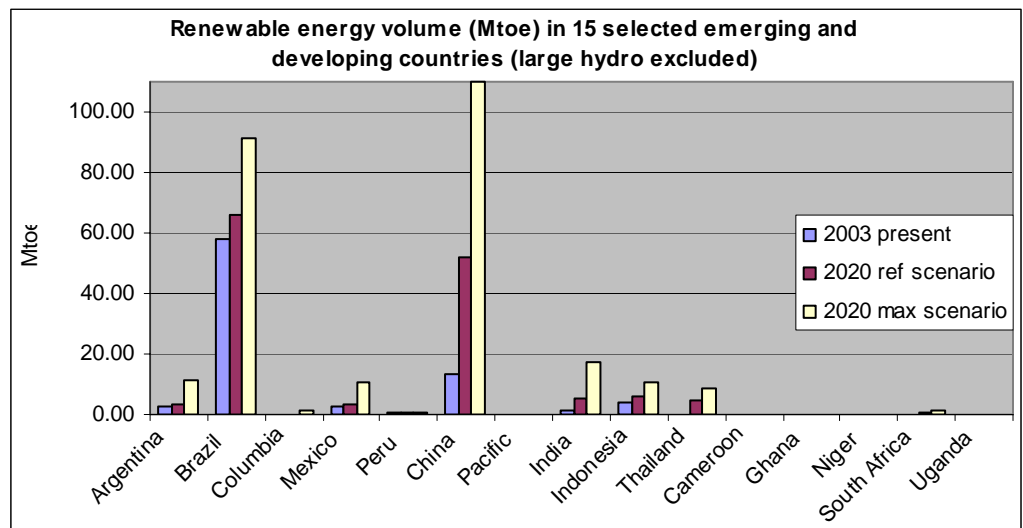
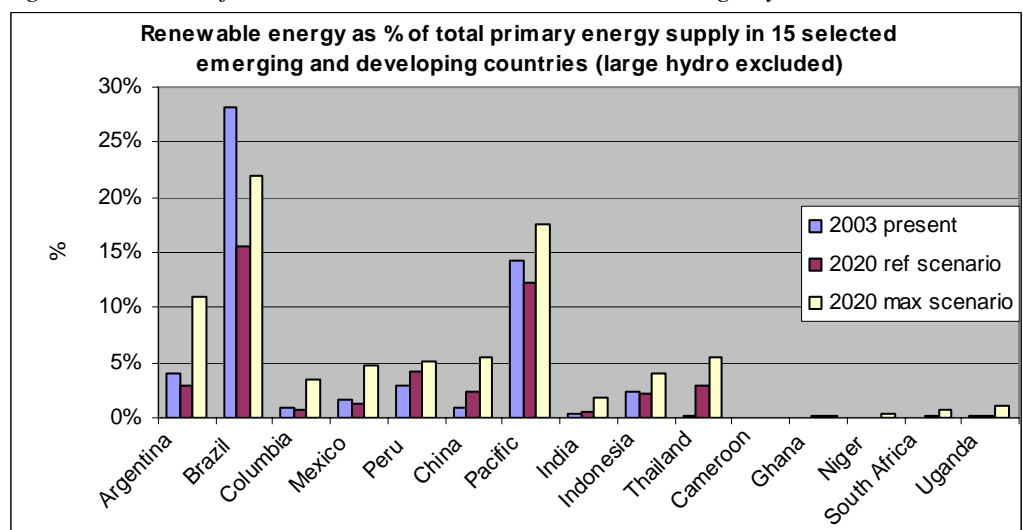


Figure 1.6: RE% of TPES in 15 selected INCO countries, large hydro excluded



1.3.2. RE issues from the country studies

The individual country analyses gave rise to a number of conclusions with regard to drivers, barriers, technologies and the implementation of renewable energy. These conclusions are listed hereafter; a country-by-country presentation is included in section 1.3.3:

- a. *Focus is on RE electricity while there's a high potential for bio-energy.* In studies, literature and policies, much attention is being given to production of electricity from renewable sources compared to other forms of energy demand. Although for rural areas not connected to the grid electrification is an important step in the development, it appears that other applications receive less attention than they deserve. This may change however in the near future with the growing attention for bio-fuels and energy from waste becoming a serious option.
- b. *Small and large systems are different worlds and require different instruments.* A market driven approach and a mandatory RE target leads to larger projects and the implementation of larger systems in a market that is already relatively successful. Little attention is given to the poorest or thinly populated regions that may require smaller systems and that involve complex organisation aspects; as a result these regions lag behind. In some countries this is at present an urgent issue because the administration needed for CDM projects can only be justified for large projects (e.g. a wind park versus wind turbines scattered over the land)
- c. *Lack of finance availability can relate to lack of funds or lack of certainty.* Lack of finance is often mentioned as a barrier in this study, but this general term can stand for quite different types of barriers for the various technologies. For small projects it can refer to the problems for consumers who cannot afford the investment or the costs, or to bank regulations and investment policies that are not adequate for the small RE projects. For larger systems it can reflect on a long return on investment period or on uncertainty of energy policies put in place, resulting in a reluctant attitude among investors.
- d. *Sharing of knowledge and experiences is not sufficiently addressed at the moment.* Most emerging and developing countries are aiming at increasing the scale of RE, from demonstration-scale to full-scale programmes, from marginal to mainstream energy production. This implies that a more long-term organisational approach is needed with adequate policy-making, energy planning, investment schemes and resources for maintenance and follow-up. On the other hand there is also a clear indication that there is a need for more country-, region- or technology specific R&D. For both approaches, the sharing of knowledge and experiences is seen as a key factor that is not sufficiently addressed at the moment. There are few incentives for private companies to share their RE technology. Access to information on RE technologies is difficult in EDCs.
- e. *Liberalisation of the energy market does not have a direct influence on RE.* Liberalisation is often mentioned in combination with an open electricity market and good feed-in tariffs. However, making laws and long-term regulations does not depend on the owner structure of the energy market but on the will and possibilities to make these laws and regulations. There

are examples of liberalised markets with success in RE, such as Argentina and Brazil, but also of less liberalised markets that are also successful in RE, such as China. In all cases government initiative in combination with public and private investment are required to attain significant levels of RE% of TPES.

- f. *Fulfilling the energy demand is key.* Small systems for rural areas, like solar home systems, that do not produce enough energy to fulfil a near future demand or do not provide enough possibilities for further economic development, can negatively influence the attitude towards renewable energy. Implementation programmes of RE in rural areas should therefore be flexible and offer different (sized) options for the various regions in a country. The actual energy systems should have the possibility to be scaled-up following the energy demand.
- g. *Special measures are required for poor and smaller countries.* The bigger and more developed countries have tempting markets for investors in RE. Attention should be paid to smaller and less-developed countries. They have difficulty profiting from international finance mechanisms that have been put in place, are unable to compete on the technology learning curve and struggle with putting effective policies in place. The quality of the country's institutions is a key to success since RE is a government-driven business. Another key to success is the fit between RE and the country's specific situation and policy: if RE fulfils a country's need, it is likely to be a sustainable solution. If RE is pushed, e.g. in RE hardware implementation projects in development programmes without a clear fit with the country's energy policy, RE is in most cases not sustainable and not successful.
- h. *Cost-competitiveness continues to be a concern.* IEA and REN21 (2005) consider the following RE technologies as cost-competitive: large hydropower, bio-energy through combustible renewables and waste, solar thermal (in hot climates) and ethanol (in Brazil). RE technologies often require high levels of automation, which implies in most emerging and developing countries importation of goods that should be paid in hard currency expenditures.

1.3.3. Country descriptions

The table hereafter summarises the main outcome of the analysis of the 15 countries that were selected for the in-depth case studies. The full country reports including supporting annexes and documents are available at www.energyrecipes.org. The website also contains country briefs for all 114 INCO countries.

Country	Characteristics, energy policy and drivers and barriers for RE
Argentina	<p>Current situation: high income/capita (\$12,400 in 2004). 40 million inhabitants. High EDI (0.7). Only 5% of population is not connected to an electricity grid. Net energy exporter with significant reserves of gas, oil and coal. 88% of TPES is from fossil sources, 4% from large hydro, 4% from renewable biomass and 4% other RE.</p> <p>Energy and RE policy: robust energy policy. Competitive deregulated power sector. Several programmes for RE, target of 40% RE electricity in 2015. Target for bio fuel is under discussion.</p> <p>Barriers for RE: no integral, explicit and coordinated energy policy on RE. Low administrative level involved and low level of coordination. Low energy prices.</p> <p>Main possibilities: high potentials for large hydro, wind and bio fuel. Low potentials for PV, small hydro and solar thermal.</p> <p>Main steps forward: explicit RE policy under strong leadership, RE investment programmes, long-term perspectives for RE through tax incentives and reliable feed-in tariffs.</p>
Brazil	<p>Current situation: high income/capita (\$8,100 in 2004). 190 million inhabitants. High EDI (0.66). Only 4% of population is not connected to the grid. Significant reserves of gas, oil and coal. Imports 10% of its fossil energy (2003). RE (especially renewable biomass and bio fuels) forms 28% of TPES, large hydro 13%, and traditional biomass 4%.</p> <p>Energy and RE policy: robust energy policy, ambitious and successful RE policy. Several programmes for RE are in place.</p> <p>Barriers for RE: lack of finance availability and limited timeframe and scope of RE programmes are the main barriers for sustaining high RE levels.</p> <p>Main possibilities: large potentials for large hydro, small hydro, wind, bio fuel, biomass. Smaller potentials for PV and solar thermal.</p> <p>Main steps forward: adopting a continued strong RE policy beyond 2010, extending RE measures (e.g. feed-in tariffs) beyond current timeframe.</p>
Colombia	<p>Current situation: average income/capita (\$6,600 in 2004). 43 million inhabitants. High EDI (0.61). 10% of population is not connected to the grid. Net energy exporter (oil and coal) with significant reserves of coal. RE forms 1% of TPES (although some calculations including bagasse add up to 6%), large hydro 12%, and traditional biomass 16%.</p> <p>Energy and RE policy: 2001 Law for the promotion of rational and efficient energy use, and alternative energy. 2003 decree for implementation. Some programmes with limited coverage. One RE target: 10% ethanol is mixed with gasoline in large cities in 2020.</p> <p>Barriers for RE: no RE targets, no plans or programmes with national coverage, no fixed feed-in tariff</p> <p>Main possibilities: wind, bio fuel, biomass, small-medium and large hydro</p> <p>Main steps forward: proactive energy and RE policy including targets and programmes. National regulation for feed-in tariff. Specific programme for RE in rural areas.</p>

Mexico	<p><u>Current situation:</u> high income/capita (\$9,600 in 2004). 106 million inhabitants. OECD member. No EDI. 5th oil producing country in the world, with significant reserves. Only 5% of population is not grid connected. RE forms 2% of TPES, large hydro 1%, and traditional biomass 4%.</p> <p><u>Energy and RE policy:</u> No integral, explicit and coordinated RE policy. Expectation that RE including large hydro forms 11% of electricity production in 2010. Target of 5% bio fuels under discussion.</p> <p><u>Barriers for RE:</u> low energy prices, lack of RE policy, difficulty to sell electricity to the grid, image of RE which is considered second best.</p> <p><u>Main possibilities:</u> wind, bio fuels, small and large hydro. To a lesser extent also PV and solar thermal.</p> <p><u>Main steps forward:</u> formulate a proactive RE policy. Remove market barrier on selling electricity to the grid. Provide better training and resources to maintenance sector. Correct image from lessons learned in previous RE projects.</p>
Peru	<p><u>Current situation:</u> average income/capita (\$5,600 in 2004). 30 million inhabitants. Average EDI (0.53). 24% of population is not grid connected. Produces its own oil and gas, and has significant reserves. RE forms 3% of TPES (RE biomass), large hydro 12%, and traditional biomass 18%.</p> <p><u>Energy and RE policy:</u> written targets, plans or programmes exist for several RE technologies i.e. bio-diesel, ethanol, PV, small wind turbines, micro, mini and large hydro.</p> <p><u>Barriers for RE:</u> lack of finance availability (concerning loans and investor opportunities). Short timeframe of policy measures (5 to 7 years). Lack of knowledge on RE. Energy prices lower than international market price.</p> <p><u>Main possibilities:</u> small + large hydro, bio-fuels, wind, PV, solar thermal</p> <p><u>Main steps forward:</u> offering investment programs, increase timeframe of RE measures, increase end-use awareness, and improve training programs.</p>

China	<p><u>Current situation:</u> emerging super power with 1.3 billion inhabitants. Average income/capita (\$5,600 in 2004). High EDI (0.60). Only 1% of population has no access to electricity. Producer of oil, gas and coal but has to import to catch up with demand. Significant fossil reserves. RE forms 1% of TPES (mainly small hydro), large hydro 2%, gas 2%, traditional biomass 8%, oil 22% and coal 64%.</p> <p><u>Energy and RE policy:</u> strong RE policy aiming to reduce oil and coal dependency, to bring down environmental burden and to bring energy to rural areas. Target of 15% RE by 2020 with specific targets per RE technology: wind 30 GW, hydro 3,000 GW, biomass power 30 GW, PV 2 GW, biogas 8 billion m³. 2006 RE law sets regulatory framework e.g. for feed-in tariffs, prioritised grid access, RTD. Special concession programs to promote production of RE technology by Chinese industry.</p> <p><u>Barriers for RE:</u> lack of interest of banks to invest in RE further to lack of skills to assess RE project profitability and risk. RE projects in rural areas sometimes lack maintenance as well as clear ownership and responsibilities.</p> <p><u>Main possibilities:</u> large and small hydro, wind, biomass power, biogas</p> <p><u>Main steps forward:</u> continue firm RE policy. Implement guaranteed pricing structure and prioritised RE grid access, as adopted. Ensure that private banks get skills to assess RE projects. Evaluate highly efficient measures as refurbishment of existing hydro. Plans to enhance operation, maintenance, ownership and responsibilities of rural RE projects.</p>
India	<p><u>Current situation:</u> average income/capita (\$3,100 in 2004). 1.1 billion inhabitants. Low EDI (0.33). 54% of population has no access to electricity. Producer of oil, gas and coal but has to import to catch up with demand. Significant fossil reserves. RE forms 0.3% of TPES, large hydro 1%, gas 5%, oil 20%, traditional biomass 33% and coal 41%. Ranks in top-5 worldwide for installed wind and PV capacities.</p> <p><u>Energy and RE policy:</u> target of 10% RE of additional electricity capacity. Several programmes directed to biomass, rural energy, solar water heating, PV, energy recovery for wastes. Fiscal incentives, subsidies and soft loan programmes are in place. Several specific targets for 2007: wind +1,500 MW, biomass +750 MW, small hydro +600 MW, and PV +2 MW.</p> <p><u>Barriers for RE:</u> lack of national RE policy, top-down approach leads to disconnection with reality and consumer needs, lack of RE awareness in energy sector and parts of government, predominant attention for grid technologies while non grid technologies fit very well with rural areas.</p> <p><u>Main possibilities:</u> large and small hydro, wind, biomass, ethanol, and to a lesser extent: PV, solar thermal and bio diesel.</p> <p><u>Main steps forward:</u> adopt national RE policy. More involvement of manufacturers, NGOs and consumers in RE programs, increase awareness for RE in energy sector and parts of government.</p>

Indonesia	<p><u>Current situation:</u> average income/capita (\$3,500 in 2004). 242 million inhabitants. Average EDI (0.41). 55% of the population have no access to electricity. OPEC member but importing oil since 2004. Exporter of gas and coal with high reserves. RE forms 2% of TPES (geothermal and biomass), large hydro 0-1%, traditional biomass 32% and fossil 65%.</p> <p><u>Energy and RE policy:</u> RE target of 13.3% of TPES in 2025. Specific targets for geothermal, bio fuels and large hydro. Laws for electricity, oil and gas, and geothermal. New regulation on non-traditional biomass but environmental impact is under discussion. Focus of rural electrification program is on grid extension and diesel generators; target is 10% RE.</p> <p><u>Barriers for RE:</u> no robust conditions for RE investment, high uncertainty for RE investors, low energy prices, price negotiation system with distribution monopoly for selling electricity to the grid.</p> <p><u>Main possibilities:</u> geothermal, large hydro, solar thermal, bio fuels, and to a lesser extent: PV, wind, and small hydro. Biomass and waste unclear.</p> <p><u>Main steps forward:</u> extent energy legislation with laws on RE and so provide certainties for investors. Robust and fixed feed-in tariff. Avoid that biomass projects (i.e. palm oil) have high local environmental impact.</p>
Pacific Islands (Fiji, Vanuatu, Kiribati)	<p><u>Current situation:</u> income/capita varies per country: average in Fiji (\$5,900 in 2004), low in Vanuatu (\$2,900) and very low in Kiribati (\$800). Fiji has 0.9 million inhabitants, Vanuatu 0.2 million, Kiribati 0.1 million. Only the EDI of Kiribati is know and is very low (0.12). Grid connection varies from 60% in Fiji to 19% in Vanuatu. Due to RE biomass and hydro, RE% of TPES is high in all countries: 27% in Fiji, 21% in Vanuatu and 33% in Kiribati. Traditional biomass varies from 23% in Kiribati to 40% in Vanuatu, the rest of TPES is oil and gas that are entirely imported.</p> <p><u>Energy and RE policy:</u> access to energy is a major concern in all countries; all have some plans and structure for RE; all have experience with PV in rural areas. Fiji has an unofficial target of 80% electricity by RE and large hydro. Vanuatu will double the capacity of its hydro plant.</p> <p><u>Barriers for RE:</u> lack of finance availability for RE, lack of structure and skills to implement new RE technologies such as wind and small hydro.</p> <p><u>Main possibilities:</u> hydro, wind and RE biomass, to a lesser extent PV.</p> <p><u>Main steps forward:</u> for the 3 countries this varies but includes good RE regulations, governmental founded organisations with budget and authority in RE, improving finance availability by access to international finance mechanisms and offering good conditions for private investors.</p>

Thailand	<p><u>Current situation:</u> high income/capita (\$8,100 in 2004). 65 million inhabitants. High EDI (0.68). Only 1% of population is not grid connected. Most fossil fuels are imported although Thailand has reserves of natural gas. RE is only 0.1% of TPES, large hydro 1%, traditional biomass 15%, and fossil fuels 84%.</p> <p><u>Energy and RE policy:</u> ambitious RE policy aiming to reduce oil dependency. RE target is 8% of TPES in 2011, large hydro excluded. From 2008 power companies are required to install 3 to 5% RE capacity of any new conventional power plant (RPS). Furthermore targets per RE technology: PV 250 MW, wind 100 MW, urban waste 100 MW, hydro 350 MW, biomass plants 1,040 MW, ethanol 5-10%, bio diesel 5-10%.</p> <p><u>Barriers for RE:</u> high implementation costs of reaching the set RE targets; artificially low oil prices; availability of biomass; competition with food sector; monopolistic position of power distribution and production</p> <p><u>Main possibilities:</u> bio fuels, biomass/waste treatment. To a lesser extent small hydro, PV, wind, solar thermal.</p> <p><u>Main steps forward:</u> adopt implementing fiscal and legislative measures to provide stability to RE investors. Correct artificially low oil prices. Establish a regulatory authority for implementing RPS. Remove barriers to deliver to the grid. Reduce administrative burden for RE industry.</p>
Cameroon	<p><u>Current situation:</u> low income/capita (\$1,900 in 2004). 16 million inhabitants. EDI is average (0.41). 60% of population is not connected to an electricity grid. 70% of energy consumption comes from traditional biomass. >95% of electricity is produced by medium and large hydropower. Oil exporting country.</p> <p><u>Energy and RE policy:</u> focus so far is on development of hydro electricity but a new integral energy plan is in the planning process. The new energy fund of the Rural Electrification Agency might enhance RE.</p> <p><u>Barriers for RE:</u> lack of foreign investment, high import taxes, negative attitude of population due to lack of successful RE projects.</p> <p><u>Main possibilities for RE:</u> hydro, PV, RE biomass and waste.</p> <p><u>Main steps forward:</u> promotion of RE through successful RE projects, attracting foreign investors in RE (e.g. by combining with the exploitation of gas reserves), support local RE industry.</p>
Ghana	<p><u>Current situation:</u> low income/capita (\$2,300 in 2004). 21 million inhabitants. EDI is low (0.30). 55% of population is not connected to an electricity grid. 60% of energy consumption comes from traditional biomass. 85% of electricity is produced by hydropower. All fossil fuel is imported.</p> <p><u>Energy and RE policy:</u> a national energy plan 2006-2020 is drafted. Main issues are energy efficiency, electrification, elimination of power shortage and liberalisation. Intention: fulfil 10% of energy need with hydro or RE.</p> <p><u>Barriers for RE:</u> lack of comprehensiveness of energy policy and financial schemes, no possibility to deliver electricity to the grid.</p> <p><u>Main possibilities for RE:</u> hydro, PV, RE biomass and waste.</p> <p><u>Main steps forward:</u> promotion of RE through successful RE projects, consistent policy including opening the grid, further and consistent support of RE equipment.</p>

Niger	<p><u>Current situation:</u> very low income/capita (\$900 in 2004). 11 million inhabitants. EDI is unknown but low. 93% of population is not connected to an electricity grid. >85% of energy consumption comes from traditional biomass. 55% of electricity is imported; all fossil fuel is imported.</p> <p><u>Energy and RE policy:</u> energy policy and poverty reduction strategy. Focus on access to energy, energy independency, environmental protection and RE. Electricity sector reform ongoing to encourage private investors. RE target including large hydro is 10% for 2020. Three large hydro plants (250 MW) are planned, one of them for 2012 (125 MW).</p> <p><u>Barriers for RE:</u> RE does not have a positive image, high fiscal charges, lack of finance availability for RE with high initial investment cost.</p> <p><u>Main possibilities:</u> hydro (large and small), biomass, PV</p> <p><u>Main steps forward:</u> create favourable fiscal network to attract investors and international funds, promotion of RE through successful RE projects</p>
South Africa	<p><u>Current situation:</u> one of the richest EDCs. High income/capita (\$11,100 in 2004). 44 million inhabitants. High EDI (0.6). 34% of population is not connected to an electricity grid. 9% of energy consumption comes from traditional biomass, 80% from coal. Significant reserves of coal.</p> <p><u>Energy and RE policy:</u> robust energy policy. Focus on a more sustainable energy mix, and on electrification in rural areas. Since 2003 a RE policy exists. RE target is 1% extra RE in 2013 (compared with current TPES).</p> <p><u>Barriers for RE:</u> RE target too low to be stimulating, cheap electricity and coal, lack of clarity on RE policy, discussion about focus on large or small RE projects, image of RE as second best, at present not being in scope of international finance mechanisms (CDM) that focus on large projects.</p> <p><u>Main possibilities:</u> large potentials for small hydro, wind and bio fuel. Smaller potentials for PV, geothermal and solar thermal.</p> <p><u>Main steps forward:</u> long-term perspectives for RE (tax incentives, reliable feed-in tariff), clarity on government policy and implementation structure, focus on fulfilling user demand in RE projects.</p>
Uganda	<p><u>Current situation:</u> very low income/capita (\$1,500 in 2004). 27 million inhabitants. EDI unknown but low. 95% of population is not connected to an electricity grid. 90% of energy consumption comes from traditional biomass. All fossil fuel is imported.</p> <p><u>Energy and RE policy:</u> focus on electrification, efficient use of traditional biomass, and access to modern energy in rural areas. Three large hydro plants planned. No RE target. Government supports local RE industry.</p> <p><u>Barriers for RE:</u> main problems are lack of finance availability and limited interest of potential investors.</p> <p><u>Main possibilities for RE:</u> mainly in small RE systems: mini/micro hydro, PV, bio-energy installations for agro industry.</p> <p><u>Main steps forward:</u> regulations for feed-in tariff, extended support to local RE industry, use of (inter)national finance mechanisms for RE.</p>

1.4. Large hydro is considered RE in many countries and accounts for 2 to 3 % of TPES

Large hydro is an important energy technology in emerging and developing countries and a zero-carbon energy technology. Many countries include large hydro as RE in their national energy balances. Some countries, however, consider large hydro not RE because of its environmental and social impacts.

In order to be able to present comparable figures, and to take account of this not clear-cut status of large hydro as RE technology, we decided to give large hydro a separate status in the RECIPES project. We collected information on the *current situation* of large hydro in the 15 selected countries. We furthermore collected information on planned large hydro plants and included these plants in the *reference scenario*. The *maximum scenario*⁴ in addition includes plans for new large hydro; in most cases this concerns large hydro plants for which an exact time frame is not yet available or the investment is not yet secured. From the 15 countries we then extrapolated to the 114 countries as we did for RE technologies.

The figures 1.7 and 1.8 show the results of this analysis at the level of the 114 emerging and developing countries. Under the *reference scenario*, the present energy production from large hydro in the 114 INCO countries will grow with a factor 1.6 in 2020, from 89 to 144 Mtoe. TPES will grow with a similar factor, factor 1.7, in the 114 countries. Under the reference scenario the contribution of large hydro to TPES therefore remains stable at 2%.

Under the *maximum scenario* a further increase of energy production from large hydro is foreseen in 2020, to 202 Mtoe. In this case the contribution of large hydro to TPES will grow to 3% and thus grows at a more rapid pace than TPES.

⁴ Note that the scenarios in the case of large hydro were not based on specific drivers and barriers as were the scenarios for RE technologies, and that large hydro was not studied in the same level of detail. As the main focus was on the other RE technologies, this does not compromise the results and outcome of the RECIPES project in our view. However, not using drivers and barriers might mean that the maximum scenario for large hydro is conservative since we took account of plants foreseen at present, while, especially in the period 2015-2020, new plants can be added to this and may be operational in 2020.

Figure 1.7: RE and large hydro volumes in 114 INCO countries

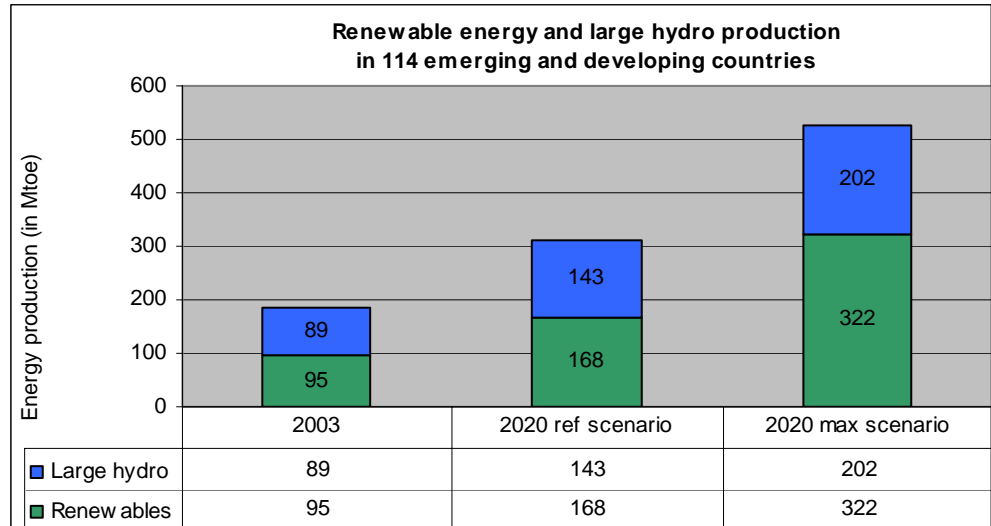
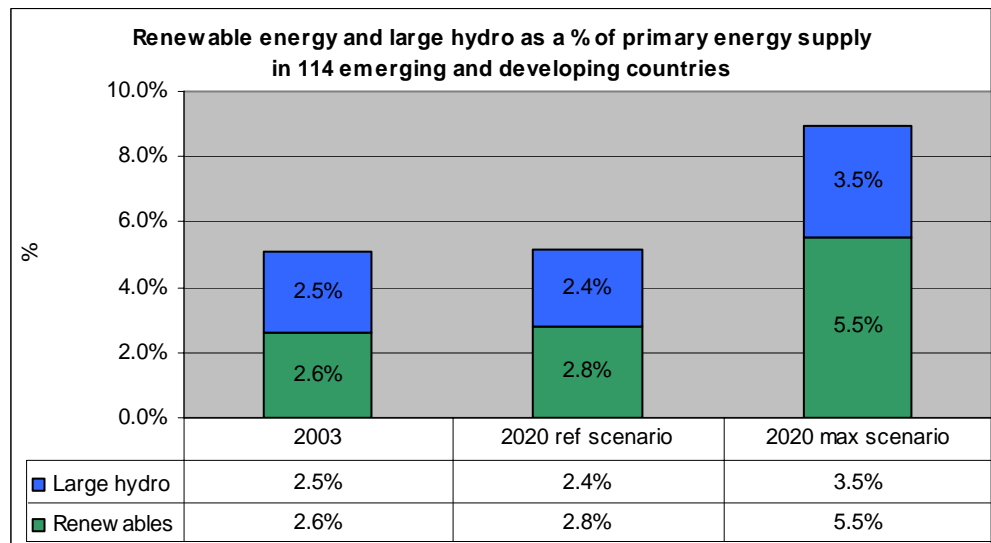


Figure 1.8: RE and large hydro as part of TPES in 114 INCO countries



At present Brazil and China have the largest volumes of large hydro in the emerging and developing countries, respectively 26 and 24 Mtoe, followed by India with 6 Mtoe. The definition of large hydro varies in the countries (between 5 and 50 MW as the lowest boundary). We have respected the boundaries that are used in the countries and thus also have used varying boundaries.

The *reference scenario* includes planned large hydro plants for which decision-making is finalised. Such plants exist in all countries except Argentina, Ghana and South Africa. In 2020 these new plants will account for an additional energy production through large hydro of 27 Mtoe in China, 6 Mtoe in India, 4

Mtoe in Brazil, 2 Mtoe in Indonesia and <1 Mtoe in other countries, in total 42 Mtoe.

In the *maximum scenario* this grows, due to targeted plants, with a further 28 Mtoe in China, 10 Mtoe in India, 4 Mtoe in Indonesia and <1 Mtoe in Cameroon, Ghana, Niger and Uganda, in total another 42 Mtoe.

Large hydro contributes most (12 to 13%) to the TPES in the Latin-American countries Brazil, Colombia and Peru. This percentage will drop in 2020 since the total capacity of new large hydro plants is not sufficient to keep pace with the increase in TPES. The environmental and social impact of large hydro refrains these countries from increases higher than accepted and planned, although the technical potential for large hydro is still abundant. Some countries with high contributions of large hydro in their total electricity production (like Brazil) strive for a diversification of their sources to secure their electricity delivery and to become less dependent on rainfall.

All Asian and African countries plan significant investments in large hydro, except South Africa. Under the 2020 reference scenario, seven out of ten Asian and African countries observe that large hydro grows at a higher pace than TPES. These countries try to mitigate the environmental and social impacts of large hydro but consider that large hydro is crucial for their national energy balance and decided to invest in it.

Figure 1.9: large hydro volume in 15 INCO countries

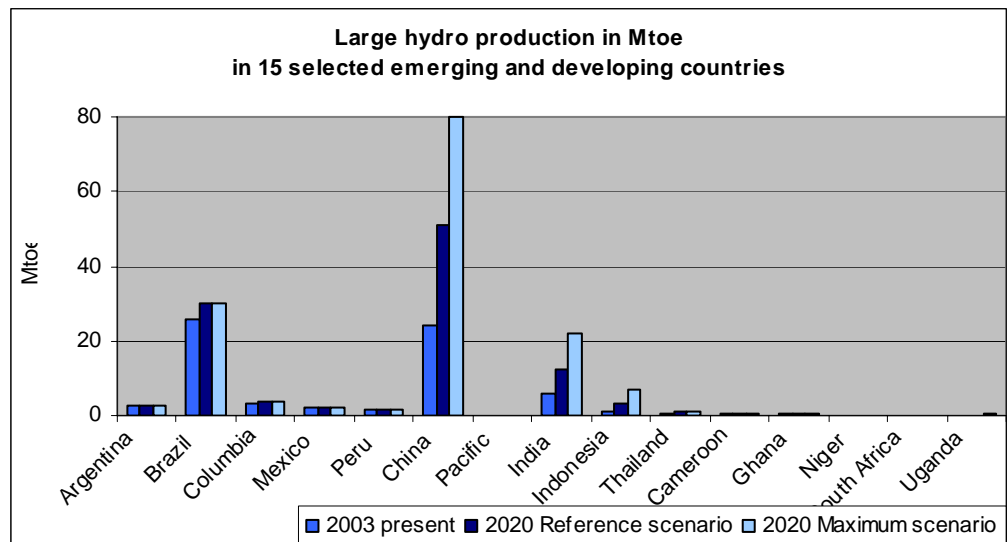
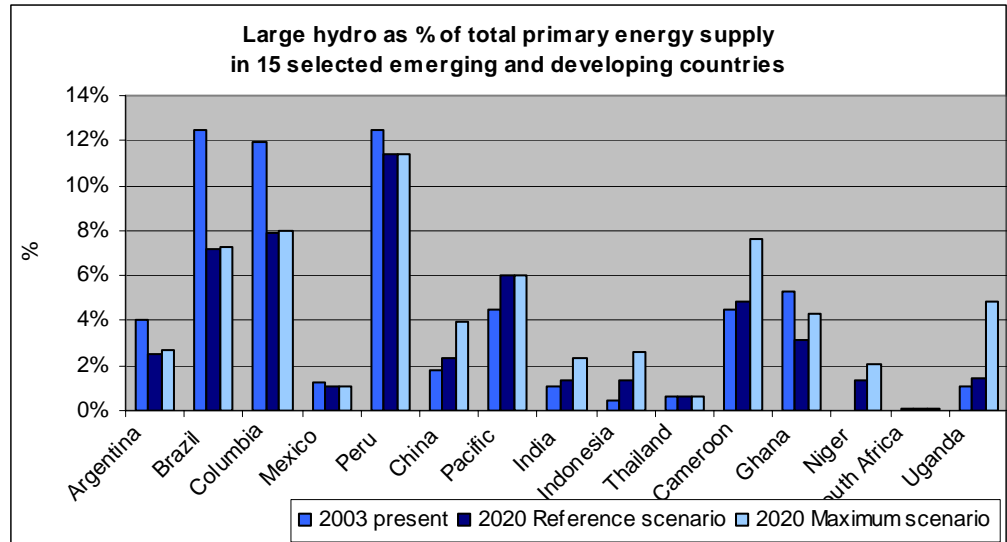


Figure 1.10: large hydro as % of TPES in 15 INCO countries



1.5. RE accounts for 13% of the total electricity production in 2020 under the maximum scenario, large hydro for 26%

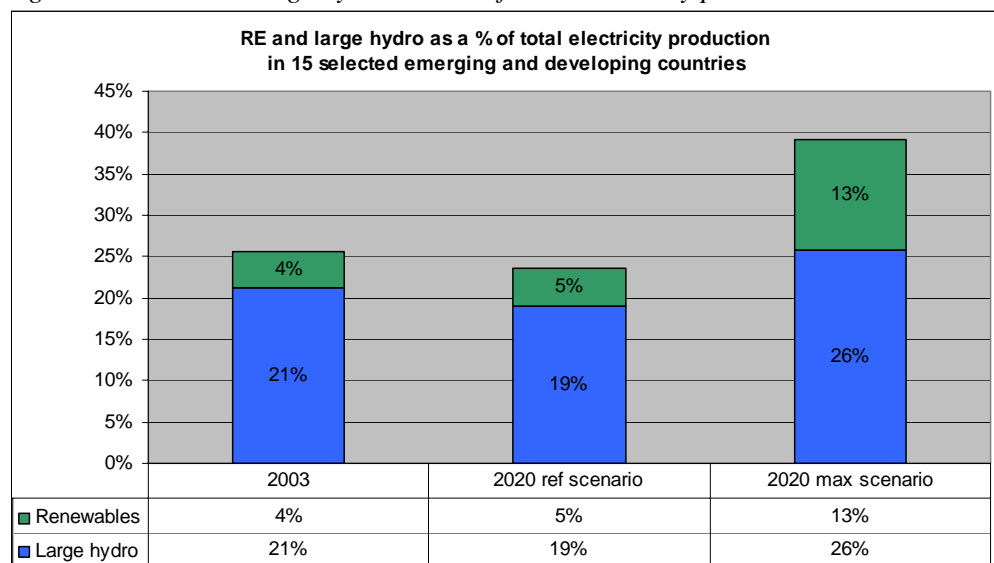
In the current situation, RE accounts for 4% of the total amount of electricity produced in the 15 emerging and developing countries under study. Under the reference scenario, the growth of RE electricity keeps up with the growth in the electricity demand: under this scenario RE accounts for 5% of the total electricity production in the 15 countries in 2020. The growth is achieved by an increase of small and medium hydropower, and to a lesser extent wind energy, biomass and agro waste.

Under the maximum scenario, the RE% of total electricity production outpaces the growth of electricity demand, and develops into a significant 13% of total electricity production in the 15 countries in 2020. The total volume of RE electricity actually grows with a factor five in this situation. Small and medium hydro, wind energy and (agro) waste treatment are important factors to achieve this high percentage of electricity produced from RE.

Large hydro is important for power generation and accounts for 21% of total electricity produced in the 15 countries in the current situation. Under the reference scenario, this percentage will slightly drop to 19% in 2020, as the planned additional capacity cannot keep up with the growth in electricity demand. However, under the maximum scenario, that includes also plants for which the timeframe is not known yet or for which the financing is not yet secured, it outpaces the electricity demand and grows to 26% in 2020.

Under the maximum scenario, large hydro and RE together account for 2/5 of the electricity production in the 15 emerging and developing countries in 2020.

Figure 1.11: RE and large hydro as a % of total electricity production



When considering the individual countries (Figures 1.12 and 1.13), the RE% of total electricity production excluding large hydro ranges between 0 and 5% in the current situation, except in Uganda, where small hydro and waste are important electricity sources in the current situation and RE currently accounts for 9% of the total electricity production.

Under the reference scenario, RE electricity keeps up with the growth of electricity demand in 2020 in all countries, except in Uganda and Indonesia, where the RE% of total electricity production shows a small decrease.

Under the maximum scenario, RE electricity grows to over 20% in two countries (Argentina and Brazil) while it grows to the level of 10 to 15% in another eight countries (Colombia, Mexico, China, India, Indonesia, Pacific, Niger and Uganda)⁵. This scenario builds upon strong and pro-active RE policy including setting targets, providing possibilities to deliver to the grid, and having regulations in place for good feed-in-tariffs for independent producers. The increase of RE electricity is notably achieved by investments in small and medium hydro, wind energy and (agro) waste treatment. PV systems and mini/micro hydro only contribute a negligible part (<1 %) to the total electricity production, with the exception of some of the Pacific Islands.

Eight out of the 15 countries have targets for RE electricity (Argentina, Brazil, Mexico, China, India, some Pacific Islands, Thailand and South Africa), either for the near future 2010-2012 or for the period 2020-2025.

Large hydro is a major source for power generation in most countries. It accounts for 70 to 90% of the current electricity production in the African countries Cameroon, Ghana and Uganda, while Niger has plans to attain the same level. Under the maximum scenario, large hydro and RE together cover between 80 and 95% of the electricity demand in Cameroon, Niger and Uganda in 2020; dependence on fossil fuels for electricity production is so avoided to a large extent. This is not achieved in Ghana where significant additional capacity is not foreseen for large hydro and where RE electricity only grows to 1% under the maximum scenario.

The Latin American countries Argentina, Brazil, Colombia and Peru also use large hydro to a large extent for their electricity production, between 40 and 80% in the current situation. However, as no significant additional capacity of large hydro plants is foreseen, because of the wish to diversify electricity production and use other sources, large hydro cannot keep up with the growth in electricity demand and the large hydro % of total electricity production drops in Argentina, Brazil and Peru with 20 to 25 percentage points in 2020.

⁵ The percentages for the maximum scenario may be conservative, as for some countries there is no information available to assess RE production from biomass and (agro) waste.

Colombia is building some additional capacity and can maintain its percentage of 80% of total electricity production.

In the Asian countries expansion of the large hydro capacity is planned; under the maximum scenario the part of power generated by large hydro grows in China, India and Indonesia to levels of 20 to 30% in 2020. Large hydro and RE together, account for 30 to 40% of the electricity production in 2020 in these countries under the maximum scenario.

The only countries that do not attain such levels are Mexico, Thailand and South Africa. They invested in large hydro but not to the extent of others for various country-specific reasons. Under the maximum scenario, large hydro and RE together, account in these countries only for 5 to 15% of the electricity production in 2020.

Figure 1.12: RE-electricity as a % of total electricity production

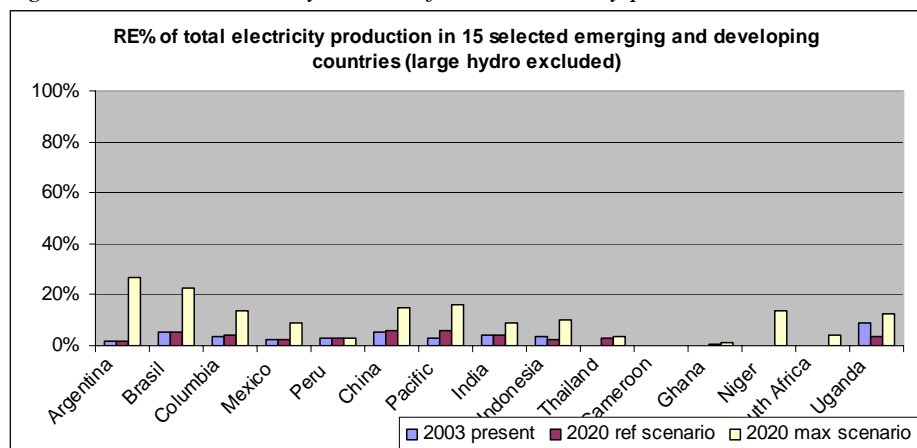
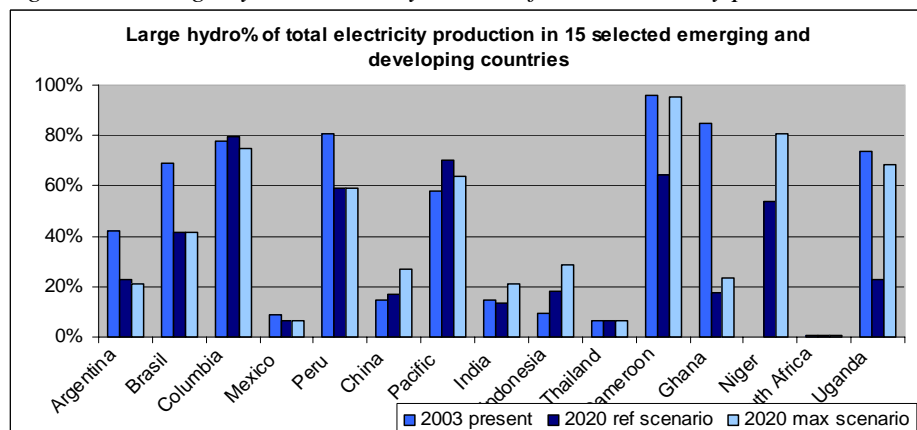


Figure 1.13: large hydro-electricity as a % of total electricity production



1.6. Other studies are in line with RECIPES although the ranges of uncertainty differ

We have compared the outcome of the technical and market potential analysis carried out in the RECIPES project with existing studies.

The analysis of these studies showed the added-value brought by the RECIPES project: there are no existing studies providing information with such a level of detail at a country level given by local experts, in terms of data for all RE market and technology combinations, but also in terms of RE market analysis, and (renewable) energy policies.

The most significant studies showing similarities with the RECIPES assessment of market potentials in 2020 are:

- US DoE Energy Information Administration – EIA scenarios
- IEA – International Energy Agency – World Energy Outlooks
- WEC – World Energy Council – scenarios to 2050
- Shell scenarios to 2050
- EREC scenarios to 2040
- Wind Force12 - Greenpeace and EWEA
- UNDP/GEF – Global Environment Facility

The first two studies (US EIA and IEA figures) had sufficient similarities in geographical scope, timescale and market scope to make a comparison possible with the RECIPES figures for the present situation. For the 2020 outlook only the US EIA figures could be used for comparison.

In order to make the comparison possible, we had to recalculate the EIA values since EIA uses the substitute methodology in contrast to IEA and RECIPES⁶.

Conclusions of the comparison carried out for the current situation, presented in Table 1.14, are as follows:

1. *For large hydro similarity is very high:* discrepancies between the three sources (RECIPES, IEA and EIA) for the present electricity production from large hydro are very limited.
2. *For RE electricity from sources other than large hydro, similarity is high but there are some noteworthy differences which can be explained easily:* the following differences can be observed in RE electricity from other sources than large hydro:

⁶ In the substitute methodology, one calculates the fossil energy that would be needed to deliver a certain amount of Renewable Energy. A conversion factor is applied to calculate a fossil fuel equivalent to RE. This conversion factor corresponds to a theoretical energy efficiency for RE: 33% for the energy efficiency for RE from all sources except for geothermal, 16% for energy efficiency for geothermal. IEA and RECIPES do not use this methodology, which means that the share of RE in TPES is directly calculated from the amount of Renewable Energy produced. See also section on abbreviations and definition under RE%.

- RE electricity figures for RECIPES are higher than IEA and EIA figures in all countries except Indonesia and Thailand. This is because RECIPES only excludes large hydro, whereas IEA and EIA exclude all hydro. The difference is pretty much the value for small hydro.
 - RE electricity value for RECIPES in China is much higher. A major difference is observed in China: RECIPES has 104.9 TWh for RE electricity while excluding large hydro, whereas IEA and EIA have respectively 2.5 TWh and 2.3 TWh. This difference is for the largest part also explained by the aforementioned reason (small hydro accounts for 93 TWh). The remaining difference comes from geothermal power: there is a production of 10 TWh/year from geothermal in China; this has not been included in the IEA figure.
3. For RE used for other purposes than electricity, RECIPES figures are higher due to a definition issue. The RECIPES figures for RE used for other purposes than electricity, are much higher than the IEA figures, while EIA does not have figures for this. This difference is explained because non-traditional use of biomass for other purposes than electricity (RE heat from biomass) is not included in the IEA figures.

Table 1.14: present RE volumes RECIPES compared to IEA and EIA

Present RE contribution	Present - RECIPES					Present - IEA				Present EIA	
	Total primary energy Mtoe	Renewable total		Renewable electricity		Renewable total		Renewable electricity		Renewable electricity	
		incl large hydro Mtoe	excl. large hydro Mtoe	incl large hydro TWh	excl. large hydro TWh	incl large hydro Mtoe	excl large hydro Mtoe	incl large hydro TWh	excl large hydro TWh	incl hydro TWh	excl hydro TWh
Argentina	69	6	3	33.8	1.3	3.01	0.10	35.0	1.1	34.6	1.1
Brasil	207	84	58	323.7	22.2	32.17	5.86	318.8	12.9	318.5	16.0
Columbia	28	4	0.2	40.0	1.7	3.16	0.05	36.7	0.5	36.3	0.5
Mexico	163	5	3	31.2	6.9	2.53	0.82	28.7	8.8	28.0	8.3
Peru	12	1.9	0.4	18.2	0.6	1.67	0.07	18.7	0.2	18.5	0.2
China	1326	37	13	384.9	104.9	25.87	1.48	286.2	2.5	280.9	2.3
Pacific	0.9	0.2	0.1	0.5	0.0	-	-	-	-	0.7	0.0
India	578	8	2	89.0	19.4	6.95	0.47	80.8	5.5	79.8	5.2
Indonesia	182	5	4	13.8	3.6	1.32	0.54	15.4	6.3	15.0	6.0
Thailand	92	0.7	0.1	7.0	0.0	0.86	0.23	9.9	2.6	9.7	2.5
Cameroon	7	0.3	0.0	3.6	0.0	0.30	0.00	3.5	0.0	3.5	0.0
Ghana	9	0.5	0.0	5.3	0.0	0.33	0.00	3.9	0.0	3.8	0.0
Niger	2	0.0	0.0	0.0	0.0	-	-	-	-	0.0	0.0
South Africa	112	0.2	0.1	2.2	0.5	0.35	0.02	4.1	0.3	1.0	0.2
Uganda	9	0.1	0.0	1.2	0.1	-	-	-	-	1.8	0.0
15 countries	2796	151.7	83.5	954.4	161.2	78.52	9.64	841.7	40.7	832.1	42.4
total 5 countries in											
Latin America	479	100.1	64.5	447.0	32.7	42.53	6.90	437.9	23.5	436.0	26.1
Asia	2179	50.5	18.9	495.2	127.9	35.00	2.72	392.3	16.9	386.0	16.0
Africa	138	1.1	0.1	12.3	0.6	0.99	0.02	11.5	0.3	10.1	0.2

For the comparison of the scenarios for 2020, we used the following two indicators: (i) TPES excluding traditional biomass and (ii) total electricity from RE including large hydro.

Prior to any comparison, one should take the following remarks into consideration:

1. *EIA and RECIPES models do not have the same approach.* EIA extrapolations are mainly based on growth of GDP and energy demand. RECIPES also takes the demand into account, but in its maximum scenario it looks for drivers which might privilege RE versus conventional energy.
2. *Reference scenario:* EIA and RECIPES reference scenarios extrapolate a continuation of the present situation, in terms of energy growth and in terms of present policies. But RECIPES emphasises the importance of the present RE policy, whereas the EIA's reference scenario is mainly based on the expected energy demand growth.
3. *Maximum scenario:* There is a noteworthy difference between the maximum scenarios: EIA assessed a maximum energy demand, and from there, a maximum RE demand, whereas RECIPES assessed the maximum RE share in the overall energy demand. Therefore, the TPES in the RECIPES maximum scenario is not the maximum TPES, but the TPES that would be obtained with a maximum RE production.

Table 1.15 shows the main outcomes; the main conclusions are as follows:

1. *The 2020 figures for the 114 INCO countries show a high similarity.* Both the TPES in 2020 excluding traditional biomass, and the total electricity from RE including large hydro in 2020 are similar. The RECIPES estimates show a wider range (from 2,000 to 3,600 TWh) in the RE contribution to electricity production than the EIA figures (from 2,200 to 2,700 TWh). This wider range is mainly explained by the difference of methodology explained in point 1 of the previous paragraph: the two RECIPES scenarios accentuate the importance of RE policies, and acting on drivers and barriers, which might result in a larger scope of RE market potentials.
2. *There is a high similarity for the TPES for Asia and limited discrepancies for Latin America and Africa.* In the case of Asia the RECIPES figures are between the low and high growth scenarios of EIA. The RECIPES figure for TPES is 15% higher for Latin America, and about the same for Africa, which appears to be reasonable given the timescale and the differences of approach chosen by RECIPES and EIA.
3. *At country level there are limited differences in the 2020 estimates for the TPES, except for Brazil.* This particular result for Brazil (nearly 50 % discrepancy) was thoroughly analysed. It is partially explained by differences in the current situation (20%), and by a higher growth rate for RECIPES (30%). RECIPES nevertheless confirms its figures, which are corroborated by official Brazilian figures.
4. *The figures for 2020 for RE electricity show rather large discrepancies (30% and beyond) but this is acceptable given the differences of approach and uncertainties of long-term scenarios.*
 - a. *At a country level:* EIA figures in 2020 are higher for Brazil and Mexico. RECIPES figures are higher for China and India. Asia figures are similar but the upper range of the RECIPES scenario is much higher. These differences are in our view related to the difference in methodology, and to the high importance of drivers and barriers in the RECIPES scenarios, which might lead to higher RE growth as explained in point 1 above. In the Chinese case, which shows the most

striking discrepancy, it should be noted that RECIPES figures might seem optimistic, but are still well below the Chinese governments targets.

- b. *At a continent level:* the comparison is indicative in this case. While EIA does not provide information about total RE production, RECIPES extrapolated RE electricity production for the 5 studied countries to the entire continent to get a view on total RE electricity production.
5. *Comparison is distorted for Africa because of Maghreb countries.* In Africa, the comparison is altered because the EIA figures include all African countries, whereas RECIPES figures are about INCO Africa and thus exclude Maghreb (Algeria, Egypt, Libya, Morocco, Tunisia) as well as Reunion and Saint Helena. The share of RE electricity from Maghreb countries was about 25% of Africa's RE production in 2003, and is expected to be about 30% in 2020 because these countries are amongst the richest and most rapidly developing African countries. The 2020 RECIPES figures are significantly higher than those of EIA but this comparison must be interpreted very cautiously as RECIPES extrapolated results for the 5 studied countries to the whole of Africa in order to be able to compare with the EIA figures on RE electricity production. The degree of uncertainty is high as the 5 African countries of RECIPES only represent 10% of Africa's RE production, Maghreb included. An extrapolation with such a high degree of uncertainty was only used in this specific case.

Table 1.15: 2020 RE volumes RECIPES compared to EIA

2020 RE contribution in electricity production (incl. Large hydro)	2020 - RECIPES				2020 - EIA scenarios					
	Total primary energy (excl. traditionnal biomass)		RE electricity		Total primary energy (excl. traditionnal biomass)			RE electricity		
	reference scenario	maximum scenario	reference scenario	maximum scenario	ref. case	HEGC	LEGC	ref. case	HEGC	LEGC
	Mtoe	Mtoe	TWh	TWh	Mtoe	Mtoe	Mtoe	TWh	TWh	TWh
Argentina	109	99	35.0	71.7	-	-	-	-	-	-
Brasil	414	405	397.7	543.8	250	271	227	566.3	576.1	498.0
Columbia	41	41	44.2	49.7	-	-	-	-	-	-
Mexico	220	217	36.8	68.1	246	262	231	78.1	87.9	78.1
Peru	13	13	20.5	20.5	-	-	-	-	-	-
China	2074	1924	791.2	1435.6	2567	2900	2272	693.3	693.3	693.3
Pacific	1	1	0.8	0.9	-	-	-	-	-	-
India	743	738	186.1	360.5	622	687	564	146.5	166.0	136.7
Indonesia	184	184	44.9	107.4	-	-	-	-	-	-
Thailand	146	146	17.5	18.2	-	-	-	-	-	-
Cameroon	3	2	4.6	6.8	-	-	-	-	-	-
Ghana	15	14	5.5	7.5	-	-	-	-	-	-
Niger	2	2	0.63	1.09	-	-	-	-	-	-
South Africa	73	71	2.2	12.7	-	-	-	-	-	-
Uganda	3	2	2.1	6.5	-	-	-	-	-	-
all INCO countries in										
Latin America	1266	-	605.1	879.8	979	1089	881	1162.0	1240.1	1015.5
Asia	4162	-	1336.3	2485.3	4155	4677	3695	1162.0	1230.3	1093.6
Africa ⁽¹⁾	655	-	144.73	183.03	540	606	491	126.9	136.7	107.4
World	6083	-	2086.1	3548.1	5674	6373	5067	2450.9	2607.1	2216.5

⁽¹⁾ EIA includes INCO countries, but also Maghreb.

The overall conclusion of the comparison is that the RECIPES estimates are in line with other studies although the ranges of uncertainty differ significantly, especially at country level. These differences were anticipated and might be considered rather limited given the level of uncertainty for such long-term projections, and the difference of approach between the EIA model and the RECIPES model.

For the full comparison we refer to the deliverable '*Comparison of RECIPES results with results of other projects/initiatives/studies*' that is available on www.energyrecipes.org.

2. An increased volume of renewable energy has a positive socio-economic impact in emerging and developing countries, but further work is required to substantiate and quantify this

Part of the RECIPES research was directed towards assessing the socio-economic and environmental impact of RE technologies in emerging and developing countries. Three activities were undertaken for this purpose:

- a. *A survey on socio-economic effects.* A survey was carried out among 123 experts in emerging and developing countries, on the socio-economic effects of RE and non-RE technologies in these countries. The RECIPES team decided for a survey, and not for an impact analysis or other qualitative or quantitative analysis of data, for a number of reasons:
 - On the basis of literature search and consultation of the Advisory Board and other experts, it was concluded that there is no good information available in literature on this issue;
 - A comprehensive survey on the subject was not done yet;
 - A survey fitted best within the scope, timeframe and resources of the project;
- b. *Estimation of the CO₂ emission reduction potential.* Based upon the market potential for renewable energy of the 15 emerging and developing countries that were studied, the potential for CO₂ emission reduction was estimated;
- c. *A comparison with other studies concerning the socio-economic impact of renewables in emerging and developing countries.* The results of the survey and the calculations were compared with existing research regarding socio-economic effects of renewable energy technologies in emerging and developing countries.

From the research activities undertaken, it emerges that RE technologies do have positive socio-economic and environmental effects in emerging and developing countries, but also that further work is required to substantiate and quantify this:

- a. The experts participating in the survey indicate that RE technologies contribute more to local socio-economic development in emerging and developing countries than non-RE technologies;
- b. Solar, hydro, bio-energy and wind technologies contribute most, fossil based and nuclear technologies least;
- c. Renewable energy technologies have a significant CO₂ reduction potential;
- d. Other studies confirm the potential of RE technology for job creation but give a confused picture on the overall socio-economic impact of RE in emerging and developing countries; thorough analysis does not exist.

These reasons are developed more in detail in the following paragraphs. For the full results of the socio-economic analysis we refer to the socio-economic report and its annexes that are available on www.energyrecipes.org.

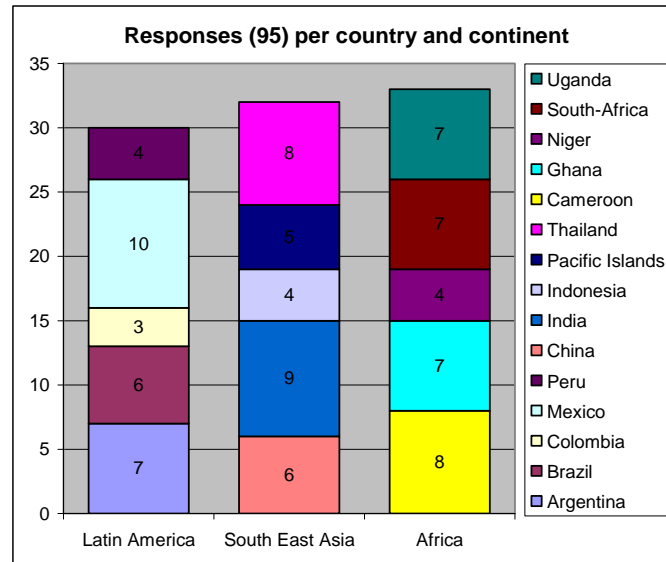
2.1. Experts indicate that RE technologies contribute more to socio-economic development in emerging and developing countries, than non RE technologies;

In the survey, 318 experts from all over the world, having a good understanding of the socio-economic impacts of energy technologies in emerging and developing countries, were invited to fill in 16 questions regarding the socio-economic impacts of (renewable) energy technologies in these countries. In total 123 experts responded, of which 97 filled in the survey substantially. We have mainly used these 97 responses for our analysis.

The respondents were well distributed over the 15 countries (see Figure 2.1); their job profiles were relevant and well spread thematically (40% energy in general, 37% renewable energy and 23% other) as well as organisation-wise (26% public authority, 23% research institution or university, 22% non profit, 19% consultancy and 10% industry). For further information we refer to annex 1 of the socio-economic report, available on the RECIPES website, that lists the organisations and job functions of all respondents.

The survey was designed to compile the view of local experts on the socio-economic impacts of various energy technologies. Respondents were requested to provide their expert opinion relying on their existing theoretical and practical knowledge. Respondents were not required to do research of any kind; they were asked to invest some 20 minutes in filling in the questionnaire.

Figure 2.1: Distribution of respondents over countries and continents



The experts were asked to assess ten types of socio-economic impact⁷ in emerging and developing countries, in relation to the implementation of eight different energy technologies⁸. The ten types of impact addressed are considered to cover the key socio-economic impacts in emerging and developing countries and provide a balanced view of the socio-economic impact in these countries⁹:

- Impact criteria 1 to 7 (see Table 2.3) were derived from the UN Millennium project and related to energy technologies;
- Impact criterion 8 ‘*Country trade balance*’ has become increasingly important given the high oil prices in recent years, especially for countries with a negative trade balance and high dependency on fossil fuels for their energy supply;
- Impact criterion 9 ‘*Security of supply*’ always has been an important factor for energy technologies or fuels and is for instance related to the political and economic instability in important energy (oil) supplying countries, and the threat of terrorism;
- Impact criterion 10 ‘*Energy costs*’ is an obvious and key aspect for energy technologies, both for decision makers and for end consumers.

Figure 2.2 presents the overall score¹⁰ per energy technology and shows that the scores differ significantly for renewable energy technologies compared to non-renewable energy technologies: respondents expressed that renewable energy technologies have a more positive local socio-economic impact in emerging and developing countries, than non-renewable energy technologies¹¹.

⁷ Experts were requested to indicate the ‘*relative*’ impact of energy technologies, by answering the following question: “*Assuming that energy technologies will be implemented to the same extent (in MW, Mtoe or kWh), what will be their impact on socio-economic aspect X*”? By asking experts to indicate a relative impact, it was avoided that impact and implementation potential were mixed. Answers were technology-related instead of potential-related.

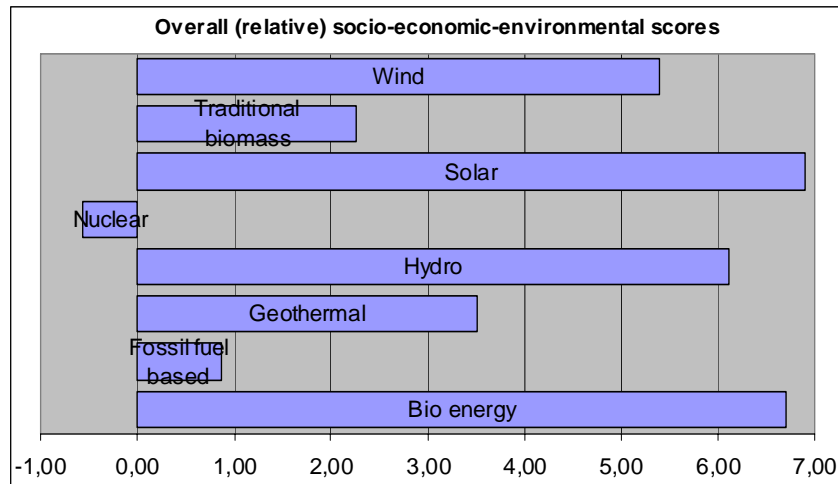
⁸ These technologies are: bio-energy (including biomass, waste and bio-fuels), fossil fuel based (coal, gas, oil), geothermal (heat and electricity), hydro (all types), nuclear, solar (solar thermal and PV), traditional biomass and wind.

⁹ Because of the specific development context of emerging and developing countries, the project team considered it important to complement economic impact criteria related to trade balance, security of supply and energy costs (criteria 8 to 10) with wider socio-economic impact criteria. These wider impact criteria were derived from the UN millennium goals that set an important part of the socio-economic agenda for developing countries. These wider impact criteria include aspects as job creation, agricultural activity but also conditions for education and gender quality.

¹⁰ The overall score is the aggregate of the ten impact criteria without weighing factors. The scores per individual impact criterion are presented in Table 2.3.

¹¹ Similar results are obtained if aggregated scores are produced from the following traditional socio-economic criteria: 1. Job creation, 8. Country trade balance, 9. Security of supply and 10. Energy costs. The results on the basis of these four criteria are: RE technologies score best (bio energy, hydro, solar and wind all score between 2 and 3), geothermal and traditional biomass score significantly lower (1.29 and 1.39 respectively), and fossil fuel based and nuclear score negative (-0.3 and -0.35 respectively).

Figure 2.2 Overall socio-economic score per energy technology



The results must be considered as an aggregate opinion of all participating experts on the socio-economic impacts of RE in EDCs, and not as the outcome of in-depth qualitative or quantitative analysis. The survey outcome can feed the debate and future work on the local impact of RE in emerging and developing countries. The aggregate opinion is in agreement with the few existing statements in this field although some aspects are nuanced, as presented in section 2.4. The survey was not designed to provide information on specifics (like the impact of bio fuel production on the food prices of certain products) but to provide a general opinion of local specialists per technology and per socio-economic effect. In the view of the RECIPES team the survey outcome is valid in this stage of research on the subject, but should be complemented with more qualitative and quantitative analysis in the longer run.

2.2. Solar, hydro, bio-energy and wind technologies contribute most, fossil based and nuclear technologies least

Table 2.3 presents the scores per socio-economic impact criterion and also highlights which technology scored best, second best or worst per impact criterion.

Solar and bio-energy are considered to contribute most to the socio-economic development in emerging and developing countries: for nine out of ten impact criteria these RE technologies obtain the best scores. Hydro and wind follow closely. Fossil fuel based and nuclear energy technologies are considered to contribute least to the socio-economic development in emerging and developing countries: either fossil fuel or nuclear received the worst score on each of the ten impact criteria.

Geothermal received relatively low socio-economic scores; the data did not permit us to fully comprehend why, but we consider that this is partly because the technology is not very well known among all the experts that participated in the survey, as this RE technology is not present in all countries and only a few installations are installed and operational.

Traditional biomass is considered to have a lower socio-economic impact than RE technologies, especially regarding indoor air pollution, conditions for education and gender equality. This is in line with other publications on the subject (see section 2.4).

Table 2.3 Overall (relative) scores of the survey

Energy technologies	Bio-energy	Fossil fuel based	Geothermal	Hydro	Nuclear	Solar	Traditional biomass	Wind
Social, economic and environmental impact area								
National job creation	0,83	0,35	0,36	0,75	-0,06	0,77	0,49	0,64
Agricultural activities	0,87	0,33	0,22	0,71	0,00	0,73	0,43	0,58
Safe cooking of food	0,75	0,38	0,21	0,41	0,00	0,69	0,30	0,27
Conditions for education	0,68	0,33	0,41	0,75	0,00	0,88	0,07	0,68
Gender equality	0,73	0,35	0,32	0,63	0,00	0,77	0,04	0,53
Indoor air pollution	0,66	-0,16	0,46	0,61	0,00	0,82	-0,14	0,57
Loss environmental resources	0,29	-0,05	0,59	0,58	-0,21	0,88	0,19	0,71
Country trade balance	0,81	-0,15	0,45	0,73	0,03	0,68	0,28	0,64
Energy security	0,83	-0,05	0,62	0,72	0,02	0,83	0,37	0,78
Energy costs	0,24	-0,45	-0,14	0,22	-0,34	-0,16	0,25	-0,01
Overall score	6,70	0,87	3,51	6,11	-0,57	6,90	2,27	5,39

Best technology

Second best technology

Worst technology

Conclusions per socio-economic impact criteria are as follows:

1. *National job creation.* Bio, solar and hydro energy technologies are considered to stimulate national job creation in emerging and developing countries the most, nuclear technologies the least; other sources (see section 2.4) confirm high job creation as a result of bio-fuel production in Brazil, and production and assembly of solar thermal installations in China.
2. *Agricultural activities.* RE bio-energy is considered to have the best (relative) potential to stimulate agricultural activities, followed by solar and hydro energy technologies;
3. *Safe cooking of food.* RE bio-energy and solar energy have the best (relative) potential to improve the safe cooking of food; other technologies stay far behind;
4. *Conditions for education.* Solar has the best (relative) potential to improve conditions for education; hydro, wind and bio energy follow closely;
5. *Gender equality.* Solar and bio have the best (relative) potential to improve gender equality; hydro and wind energy follow closely;

6. *Indoor air pollution.* Solar has the best (relative) potential to reduce indoor air pollution; bio, hydro and wind energy follow at a distance;
7. *Loss of environmental resources.* Solar and wind are considered to have the best (relative) potential to reduce the loss of environmental resources, followed by hydro and geothermal. Bio-energy and traditional biomass follow at a distance; some experts indicated the negative impacts of traditional biomass on deforestation and the possible negative impacts of bio-energy on deforestation and land-use;
8. *Trade balance.* RE bio-energy has reportedly the best (relative) potential to improve the trade balance; closely followed by hydro, solar and wind;
9. *Energy security.* Solar, bio, wind and hydro are considered to have the best (relative) potential to improve energy security; geothermal follows closely, the rest stays far behind;
10. *Energy costs.* The respondents considered traditional biomass, bio-energy and hydro as the cheapest energy technologies; fossil fuel based and nuclear technologies as the most expensive ones. This partly fits with figures presented by IEA and REN21 that consider the following RE technologies as cost-competitive: large hydropower, bio-energy through combustible renewables and waste, solar thermal (in hot climates) and ethanol (in Brazil). The respondents' opinion for fossil fuels is however awkward: fossil fuel based technologies can be expensive in some applications but are definitively cost-competitive in many other situations, also in emerging and developing countries. The RECIPES team found a higher variation in the answers regarding energy costs, but could not find a conclusive reason for this. A sensitivity analysis showed that the scoring on the 'energy cost' criterion did not fundamentally change the overall conclusions. The outcome for this criterion demonstrates, once again, the need for further in-depth research and discussion regarding the socio-economic impact in emerging and developing countries.

2.3. RE technologies have a significant CO₂ reduction potential

An additional and obvious advantage of RE technologies is the reduction of carbon dioxide emissions, when compared with fossil fuel based technologies.

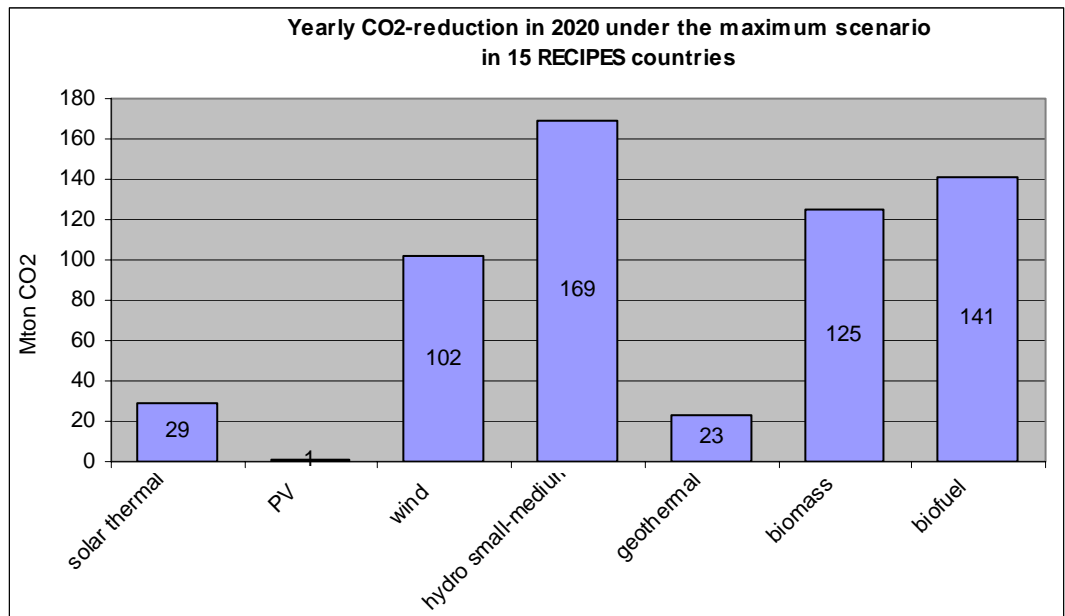
Under the maximum scenario, replacement of non-renewable energy technologies with renewable energy technologies leads to a CO₂ emission reduction of 590 Mton CO₂ per annum in the 15 emerging and developing countries in 2020. If the present capacity of renewable energy installations is added, the overall CO₂ emission reduction is 780 Mton CO₂ per annum in the 15 emerging and developing countries in 2020.

The CO₂ reduction under the maximum scenario is small compared to the increase in CO₂ emission foreseen for EDCs: the EIA foresees that the CO₂ emission of EDCs will grow from 8,400 Mton CO₂ per annum in 2003 to 16,100 Mton CO₂ per annum in 2020 (source: www.eia.doc.gov).

Figure 2.4 shows that small and medium hydro, bio-fuels, bio-energy and wind energy have the highest CO₂ reduction potential.

Note that reduction of CO₂ emissions is not considered as a prime driver for RE in the 15 countries under study: main drivers for RE in emerging and developing countries are coping with increased energy demand, providing access to energy and securing energy independency at reasonable cost.

Figure 2.4 CO₂-reduction potential



* Biomass: including waste, gasification, etc. for electricity generation and industry (heat)

** CO₂-reduction based on the numbers of installations implemented in the maximum scenario

2.4. Other studies confirm the potential of RE technology for job creation but provide a confused picture on the overall socio-economic impact of RE in emerging and developing countries; thorough analysis does not exist

This section provides the main conclusions of a comparison of the aforementioned results and conclusions of the RECIPES project with the outcome of other studies. The results of the following studies have been taken into consideration in this comparison:

- IEA / OECD, 2003: 'Creating markets for energy technologies';
- IEA, 2003: 'Renewable energy... into the mainstream';
- Martinot, E, 2002, 'Renewable Energy markets in Developing Countries';
- Martinot, E. (2005, 2006), 'REN21: Renewables Global Status Report 2005' and 'Renewables Global Status Report – 2006 update';
- UNDP, 2000: 'Sustainable Energy strategies – materials for decision makers'.

Subject of the comparison are the following topics: contribution to socio-economic aspects of RE technologies compared to non-renewable technologies and the relative contribution of various RE options. For a comparison with regard to the CO₂ reduction potential of RE technologies, please refer to paragraph 1.6, as this topic is directly corresponding to the potential market volume.

The conclusions are as follows:

- Other studies confirm the job creation potential of bio-energy and solar;
- Other studies nuance the overall socio-economic benefit of RE, but little information is available on the socio-economic impact of RE, particularly in relation to emerging and developing countries;
- The RECIPES work can be used as a starting point for further work and debate on the socio-economic impact of RE in emerging and developing countries.

These conclusions are detailed in the sections below.

2.4.1. Other studies confirm the job creation potential of bio-energy and solar

The RECIPES survey identifies bio-energy as the best scoring technology with regard to job creation (closely followed by solar and hydro). This is confirmed by several other studies, including the UNDP publication ‘Sustainable Energy strategies – materials for decision makers’, which identifies biomass as a source of RE which is likely to have a relatively high impact both on the local socio-economic and on the local environmental situation due to its land- and labour intensiveness.

REN21 reports that over 50% of all (1,700,000) jobs in RE are related to the production of bio fuels (a total of 900,000 direct jobs, of which 400,000 in Brazil). The second largest share - a further 15% of all jobs (250,000 jobs) - is related to solar hot water production in China (REN21, 2005).

2.4.2. Other studies nuance the overall socio-economic benefit of RE, but little information is available on the socio-economic impact of RE, particularly in relation to emerging and developing countries

The potential socio-economic benefits (including job creation, income generation possibilities, health, education) in which the implementation of renewable energy options can result at a local level, are also underlined in the publication ‘Renewable energy... into the mainstream’ (IEA 2003). Apart from the general benefits that modern energy services can bring to areas that currently have no access to these services, the report stresses the particular benefits of renewables for medical services (which value reliable, low pollution energy sources) and the higher job creation potential compared to fossil based technologies. The report furthermore highlights the importance of various RE options that could replace the use of traditional biomass for cooking (such as advanced woodstoves) for the improvement of local health conditions.

The publication 'Creating markets for renewable energy' (IEA / OECD 2003) places emphasis on that RE options are not necessarily better from a socio-economic or environmental perspective, this depends on the situation and on how they are implemented. Governmental actors should ensure that the development is steered in this direction where possible. This is also concluded in the publication 'Renewable energy... into the mainstream' (IEA 2003), which highlights that national policy will have to address the important issue of stimulating technology options that have the least negative impacts, and that will result in the largest improvements of the local environmental situation.

The conclusion that can be drawn from the RECIPES survey that experts consider fossil and nuclear technologies less beneficial for socio-economic development in emerging and developing countries than RE technologies, is thus somewhat nuanced by the studies that were taken into consideration in the comparison.

Several specific examples are given in the studies in which electricity from renewable sources is preferred over fossil energy based technologies as they can offer a better security of supply and are causing less local pollution. The benefits brought up by the aforementioned studies are mainly related to rural electrification and are not particularly related to RE. Furthermore, it is mentioned by several studies that the socio-economic impacts of RE are highly dependent on the specific local situation.

In general it can be stated that most sources agree on the job creation benefits that renewable energy can bring compared to fossil fuel based and nuclear energy systems. Regarding other socio-economic benefits of RE, it is mentioned that these are to a high extent case-specific, however little information is available on this subject, whether in general or in relation to emerging and developing countries.

2.4.3. The RECIPES work can be used as a starting point for further work and debate on the socio-economic impact of RE in emerging and developing countries

The literature search and comparison show that little work has been done on the socio-economic impact of RE, in general and in relation to emerging and developing countries in specific. The RECIPES survey outcome can feed the debate and future work on the local impact of RE in emerging and developing countries. In the view of the RECIPES team the survey outcome is valid at this stage of research on the subject, but should be complemented with more qualitative and quantitative analysis in the longer run. The added value of the RECIPES work is in particular:

- *Having added to the current research available. Work on the socio-economic impact of RE in EDCs is materially inexistent so far, which is in a striking contrast to its importance for decision-making on energy technologies and RE. A comprehensive survey under specialists on the socio-economic impact of RE in EDCs was not done so far. The survey is a step to further work in this field;*

- *Integrating work on socio-economic benefits and work on potentials.* The outcome of the survey on socio-economic impact is integrated with work on scenarios and future potentials (win-win). A positive socio-economic impact is the most powerful driver for RE implementation;
- *Bringing together viewpoints of different existing studies.* In this section 2.4 RECIPES presents the outcome of different existing studies and compares it with the outcome of the RECIPES survey on socio-economics.

3. An increased volume of renewable energy in emerging and developing countries presents a highly interesting market for EU industry but competition is fierce and risks are higher than in the domestic market

This chapter reports on the market opportunities for the EU RE industry to do business in emerging and developing countries. To this purpose we used the market volumes for the different RE technologies as presented in chapter 1 and combined this with an analysis of the current situation of technology manufacturing and import in the 15 RECIPES countries, with risks and barriers for doing business in these countries, and with general information on the RE markets and RE industries worldwide. Conclusions apply to the 15 RECIPES countries only; it was not possible to extrapolate to the 114 INCO countries.

The possibilities for EU RE industry can include export of goods, hardware and equipment, as well as transfer of know-how, consultancy, training and other services. It can also contain investment in local manufacturing capacity or in local RE plants.

The research shows that an increased RE volume in emerging and developing countries presents a highly interesting market for EU industry, but also that competition is fierce and that risks are higher than in the domestic market.

This is developed more in detail in the next paragraphs. For the full results of the analysis of the market opportunities for the EU industry we refer to the EU industry report that is available on www.energyrecipes.org.

3.1. The volume of the RE market in emerging and developing countries is significant and interesting for EU industry

Significant market growth is expected for renewables in emerging and developing countries as concluded in chapter 1. This market is, in the maximum scenario, in the same order of magnitude as the market for the EU, which is one of the biggest markets in the world (see Table 3.1).

Table 3.1: RE present and market growth of EDCs compared to EU (large hydro excluded)

RECIPES	2003 contribution RE to TPES (Mtoe)	2020 market growth (ref scenario) (Mtoe)	2020 market growth (max scenario) (Mtoe)
Emerging and developing countries (114 INCO-countries)	95	73	227
EREC 2004	2000 total inland consumption (Mtoe)	2020 market growth expectations EREC (Mtoe)	
EU-15	88	228	

Sources: RECIPES and EREC (2004): "Renewable energy target for Europe; 20% by 2020, Brussels 2004. Note: this comparison must be considered as indicative since the RECIPES and EREC studies use different assumptions and calculation methods.

3.2. Country and RE sector specific barriers and risks show that the investigated Asian and Latin American countries are most attractive for doing business in RE. This is more difficult in the African countries except in South Africa

A number of restrictive non-technical conditions in emerging and developing countries make it more difficult to do business in these countries. In this section the risks and barriers are described that are related to doing business in RE in emerging and developing countries.

We distinguished two types of risks and barriers:

- Country risk general level*: political and economic country stability (based on AON risk map – AON 2006);
- RE industry and import*: readiness of countries to participate in CDM projects, the availability of import facilities, and the openness of a country to import/foreign investments in general (information gathered by local experts in the 15 countries);

The overall attractiveness for doing business in the RE sector in the 15 RECIPES countries, taking both aspects mentioned above into account, is as follows (see Table 3.2):

- Attractive*: Brazil, Mexico, China, India, Thailand, Pacific Islands Kiribati and Vanuatu;
- Medium attractive*: Argentina, Colombia, Peru, Indonesia, South Africa, Pacific Island Fiji;
- Not attractive*: Cameroon, Ghana, Niger and Uganda.

Table 3.2: attractiveness for doing business in RE in the 15 INCO countries

	Country Risk Level general	Effect of attitude towards RE industry and cooperation with companies from abroad	Overall conditions for EU export
Latin America			
Argentina	medium-high	neutral	medium
Brazil	medium-low	positive	high
Colombia	medium-high	neutral	medium
Mexico	medium	neutral- positive	high
Peru	medium-high	neutral	medium
Asia and Pacific			
China	medium	positive	high
India	medium	positive	high
Indonesia	medium-high	neutral	medium
Fiji Islands	medium-high	neutral- positive	medium
Kiribati	medium-low	neutral- positive	high
Thailand	medium	positive	high
Vanuatu	medium	neutral- positive	high
Africa			
Cameroon	medium-high	neutral	low
Ghana	medium-high	neutral	low
Niger	high	neutral	low
South Africa	medium	neutral- positive	medium
Uganda	medium-high		low

3.3. Market opportunities for EU industry vary per RE technology but are generally best in the investigated Asian and Latin American countries, and small in the African countries, except in South Africa

The following sections present the market opportunities for EU RE industry per technology. The underlying analysis is based on the current market characteristics, the expected market increase, where the hardware for this technology is manufactured, and information about knowledge and organisational degree in a country. Concerning the hardware of a RE technology, information was collected on which parts are produced in the country and which are imported.

Per RE sub sector the conclusions are summarised hereafter. More details can be found in sections 3.3.1 to 3.3.7.

Wind power presents without doubt the **biggest market opportunities** for the EU RE industry in emerging and developing countries in the near future. The market potential in emerging and developing countries is significant: the additional installed capacity in 2020 in 15 RECIPES countries is estimated at 85 GW under the maximum scenario. Countries with high potential markets are China, Brazil, India, Argentina and Mexico. The EU wind industry clearly has the lead in this sector. Maintaining the lead in this booming sector is the main challenge for the EU wind power industry.

Also **small and medium hydro** present **high market opportunities** for EU industry in emerging and developing countries: the additional installed capacity in 2020 in the 15 RECIPES countries is estimated at 75 GW under the maximum scenario. High potential markets are China, India and Brazil. The other Asian and Latin American countries, as well as South Africa and Uganda follow at a distance. The EU industry is technologically leading because of high yields and low environmental impacts, but faces high competition with well-implanted local industries.

Bio fuels for transport present **potentially high market opportunities** for EU industry in emerging and developing countries: the additional volume in 2020 in the 15 RECIPES countries is estimated at 75 billion litres ethanol and 22 billion litres bio-diesel. This presents significant opportunities for EU industry that is leading in bio diesel and increasing its involvement in ethanol. Note however that the estimates have a high degree of uncertainty due to the early stage of the market.

Photovoltaic also presents **potentially high market opportunities** for EU industry in emerging and developing countries: the additional installed capacity for PV in 2020 in 15 RECIPES countries is estimated at 1.8 GWp under the maximum scenario. The markets in emerging and developing countries are growing, especially in China, Indonesia, Thailand, Brazil and South Africa. It is however unsure whether these markets will become as attractive as the currently dominating and strongly subsidised markets of the EU, Japan and the

US, that create the high growth rates of this industry (the average annual growth rate was 40% or more in the last five years). International competition is high between the top producers in Japan, the EU, China and the US.

Solid biomass and biogas also present **potentially high market opportunities** for EU industry in emerging and developing countries. The international market for bio-energy is still in a very early stage but is expected to grow considerably in both industrialised and developing countries in the next years. EU industry is composed of many small companies but has valuable experience in the sector and is well positioned to benefit from this.

Solar thermal hot water installations are considered to present **low market opportunities** for EU industry in emerging and developing countries. Chinese industry is servicing its home market that is by far the biggest in the world; this industry produces installations at a fraction of the costs of those produced in the EU. EU industry may find an opportunity to import this low-cost technology or to produce under licence, and so boost its home market.

For **geothermal energy**, the market opportunity level for EU industry in emerging and developing countries remains **unclear**. The geothermal *power* sector is expected to grow, especially in South East Asia and Latin America, but the available information did not enable us to develop scenarios for emerging and developing countries for 2020. There is high competition between the five leading manufacturers one of which is European. EU industry itself does not expect much from the geothermal *heat* market in emerging and developing countries.

Also for **solar thermal power**, the market opportunity level for EU industry in emerging and developing countries remains **unclear**. The EU is investing in this sector and can take the lead in this technology, which potentially presents huge opportunities in emerging and developing countries. However, solar thermal power is still in an emerging stage and therefore not studied in detail in RECIPES.

The aforementioned conclusions are generic and apply to the EU RE sub sectors as a whole. Niche players with specific products or breakthrough technologies can have a quite different level of opportunity in specific markets or countries.

3.3.1. *Wind power: additional installed capacity in 2020 in 15 RECIPES countries is estimated at 85 GW under the maximum scenario. Highest opportunities for the EU wind industry are in the investigated Asian and Latin American countries, and in South Africa. The other African countries hardly represent any potential. EU industry is very well positioned to grasp these opportunities.*

Wind power market

In the 15 RECIPES countries, the installed capacity will grow under the maximum scenario from 5 GW at present to some 90 GW in 2020, a growth of 85 GW, showing the high potential for the wind power market in these countries (see Table 3.3). China will have an installed capacity of 30 GW in 2020; Brazil and India will have comparable installed capacities (20 GW each). Other countries with high potentials are Argentina and Mexico.

Table 3.3: present situation and scenarios wind energy in the 15 countries

Wind	Present		Scenarios 2020		product manufactured			
	MW	Target	Ref MW	Max MW	This country	North America	Europe	Asia
					yes/no and if available %			
Argentina	27	Yes	315	7,500	No	No	95	No
Brazil	28	Yes	3,300	20,000	No	No	Yes	No
Colombia	19.5	No	90	1,250	No	No	100	No
Mexico	2.6	No	105	9,400	No	No	100	No
Peru	0.7	Yes	6	65	No	No	Yes	No
China	570	No	7,000	30,000	yes	Na	Na	No
Pacific Islands	0.0	na	0	0				
India	4500	Yes	12,500	20,000	50	No	50	No
Indonesia	0.4	na	1.4	100	No	0	0	No
Thailand	0.7	Yes	135	330	No	No	Yes	Yes
Cameroon	pm	Yes	pm	pm	No	No	No	No
Ghana	0.3	na	0.3	0.3	No	No	No	No
Niger	pm	No	pm	0.8	No	No	Yes	No
South Africa	3.2	No	18	200	No	No	Yes	No
Uganda	pm	No	pm	pm	No	No	No	No

In 2005 the world wind power capacity grew to 58 GW, corresponding to an annual average growth rate of 28% throughout the last ten years. The installed capacity was 41 GW in the EU, 10 GW in US and Canada, 6 GW in Asia, and 1 GW in the rest of the world. In 2005 an additional 10 GW was added, mainly in the EU, the US and India. Forecasts foresee an installed EU capacity of 75 GW in 2010 (EurObserv'ER 2006f).

Wind power manufacturing industry

European industry leads the wind power industry that operates in an increasing global market dominated by a small number of manufacturers. The top-10 wind power manufacturers account for 96% of the market in 2004; seven of them are European. Market leader Vestas (Denmark) is followed by Gamesa (Spain), Enercon (Germany), GE Wind (US), Siemens (Germany) and Suzlon (India). Wind power manufacturing has become a multi-billion-euros business; the turnover of market leader Vestas was estimated at 3 billion euros in 2005 (EurObserv'ER 2006f).



The important role of the EU wind industry is clearly visible in the 15 RECIPE countries (Table 3.3). Currently all countries import turbines from the EU except three: India, China and Thailand. In China wind power technology was imported until recently, but the new bidding rounds include the conditions that components must be manufactured in China, and a percentage hereof by Chinese industry itself.

Wind power manufacturers are in the process of expanding international production in crucial growth markets with a special focus on China. Vestas (Denmark) plans a factory in China by 2007 to assemble nacelles and hubs, Nordex (Germany) began producing blades in China in 2006, and Acciona (Spain), Suzlon (India) and GE Energy (US) were all opening new manufacturing facilities in China. China had 4 domestic manufacturers in 2005: Goldwind, Zhejiang Windey, Dongfang Steam Turbine Works and Harbin Electric Machinery Co (REN21 2006).

Increased turbine size has been a driver for growth in the industry. European and US industry now produce turbines in the 1-3 MW range and prepare the introduction of turbines in the 5 MW range. Production up to 1 MW is common in India and China. RECIPE local experts indicate that small wind turbines (<30 kW) are produced in Argentina, China, and Thailand, and that medium-sized wind turbines (up to 1 MW) are produced in China and India. Several other countries such as Brazil produce components like blades or towers.

Regarding capacity building, all RECIPE countries except Peru and Cameroon have a wind energy map available. The RECIPE local experts mention a lack of maintenance capacity in countries with smaller stand-alone systems: the transfer of know-how and skills can more easily be organised in the case of large wind farms than of smaller systems scattered over a wide region.

Market outlook in RECIPE countries

The maximum scenario predicts that the biggest capacity increase will be in China, Brazil, India, Mexico and Argentina (Figure 3.4).

Figure 3.5 shows the opportunities in all RECIPE countries, depicting their market volume as well as the conditions for export and the presence of domestic production. The conditions for export are derived from the analysis in section 3.5. Dotted lines are corrections for domestic production.

Colombia, Thailand, Indonesia, Peru and the African countries will, due to their realistic potential, probably not produce wind turbines but import most components. China and India already produce turbines, while India exports them; EU industry thus concentrates more and more on local production, joint ventures and export of services in these countries. In the near future, a similar process might start in countries like Argentina, Brazil and Mexico. These countries may be interested in producing components of wind turbines

domestically via investment from abroad, or by joint ventures with foreign parties.

Figure 3.4: market potential wind energy in the 15 countries (under maximum scenario)

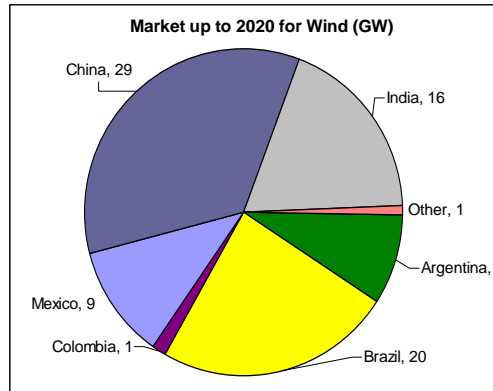
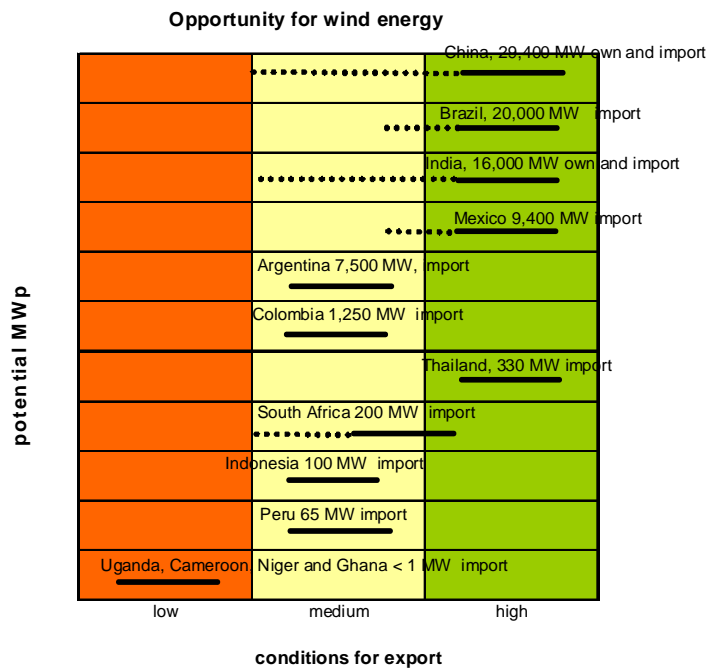


Figure 3.5: Opportunities EU industry wind energy in the 15 countries (under maximum scenario)



3.3.2 *Small and medium hydro: additional installed capacity in 2020 in 15 RECIPES countries is estimated at 75 GW under the maximum scenario. High potential market growths are China, India and Brazil. The other Asian and Latin American countries, as well as South Africa and Uganda, follow at a distance. The EU industry needs to compete with many others and thus to focus on niche markets.*

Market for hydro

In the 15 RECIPES countries, the installed capacity will grow under the maximum scenario from 40 GW at present to some 115 GW in 2020, up with 75 GW, showing the potential for the small and medium hydro market in these countries (see Table 3.6). China leads with an installed capacity of 80 GW in 2020, which is higher than any country today. High capacities are also foreseen for India (15 GW) and Brazil (12 GW).

For small and medium hydro, the global capacity was estimated at 66 GW in 2005¹². New capacity added in 2005 was 5 GW; the growth rate was 8% (REN21 2006). More than half of the world's small and medium hydropower capacity is in China. In 2005, the EU had an installed capacity of 12 GW. Average annual growth rate in the EU is 2% per year (EurObserv'ER 2006d).

Table 3.6: present situation and scenarios small/medium hydro in the 15 countries

Small and medium hydro	Present		Scenarios 2020		Product manufactured					
	MW	Target	Ref	Max	This country	North America	Europe	Asia	Latin America	import but no more information
			MW	MW	yes / no and if available %					
Argentina	280	No	350	550	100	0	0	0	0	
Brazil	2500	Yes	3,250	12,300	yes	0	0	0	0	
Colombia	84	No	165	650	yes	0	0	0	yes	
Mexico	134	No	230	1,900	100	0	0	0	0	yes
Peru	39	Yes	46	60	na	0	0	0	0	
China	34,000	No	64,000	80,000	100	0	0	0	0	
Pacific Islands	0.6	na	1.2	1.2	0	0	0	100	0	
India	1694	Yes	4,650	15,000	100	0	0	0	0	
Indonesia	210	No	360	770	yes	0	0	0	0	
Thailand	200	Yes	560	900	50	20	10	20	0	
Cameroon	na	Yes	0.2	5.0	na	0	0	0	0	
Ghana	na	No	0.2	2.0	na	0	0	0	0	
Niger	na	na	0.2	2.2	yes	0	0	0	0	yes
South Africa	68	No	100	1700	yes	0	0	0	0	
Uganda	0.01	No	30	115	na	0	0	0	0	

¹² Estimating the present capacity for small and medium hydro is difficult, for several reasons. First of all because of the different definitions applied throughout the world: the upper boundary for small and medium hydro varies between 5 and 50 MW and is set by each country. Secondly, the inventory of the many small installations proves difficult since many of these installations exist since long and are not monitored by subvention bodies.



For large hydro, the global capacity was estimated at 750 GW in 2005. Hydro supplied 16% of the global electricity production in 2004. Capacity has grown historically at slightly more than 2% per year. The top-5 hydropower producers in 2004 were Canada, China, Brazil, the US and Russia. Emerging and developing countries show the highest growth rates in terms of installed capacity: China added 7 GW in 2005, Brazil 2.4 MW and India 1.3 GW. Globally, the added installed capacity was 12-14 GW in 2005 (REN21 2006).

Hydropower manufacturing industry

RECIPES local experts point out that most countries have domestic production of small and medium hydro installations:

- Systems between 10 and 25 MW are produced in Brazil, China and Indonesia;
- Systems <10 MW are produced in Brazil, China, Colombia, Indonesia and Mexico; China has at least 500 enterprises producing hydro generators (REN21 2005).
- Other countries like Argentina, India, South Africa and Thailand also have domestic manufacturing of various parts of the hydro systems in some turbine ranges.

No conclusive information could be collected on the production of mini and micro systems. However, almost all countries using these systems produce the equipment in their own country, except countries that only have a few hydro plants, like Cameroon.

The EU has a world-leading position in the manufacturing of small hydraulic power plants, further to the demanding requirements on productivity and environmental impact in its domestic market (REN21 2006, EurObserv'ER 2006d). It is because of the know-how acquired in its domestic market that EU manufacturers can export their products to countries with high potential in Asia and Latin America. This position has been fading during the last decades due to a lack of home markets, but the home market is recovering since the EU Renewables Directive¹³. The European Small Hydraulic Association (ESHA) estimates a turnover of the European sector between €150 and €180 million. Upgrading and refurbishing existing plants was a particular concern of the EU industry in recent years.

The EU has about fifty hydraulic turbine manufacturers. Four of these are multinational companies (Alstom Power Hydro, VA Tech/Andritz, Voith Siemens and GE Energy) that dominate the large-scale turbine market and are present on the small hydraulic market segment as well. Alongside these big companies, numerous small and medium sized companies are active on the small turbine segment. These companies are mainly located in the important small hydraulic power countries in the EU: Italy, France, Germany, Austria and

¹³ Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market.

Sweden, but also in the Czech Republic, Poland and Slovenia. The activity of all these companies is largely geared towards export. Some companies have subsidiaries in RECIPES countries; the Austrian company Gugler Hydro Energy, for instance, has a subsidiary in India (EurObserv'ER 2006d).

Market outlook in RECIPES countries

The maximum scenario predicts that the biggest capacity increases in small and medium size hydro will be in China, India and Brazil. These three countries together account for 69 GW increase in installed capacity over the period until 2020. The other 12 RECIPES countries account for 6 GW (see Figures 3.7 and 3.8).

The RECIPES local experts point out that many small systems do not function optimally, due to neglected maintenance or a lack of finance to maintain and upgrade the plants properly. The knowledge and skills to maintain a hydro plant are available in all countries; however not always in the regions in which the hydro power plants are situated.

Key growth markets are expected to be China, India and Brazil in terms of new installations. However, these markets have their domestic manufacturing of hydraulic power plants in place. This is also the case for the other countries with growth perspective: most RECIPES countries simply can produce essential parts of the hydro power plants themselves. European industry can anticipate in various manners this situation, for example:

- Continue to invest in and set up local production in key growth markets;
- Continue to invest in research and development, in the EU and in the key growth markets, in order to maintain its position at the forefront of high productivity and low environmental impact, with solutions that fit with local conditions;
- Continue to export goods and services on the basis of the know-how gained in Europe, for example with refurbishment and maintenance programmes of existing hydro plants.

Figure 3.7 Market potential small and medium hydro in the 15 countries (under maximum scenario)

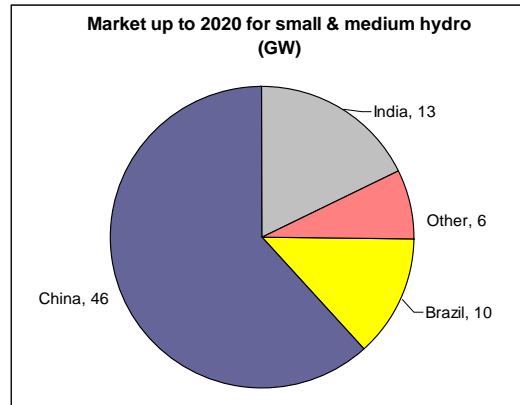
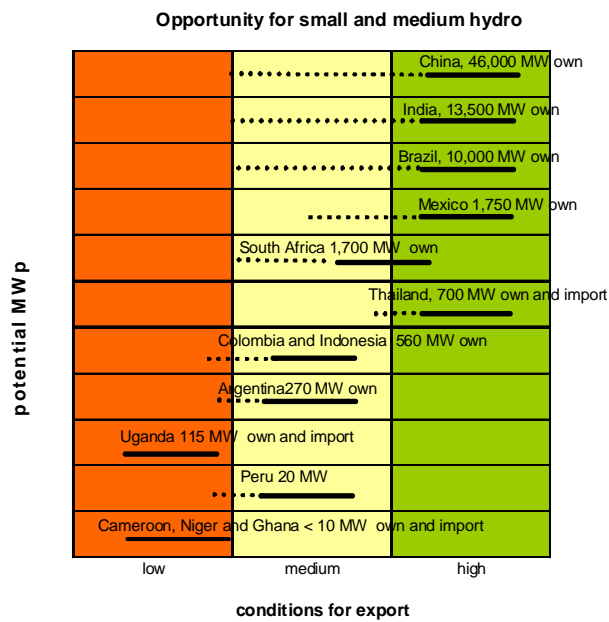


Figure 3.8: opportunities EU industry hydro in the 15 countries (under maximum scenario)



3.3.3. *Solar thermal: the expected market growth in EDCs is huge, 120 million additional installations in 2020 under the maximum scenario, of which 110 million in China. Most EDCs have their own industry. There may be some possibilities for export for EU industry but the main challenge is to keep up with the high growth in the EU domestic market. EU industry could in this respect benefit from production under licence in low wage countries.*

Market for solar thermal

In the 15 RECIPES countries, the installed capacity will grow from 40 million installations at present, to some 160 million in 2020 under the maximum scenario, so up with 120 million installations (see Table 3.9). China continues to lead with an installed capacity of 150 million installations in 2020, far ahead of the others, where markets are smaller by a factor 40 to 100: Brazil 3.5 million installations, Indonesia 2.8 million, India 2 million, South Africa 1.5 million and Mexico 1.3 million.

The global capacity for solar thermal hot water installations¹⁴ reached 88 GWth in 2005 (REN21 2006). China has the biggest capacity installed (56 GWth) corresponding to 63% of the installed capacity worldwide, followed by the EU (12 GWth), Turkey (6 GWth) and Japan (5 GWth). In 2005, 13 GWth of new capacity was added, an average global growth of 17% compared to 2004. High growth rates (20 to 30%) were observed in China, India and the EU.

Table 3.9: present situation and scenarios for solar thermal in the 15 countries

Solar thermal	Present		Scenarios 2020		product manufactured				
	number installation	m2	Ref number installations	Max number installations	This country	North America	Europe	Asia	Australia
Argentina	12.000	24.000	15.000	31.000	100	No	No	No	No
Brazil	500.000	2.100.000	1.2 mil	3.5 mil	100	No	No	No	No
Colombia	na	na	9.000	115.000	Yes	Yes	Yes	Yes	No
Mexico	300.000	600.000	750.000	1.300.000	No	Yes	Yes	No	No
Peru	8.000	na	26.000	181.000	Yes	No	No	Yes	Yes
China	40 million	80 million	150 mil	150 mil	Yes	No	No	No	No
Pacific Islands	>1000	na	pm	pm	100	No	No	No	No
India	700.000	1.000.000	1.3 mil	2 mil	Yes	No	No	Yes	Yes
Indonesia	150.000	400.000	350.000	2.8 mil	90	No	No	Yes	No
Thailand	50.000	na	58.000	165.000					
Cameroon	pm	pm	300	3.700	No	No	No	No	No
Ghana	750	na	1.200	2.200	No	No	No	No	No
Niger	pm	pm	250	700	100	No	No	No	No
South Africa	na	750.000	1 mil	1.5 mil	Yes	No	No	Yes	Yes
Uganda	165	4.900	300	650	No	No	Yes	No	No

In terms of market penetration – installed capacity of solar hot water installations per 100,000 inhabitants – the leading countries are Cyprus (63 MWth), Israel (52 MWth) as well as Greece and Austria (19 MWth) (2004).

¹⁴ Unglazed swimming pool heating excluded; these collectors are predominantly installed in developed countries.



China was 13th with 3.3 MWth per 100,000 inhabitants in 2004, Brazil 22nd with 0.9 MWth per 100,000 inhabitants (IEA SHCP 2006).

Solar thermal manufacturing industry

RECIPES local experts point out that all countries with a significant number of solar thermal hot water installations have domestic production of these installations. Imports are coming from Asia, Australia, Europe or the US. All countries except Brazil have some import of parts (collectors, storage units) from abroad. Companies providing installation and maintenance services are available in all countries where solar thermal is present.

Flat-plate collectors are predominant in all markets, except in China, where evacuated tube collectors are dominant. The solar thermal industry in China is well established, has over a thousand manufacturers (ESTIF 2003) and has its own patents. Technologies have become increasingly mature thanks to joint efforts by Chinese research institutes, universities and enterprises over the past 20 years. The industry has been able to absorb continued annual growth rates of 30%. Sales in 2002 were 11 RMB billion (about 1 billion euros) (CREIA 2006). Only a small percentage of the production is exported (1% according to ESTIF 2003); policy is to meet home market needs first and then enter into the international market.

The European solar thermal industry is most developed in Germany, Austria and Greece. The solar thermal sector in these three countries generated a turnover of 1.2 billion euros in 2005 and expected a turnover of 1.5 billion euros in 2006. The industry is fragmented with a large number of small and medium sized companies and a few big actors. However, there is a trend that these big actors are gaining more ground; most of them are preparing significant expansion. Lowering installation costs is a priority for the sector industrialists, as well as facilitating the work of installers (EurObser'ER 2006e).

Some companies import tubes from low-wage countries. Ritter Solar, for instance, a German manufacturer of vacuum tube collectors, imports its tubes from China via a joint venture with the Chinese company Lino, one of the world's biggest producer of vacuum tubes (EurObser'ER 2006e).

Market outlook in RECIPES countries

China is the biggest market but is fully covered by Chinese industry. Other growth markets with a significant size in 2020 are Brazil, India, Indonesia and South Africa, but these countries already have a domestic industry in place for the manufacturing of solar thermal installations.

The opportunities for export of goods to RECIPES countries are thus limited. EU industry will therefore most likely have to focus on keeping pace with the strong growth in its domestic market. EU industry might in this perspective benefit from technologies manufactured under licence in low-wage countries.

Figure 3.10: market potential solar thermal in the 15 countries (under maximum scenario)

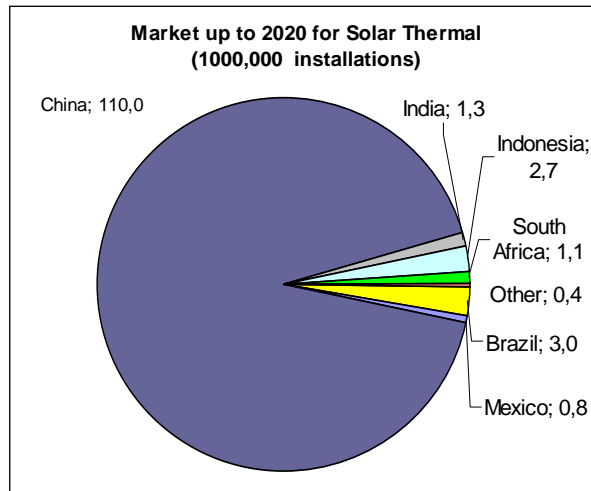
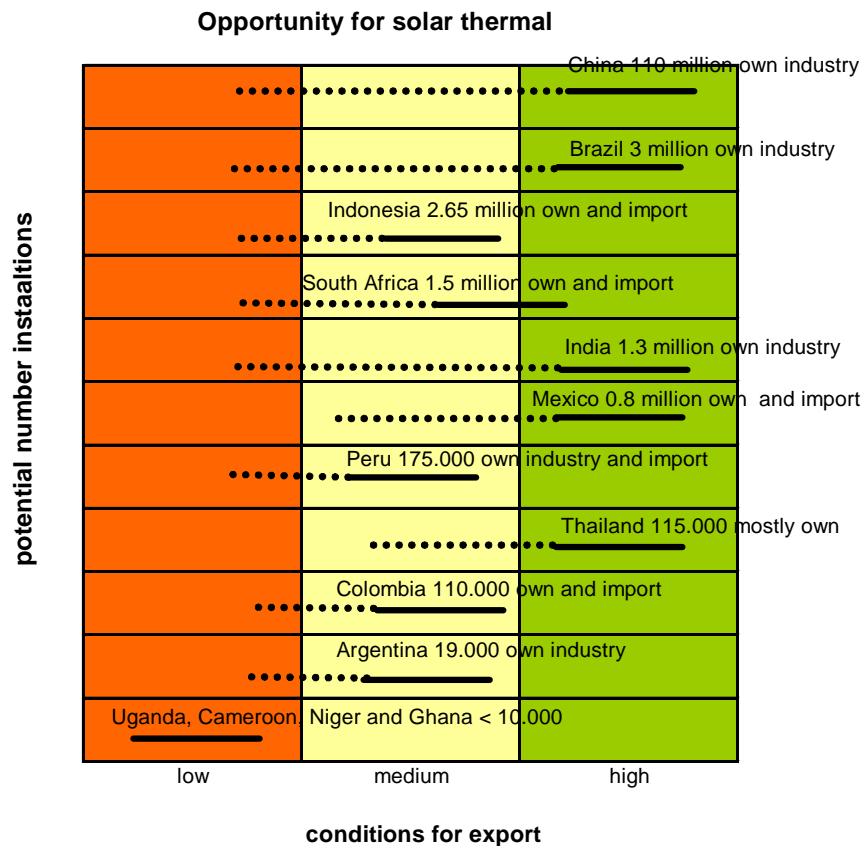


Figure 3.11: opportunities EU industry for solar thermal in the 15 countries (under maximum scenario)



3.3.4. *Photovoltaic: the additional installed capacity for PV in 2020 in 15 RECIPES countries is estimated at 1.8 GWp under the maximum scenario. The market in EDCs is growing, especially in China, Indonesia, Thailand, Brazil and South Africa. It is however unsure whether these markets will become as attractive as the strongly subsidised markets of the EU, Japan and the US. EU industry observes tough competition from Japan and China.*

Photovoltaic market

The present installed capacity in the 15 RECIPES countries is 0.2 GWp, 4% of the installed capacity worldwide, with highest capacities installed in India and China (see Table 3.12).

The total installed capacity of PV worldwide was 5.4 GWp in 2005, 3.1 GWp grid-connected and 2.3 GWp off grid. Growth of installed capacity was 1.4 GW or 35%, and mainly came from grid-connected PV. Almost half of the 2005 growth occurred in Germany thanks to long-term government support. Other important markets were Japan and the US. Average growth rates over the last five years were higher than 40% (REN21 2006).

In 2020, under the RECIPES maximum scenario, the installed capacity in the 15 RECIPES countries will grow from 0.2 GWp to 2 GWp, up with 1.8 GWp, with highest capacities in China, India, Thailand, Brazil and South Africa. This scenario is based upon strong policy in the 15 RECIPES countries.

Table 3.12: present situation and scenarios PV in the 15 countries

Photo voltaic	Present		Scenarios 2020		product manufactured				
	MWp	Target	Ref	Max	This country	North America	Europe	Asia	Australia
Argentina Brazil Colombia Mexico Peru	4.7	No	15	33	No	Yes	Yes	No	No
	5.2	No	50	130	Yes	Yes	Yes	Yes	No
	2.0	No	4	40	No	Yes	Yes	Yes	No
	15.1	No	16	55	No	Yes	Yes	Yes	No
	3.7	Yes	10	31	No	Yes	Yes	Yes	No
China Pacific Islands India Indonesia Thailand	50	No	300	1,000	Yes	No	Yes	No	No
	0.3	0	2	4					
	83	Yes	105	145	Yes	No	No	No	No
	2.0	No	6	85	0	0	Yes	Yes	0
	24	Yes	275	575	Yes	Yes	Yes	Yes	No
Cameroon Ghana Niger South Africa Uganda	0	Yes	0	0	No	Yes	Yes	Yes	Yes
	0.9	No	1	7	No	Yes	Yes	Yes	No
	1.0	Yes	2	6	No	No	Yes	Yes	No
	6.5	No	14	115	Yes	Yes	Yes	Yes	No
	0.23	No	1	3	No	No	Yes	Yes	No

The growth envisaged in the RECIPES scenarios is much more conservative than in the recently published scenario of EPIA / Greenpeace (2006). The latter

scenario is based on a continuation of the high growth rates in the EU, Japan and the US, and on the likely take-off of the PV market in the other countries when the technology spreads. Under this scenario, the installed PV capacity in 2020 is 28 GWp in China, 11 GWp in India, and 4 GWp in Brazil and Thailand. Note that the 2020 target of China is a factor 15 lower: 1.8 GW.

PV manufacturing industry

Of the RECIPES countries, China, India and Thailand have production of PV cells. Brazil and South Africa import PV cells but assemble the frame and invertors themselves. All countries import invertors; the most developed RECIPES countries also produce invertors.

Worldwide, there are four main cell production zones: Japan leads (0.8 GWp capacity in 2005), followed by the EU (0.5 GWp), China (0.2 GWp) and the US (0.2 GWp). The industry is highly concentrated: the top-10 manufacturers together hold nearly 80% of the market and are heavily involved in expanding their production capacity in order to maintain their top position, and in building local module production plants capable of supplying markets with strong growth potential. With yearly growth rates over the last five years of more than 40%, the PV cell manufacturing industry is one of the fastest growing industries at present. The industry has become a € billion business in 2005; business analysts predict the market volume to increase to €40 billion in 2010 (EC JRC EIS 2006).

Chinese PV cell manufacturing industry more than tripled its production capacity in 2005, and has two manufacturers in the top-10: Suntech (China) and Motech (China/Taiwan). Chinese manufacturers intend to continue the high export rate (90% in 2005) of their production to the growing markets in the EU, the US and emerging countries (EurObserv'ER 2006c).

Market outlook in RECIPES countries

The RECIPES maximum scenario predicts that the biggest capacity increases will be in China, Thailand, Brazil, Indonesia and South Africa (Figure 3.13).

Figure 3.14 shows the opportunities in all RECIPES countries, depicting their market volume as well as the conditions for export and the presence of domestic production. The conditions for export are derived from the analysis in section 3.2. Dotted lines are corrections for domestic production.

The countries in the lower part of Figure 3.14 (African countries, Argentina, Peru, Colombia) will, due to their potential, probably not produce cells but assemble solar systems with cells imported from abroad. The opportunities for export of goods and services are high. Three countries in the upper part (China, India and Thailand) already produce cells, other countries in this part (e.g. Brazil, South Africa, Indonesia) may be interested in producing them in their own country via investment or joint ventures from abroad, or start more sophisticated assembling industries.

There are opportunities in Mexico that is currently importing almost all the components. But, because of the potential and the capacity of the Mexican industrial sector, it is likely that Mexico will start an own production or assembly industry. Indonesia is in a similar situation. South Africa already has its own assembly industry.

Figure 3.13: PV market potential in the 15 RECIPES countries (under maximum scenario)

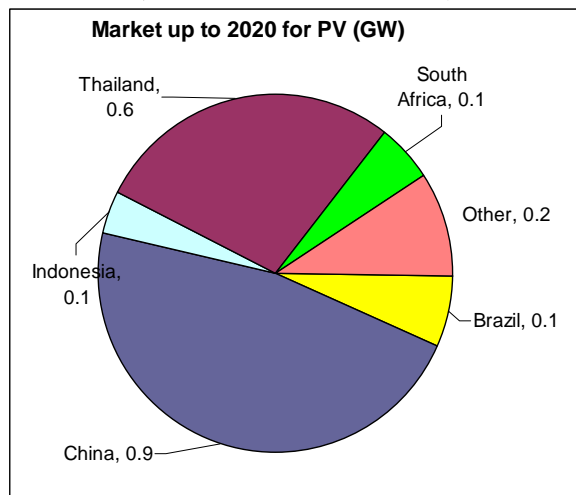
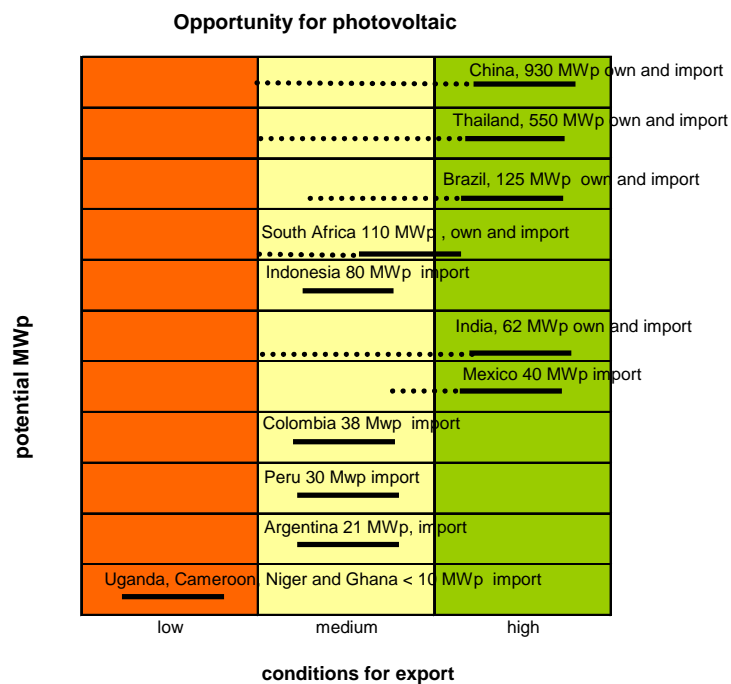


Figure 3.14: opportunities EU industry PV in the 15 countries (under maximum scenario)



3.3.5. Solid biomass and biogas: the international market for bio-energy is still in a very early stage but is expected to grow considerably in both industrialised and developing countries in the next years. EU industry is composed of many small companies but has valuable experience in the sector and is well positioned to benefit from this.

Market solid biomass and biogas

Within the RECIPES project it was not possible to provide a clear picture of the current situation of bio energy in the 15 RECIPES countries, or to define scenarios for 2020. Some information could be gathered for 8 of the 15 countries (see country reports) but the figures were not always reliable. Only some of these countries have information available on potentials and policy.

Also at world level, precise and reliable data on bio-energy is difficult to obtain and not available at present. Traditional biomass energy is believed to provide between 7 and 11% of the world's primary energy supply. This percentage is much higher in developing countries, and as much as 90% in the poorest countries, as the RECIPES country studies show. Modern biomass energy provided about 250 Mtoe/year or 2% of the world's primary energy supply in 2000 (ESMAP 2005).

Emerging and developing countries lead in biomass energy used in industry: this is estimated at 40 Mtoe/year in Latin America in 2000, 40 Mtoe/year in Asia, and 25 Mtoe/year in Africa against 40 Mtoe/year in OECD countries. In Latin America and Africa about one fourth of the total energy used by industry comes from modern bio-energy (this might include some traditional biomass) (ESMAP 2005).

The market for biomass electricity, combined heat and power, and district heating is in developed countries: OECD countries account for 100 Mtoe/year in 2000, non-OECD countries for 10 Mtoe/year.

The available global bio-energy scenarios show a large variation: they indicate that bio-energy could contribute worldwide between 1,500 and 9,000 Mtoe/year by 2025¹⁵ (IMET 2005); this is 1.3 to 8 times what is used today. The wide contribution range reveals the uncertainty in the bio-energy market: the deployment of bio-energy faces significant technical, economic, social and regulatory barriers; the bio-energy sector and related policies and markets are still in an early stage of development. Up to now, modern bio-energy use has not experienced rapid growth: in the last ten years the growth rate of solid biomass has been equal to 1.6% per annum. The highest growth, 7.4% per annum, has been experienced in municipal solid wastes, liquid and gaseous biomass (IMET 2005).

¹⁵ Including bio fuels.

Solid biomass and biogas industry

The bio-energy sector is a very diverse sector, ranging from agricultural and forestry activities to waste treatment activities, from micro-scale domestic applications (cookers, boilers) to small and medium scale plants (gasification, combined heat and power plants, biomass power plants).

Comprehensive information on bio-energy manufacturing in the RECIPES countries could not be collected. From the characteristics of the market, it is however likely that local manufacturers serve the local bio-energy markets. There are some examples of technology transfer in the frame of development cooperation projects or CDM projects.

In the EU, the solid biomass and biogas sectors experienced a significant growth in 2005, respectively 6% and 16%. Boiler manufacturers increased their production capacities, both in the small and larger scale ranges. Leading boiler manufacturers in the EU market are Kvaerner Power (Norway/Sweden – higher range), Fröling (Austria – lower range) and Wärtsila Biopower (Finland). Leading manufacturers of waste gasification plants are Linde, Schrack Biogas and BTA (Germany), Organic Waste Systems (Belgium) and Valgora (France), all having their own methanisation processes (EurObserver 2006b, 2006f).

Market outlook in RECIPES countries

EUBIA, the European Biomass Industry Association, expects high demand for biomass conversion and utilisation technologies in the future, in both industrialised and developing countries, and sees major export opportunities for European technologies, know-how and services, particularly for small and medium capacity plants (EUBIA 2006).

The market is expected to grow worldwide although there is high uncertainty. EU industry has a long experience in the solid biomass and biogas sectors and is well positioned to use this know-how in emerging new markets. The sector is however still in an early stage of development and is composed of many small actors. Also the bio-energy market worldwide is in an early stage, in most cases locally oriented, and not transparent. This is expected to change in the next decade when demand of bio-energy will develop and international trade of bio-energy will increase. Many international initiatives are launched to develop the bio-energy market.

3.3.6. *Bio fuels for transport: the additional volume in 2020 in the 15 RECIPE countries is estimated at 75 billion litres ethanol and 22 billion litres bio-diesel. This presents significant opportunities for EU industry that is leading in bio diesel and increasing its involvement in ethanol. Note: these estimates have a large range of uncertainty due to the early stage of the market.*

Bio fuel markets

Ethanol production increased to 33 billion litres in 2005, up with 8% compared with 2004. Production is dominated by Brazil and the US with 15 billion litres each in 2005. Other significant producers are China (1 billion litres in 2005), the EU (1 billion litres) and India (0.3 billion litres). Fuel ethanol supplies 41% of all non-diesel motor-vehicle fuel sold in Brazil in 2005, by far the highest percentage in the world (REN21 2006).

The ethanol production is expected to observe strong worldwide growth in the next decade. IEA (2004) considered a quadrupling of the ethanol production to 120 billion litres in 2020, taking account of the change of trends and the ongoing policy initiatives. The RECIPE maximum scenario also predicts high growth: the 15 RECIPE countries would produce some 90 billion litres in 2020, up with 75 million litres, with Brazil, India and China as main producers with respectively 54, 15 and 10 billion litres per year (see Table 3.15 below).

Bio diesel production is expanding at high rate and reached 3.9 billion litres in 2005, up from 2.1 billion in 2004, 85% growth. The EU dominates bio diesel production and accounts for 90% of the world production.

Also the bio diesel production is expected to observe strong worldwide growth in the next decade. IEA (2004) considered bio diesel production in 2020 at the 25 billion litres level, mainly on the basis of the EU policy initiatives. The RECIPE maximum scenario predicts a similar level of production in the 15 RECIPE countries: together they would produce 22 billion litres in 2020, up from 0.2 billion litres at present. Biggest producers would be Argentina, Brazil Indonesia and Thailand.

Note however that the development of the bio fuels market is highly uncertain as it is in an early stage and predominantly policy driven. It is to date primarily nationally and regionally oriented: global trade is developing, but so far relatively limited. In the near future, however, as demand is expected to increase, and production and demand do not coincide geographically, an international market is expected to arise. In principle, the largest production capacities can typically be found in tropical countries in South America, Sub-Saharan Africa and East Asia as well as in low population density countries as Russia and Canada, whereas the largest demand for bio fuels is concentrated in the industrialised, large energy consuming countries. This is likely to be a driving force for an international market and trade (CEIP 2005).

How quickly this market will develop is determined by several geopolitical, technological and economic factors. Important geopolitical factors are security of supply, CO₂ reduction targets and the impact on food prices and the agricultural sector. Key economic factors are the prices of primary biomass and petroleum, as well as the technological development influencing the price of conversion of biomass to end-use fuels. International certification is likely to play a key role in determining whether or not this market will develop in an ecologically sound way (CEIP 2005).

Table 3.15: present situation and RECIPES maximum scenario in 9 countries

	Ethanol (billion l/year)		Bio diesel (million l/year)	
	Present	2020	Present	2020
Argentina	0	1	pm	3,300
Brazil	15	54	8	11,500
China	1	10	50	1,000
Colombia	0	<1	pm	Not available
India	0.3	15	1.8	34
Indonesia	0	3	0	3,100
Peru	0	<1	0	Not available
Pacifics	0	pm	pm	0.02
Thailand	0	4	128	3,100

Note that for 6 of the 15 RECIPES, including Mexico and South Africa with possibly interesting markets, no potential could be assessed because of a lack of data.

Bio fuel industry

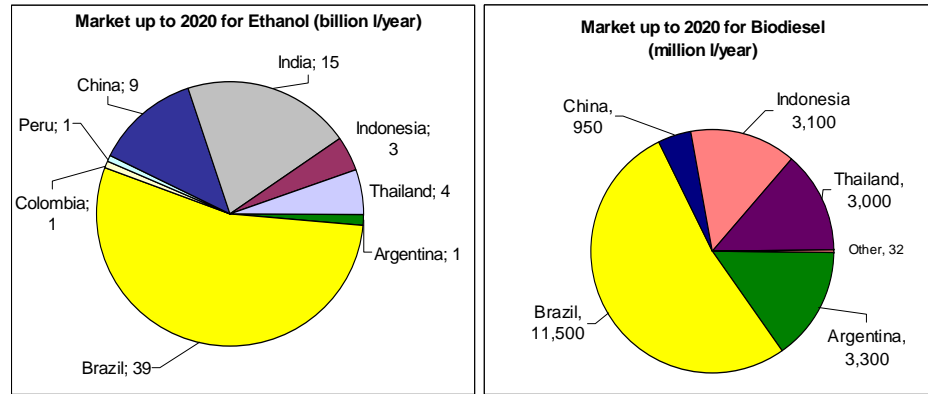
The ethanol industry is dominated by Brazil and the US. Brazil has over 300 plants operating, 80 new distillers were licensed in 2005. The US had 95 operating ethanol plants in 2005, with a total capacity of 16 billion litres per year and with a foreseen expansion of capacity of 8 billion litres for plants under construction in 2006. Installed capacity in the EU in 2005 was 1.5 billion litres and is growing quickly (REN21 2006, EurObserv'ER 2006a).

The EU dominates the bio diesel industry; the EU had an operating capacity of over 7 billion litres per year in 2006. The leading EU producers are Diester Industry (France), ADM (US), EOP Biodiesel (Germany), Novaol (Italy) and MUW (Germany).

Market outlook in RECIPES countries

For ethanol, the RECIPES maximum scenario predicts that the biggest capacity increases will be in Brazil, followed by India, China, Thailand and Indonesia (Figure 3.16). For bio diesel, the biggest capacity increases are predicted to be in Brazil, Argentina, Indonesia, Thailand and China (Figure 3.16). Note however the high degree of uncertainty of these figures due to the current market uncertainties.

Figure 3.16: market potential bio fuels in the RECIPES countries (under maximum scenario)



EU industry is currently leading in bio diesel production and is also quickly expanding its production capacity in ethanol. The EU also prepares strategic initiatives to develop the domestic bio fuel market, to enhance trade, and to strengthen cooperation with emerging and developing countries¹⁶.

EU industry is therefore well positioned to benefit from the market growth. This might present opportunities in various sectors: investment companies, manufacturing industry, R&D and consultancy in fields such as bio fuel production, agriculture, fuel combustion technology and assessment of environmental impacts.

¹⁶ EC (2006): "An EU strategy for bio fuels", SEC(2006)142, February 2006

3.3.7. *Geothermal energy: the geothermal power sector is expected to grow, especially in South East Asia and Latin America, with opportunities for the five leading manufacturers one of which is European. EU industry does not expect much from the geothermal heat market in INCO countries*

Geothermal market

The geothermal power sector had a worldwide installed capacity of 8.9 GW in 2004, up from 8.0 GW in 2000. The US has the biggest capacity installed (2.5 GW), followed by the Philippines (1.9 GW), Mexico (1.0 GW), Indonesia (0.8 GW) and Italy (0.8 GW). Between 2000 and 2004, the worldwide installed capacity grew at an annual growth rate of 3%; growth rates in RECIPES countries Mexico and Indonesia over this period were significantly higher, respectively 6% and 8%.

In the 15 RECIPES countries, apart from Indonesia and Mexico, also China and Thailand have some capacity for geothermal power installed, but these capacities are low (respectively 32 and 0.3 MW). Targets for geothermal power energy are set in two RECIPES countries: Indonesia plans to extend its capacity to 6 GW in 2020, while Uganda intends to produce 143 GWh on an annual basis in 2025. Geothermal potential studies are available for four other countries (Brazil, India, Mexico and Thailand).

The geothermal heat sector had a worldwide installed capacity of 12 GW in 2004 for the so-called low and medium temperature applications directly exploiting hot water tables¹⁷. This corresponds to an increase of 10 GW in 2000, equating to a 5% average annual growth rate. The EU accounted for 2 GW installed capacity in 2004.

In Argentina and Brazil there is some capacity installed for geothermal heat (respectively 150 and 16 MW); this capacity is used for heat in small industry or tourist accommodations.

Geothermal manufacturing industry

Five large companies dominate the geothermal power manufacturing industry: Fuji, Mitsubishi and Toshiba from Japan, Ansaldo from Italy, and Ormat from Israel, that together account for some 90% of the market. In countries with geothermal power plants some equipment is produced within the country itself but the geothermal technology and turbines are imported (EurObserv'ER 2005).

There is little information available on the production of the components for geothermal heat technology. Countries like Brazil and Argentina produce their own equipment.

¹⁷ The other geothermal heat market is that of heat pumps. This market is not studied in RECIPES because these pumps are predominantly installed in developed countries.

Market outlook in RECIPES countries

Scenarios for the 15 RECIPES countries were not developed, as the information available on geothermal energy and on barriers and drivers did not enable projections.

For the geothermal power market, EGEC sees Latin America and South East Asia as the main growth markets (EGEC 2004), with opportunities for the five manufacturers dominating the geothermal power market. Opportunities were identified for three actors: (i) consulting engineering companies specialised in geothermal power (exploration, field development, plant design, project analysis and management), (ii) power plant suppliers and (iii) investors and operators of the field and plant. Opportunities, however, depend very much on how the concessions for field development and plant operation are defined in a specific country.

For the geothermal direct heat market, little development is expected in Latin America and little information is available on South East Asia (EGEC 2004).

3.4. This is in line with and complementary to other studies

The following paragraphs provide the main conclusions of a comparison of the aforementioned results and conclusions of the RECIPES project with the outcome of other studies. The results of the following studies have been taken into consideration in this comparison:

- EREC (2002), 'European Renewable Energy Export Strategy';
- IEA / OECD (2003): 'Creating markets for energy technologies';
- IEA (2003): 'Renewable energy... into the mainstream';
- Martinot E. (2002), 'Renewable Energy markets in Developing Countries';
- Martinot, E. (2005, 2006), 'REN21: Renewables Global Status Report 2005' and 'Renewables Global Status Report – 2006 update';
- UNDP (2000): 'Sustainable Energy strategies – materials for decision makers'.

The results concerning the possibilities for the RE EU industry are compared with regard to the following issues:

- Markets for RE technologies in emerging and developing countries and competition with local production and other economies;
- Risks and barriers that are associated with doing business in emerging and developing countries;
- Countries and regions that show the best opportunities for EU industry.

3.4.1. Market growth potential for RE technologies and competition

In the RECIPES project a number of conclusions have been formulated with regard to market potentials of different technologies and the share of the market that is likely to be achieved with locally produced technologies.

In the following paragraphs, conclusions are presented of the comparison of both reports regarding four technologies: wind energy, solar thermal, PV and bio fuels.

- *For wind energy*, RECIPES concludes that the opportunities in China and India are good but that both countries produce (and in the case of India also export) wind turbines, therefore the EU industry has to concentrate on joint ventures and export of services in these areas. The GSR reports an impressive increase of domestic production in China and India, and mentions the event of the first fully domestically developed turbine in this country. Furthermore, it reports that leading companies in the wind energy sector from the EU, the US and India have recently invested in manufacturing facilities in China.
- *For solar thermal energy*, RECIPES concludes that potentially there is a very large market – especially in China. However, due to the relatively simple technology and the well-implanted Chinese industry, the options for the EU industry are not very favourable at the moment. This is confirmed by the GSR (2006 update), which shows a huge increase of installed capacity of this technology in China.

- *With regard to the PV industry*, RECIPES concludes that there is a certain potential for PV technology which offers good opportunities for export of goods and services. However several countries with high realistic potentials for this RE option will most likely start (or, in the case of China and Thailand, already have started) producing cells domestically. China is seen as the country with the largest potential and best opportunities. The GSR reports that Japan and Europe are in the lead in this technology. China is currently in third position with an expected very high growth rate in the coming years (up to 2010);
- *Concerning bio fuels*, RECIPES concludes that the EU industry is currently not in a leading position for ethanol. Other countries with more experience, like Brazil, have higher prospects and are already active in other developing and emerging countries. Many countries are currently formulating bio fuels policies. Exports of goods or services to build bio fuel installations offer opportunities for the EU industry. The GSR reports that Brazil will retain its leading position in ethanol, mainly as a result of a national plan to increase sugar cane production by 40%. With regard to bio diesel, the GSR confirms the leading position for the EU.

3.4.2. Risks and barriers associated with doing business in EDCs

There are several studies that have addressed the issue of risks and barriers for the implementation of RE in developing countries, especially the non-technical aspect of the issue. The lack of a strong supporting national policy is perceived as an important barrier. The availability of a clear national policy and targets (including financial measures) with regard to RE options is seen as a crucial factor for the implementation of renewable energy by various studies: this is concluded in the RECIPES project as well as in the European Renewable Energy Export Strategy (EREC 2002), the IEA publication 'Renewable energy... into the mainstream'; the UNDP report 'Sustainable Energy strategies – materials for decision makers' and 'Renewable Energy markets in Developing Countries' (Martinot, 2002).

With regard to these policies it is furthermore stressed that all relevant stakeholders should be involved in formulating and implementing them (IEA / OECD, 2003), to ensure that a sound local support structure is available and that the options are well suited to their intended end-users. This is concluded in the publications by Martinot (2002) and UNDP (2000). The latter publication furthermore mentions that from the perspective of RE industry, building solid partnerships with local partners is seen as a successful way of securing an effective and efficient local support strategy. An important failure factor in the past has been that the energy systems implemented were not suited to their intended user, either by a misfit of supply and demand or by lacking maintenance and support structures.

Finally, an important risk that is discussed in the publications 'Renewable Energy markets in Developing Countries' (Martinot, 2002) and 'Sustainable Energy strategies – materials for decision makers' (UNDP, 2000) is the risk of a market driven approach to be potentially highly successful in a market where

consumers are (starting to be) able to afford energy or generate income from it, while the poorest countries and consumers will be lagging behind. This issue will require the continuous attention of governmental actors / policy makers at national and international level.

The market potential study carried out in RECIPES appears to confirm this image by showing that in the relatively more developed markets RE implementation is accelerating at a high pace, while in the poorest countries generally little growth is expected in the coming decades. However, in some cases also an adverse effect of the existence of a relatively wealthy part of society is noted in the RECIPES study: in some cases this section of society regards renewable energy options as second best (for instance because a grid connection is preferred) which may hamper their implementation.

3.4.3. Countries / regions with the best opportunities for EU industry

In sections 3.3.1 to 3.3.7 potentials per technology and per country are presented. The most comparable study with respect to this aspect is the European Renewable Energy Export Strategy (EUREES), published by EREC in 2002. Although this study is not focusing in particular on EDCs, there is a large similarity between the countries that have been identified by both studies as interesting export markets for EU industry. Brazil, China and India are regarded as the most interesting current markets for EU RE technology (EREC 2002).

A potentially important role for EU industry is identified in both studies with potentially significant economic benefits in the EU as a result (competitive position, job creation in various sectors including energy related R&D, technology suppliers, service providers, installing and maintenance). This is also confirmed by the publication 'Renewable energy... into the mainstream' of the IEA (2003).

4. Further actions: recommendations for main stakeholders

This chapter contains the recommendations for the main stakeholders, and is based upon the observations of the RECIPES team all along its work. It also contains suggestions for follow-up, at the end of the chapter.

4.1. For the EC (DG ENV, DG TREN, DG RTD, EuropeAid)

The first set of recommendations is addressed to the European Commission, in particular to the Directorate-Generals Environment, Research, and Transport and Energy as well as to the EC co-operation office EuropeAid. All play an important role in the deployment of renewable energy technologies, both in the EU domestic markets and in emerging and developing countries. The recommendations are as follows:

- a. *Put energy technology cooperation at the heart of cooperation programmes.* Energy is an enabler for development in EDCs; renewable energy technologies have a positive contribution to the local socio-economic development. Moreover, industrialised and developing countries are bound together to reduce CO₂ emissions, which for a large part are caused by the production and use of energy. Energy technology cooperation is beneficial for both the developing and developed countries and should therefore, in our view, be a cornerstone of North-South cooperation programmes. EC cooperation programmes might for instance make RE a preferred technology in development cooperation projects.
- b. *Intensify exchange of RE knowledge with EDCs.* Unfamiliarity with the available information, and access to this information, are identified as major barriers for implementing RE in EDCs. Exchange of knowledge leads to new and improved RE solutions adapted to the EDC context, better understanding of the barriers and opportunities of RE technologies, and an improved implementation approach. It is therefore important that the exchange of technology, know-how, education, training programmes, information, statistics and data is promoted, on best available environmentally sound energy technologies, performance standards, safety codes as well as relative and absolute energy costs. The EC might consider setting up training and exchange programmes for energy scientists, energy policy makers and energy planners of EDCs and EU, to the benefit of both.
- c. *Give special attention to the poorest.* Governmental actors at the international level should give intensified attention to the poorest countries, in Africa and in the other continents, as these are the ones lagging behind when a market-driven approach is chosen. Actors in these markets are often unable to compete on the technology learning curve, and struggle with putting in place effective policies. The EC and other international bodies should, in our view, adopt a comprehensive package of measures to address this, that includes:

- Special programmes that help the poorest countries to define their own policies in energy and renewable energy;
 - Special facilities for RE demonstration projects in the poorest countries that cover both the hardware and the implementation costs (training, setting-up, integration in local social context, financing structure);
 - Special programmes supporting the development of local RE industry (such as UNEP's programme SFA - Special Focus on RE in Africa).
- d. *Continue to put high focus on R&D and RE.* It is obvious that new energy technologies will play a major role in the future global energy system. This calls for a continuation of the attention and resources given to R&D on RE technologies. Given the challenge to deploy sustainable energy systems in EDCs, special consideration should be given to research into socio-economic benefits of RE in EDCs. Very little research is done on this subject so far.
- e. *Create favourable conditions for international RE markets.* Several RE markets move progressively from local to global markets. Commodity markets like bio fuels and biomass are striking examples but also technology markets like wind and PV technology. It is in our view important that the EC plays an active role in setting up these markets, for instance by developing appropriate international standards, taking away barriers, facilitating information exchange, putting in place certification schemes (e.g. for bio fuels and biomass), and launching or supporting initiatives to promote such markets. International RE markets can contain a win-win opportunity: they have the potential to boost RE implementation worldwide, and reduce risks for quickly expanding industries.
- f. *Set up information services on high potential RE markets.* The main challenge for EU RE industry is to keep up with the home market and, at the same time, to develop and maintain a leading position in the highly competitive global markets. Some of the EU RE industries are well placed to face this challenge. Others however, especially in sectors with a high number of small and medium-sized enterprises, do not have the capacity to grasp these opportunities without a significant transformation. In order to help the industry, the EC has set up information services that offer high quality information on EU trends in the form of EurObserv'ER and JRC reports. Such information should in our view also be available on high potential markets in emerging and developing countries. This need was already identified by EREC in its 2002 export strategy and is even more pressing today.
- g. *Continue to develop the EU domestic market.* The leading position of the EU RE industry worldwide, e.g. in wind power and bio diesel, is clearly related to the strong policy support that RE has in its domestic market, and to the scale and attractiveness of this market. Other factors are the continued focus on RE R&D, and the high standards applied in the EU. A continued long-term policy support for RE in the EU is vital, in our view,

to maintain and further exploit these leading positions. This support can also be effective to be well positioned in emerging technologies such as solar thermal power.

4.2. For energy actors in emerging and developing countries

The second set of recommendations is addressed to energy actors in emerging and developing countries. The recommendations are as follows:

- a. *Develop a tailor-made RE policy.* If RE fulfils a country's need, it is likely to be a sustainable solution. If RE is pushed without a clear fit with the country's energy policy, e.g. in RE hardware implementation projects in development cooperation programmes, RE is in most cases not sustainable and not successful. It is therefore vital to develop a tailor-made energy policy and RE policy for the country. Inspiration can be found in good examples available in other countries. RE policy should be integrated in other (country specific) policies like energy, economic and social development, environment, electrification and poverty eradication. Issues such as deregulation of energy markets, support mechanisms for renewable energy (feed-in tariffs, quota system, capital grants, green certificates, etc.), internalisation of external costs, support of local RE industry and socio-economic benefits need to be taken into consideration in the RE policy.
- b. *Shift the path of financial flows towards long-term energy solutions.* Rapid growth of energy demand means investments in energy infrastructure, with public and/or private funds. The incremental cost of de-carbonising the power sector in the developing countries, according to World Bank research, is 10% of the total investment need for energy. This extra cost avoids investing in energy technologies that have the risk of being outdated soon. Costs of inaction are much higher. Also the independence of fossil fuels from other countries can be important in the near future as energy prices are likely to stay high or even increase. The recommendation is to take action now and to shift the path of financial flows towards long-term energy solutions.
- c. *Create an attractive financial climate for RE.* In order to attract RE investors and RE knowledge, it is important to create an attractive investment climate for local and foreign organisations: robust RE legislation and policy, high quality RE institutions and financial incentives that provide long lasting guarantees. Focus must be on the RE technologies that have the highest local socio-economic benefits.
- d. *Support local RE industry.* Nurturing local RE industry gives local benefits and provides an important driver towards increased use of RE. This can coincide with attracting foreign investors into this industry.
- e. *Make a point of knowledge transfer.* Knowledge transfer is crucial for the success of RE policy, and includes, inter alia:

- Providing information and general training to national and local government officials;
- Providing specific information and training to local energy actors;
- Implementation and enforcement of energy and environmental standards;
- Programmes for grants and concessional loans;
- Promotion of joint ventures and licensing agreements;
- Support to incremental innovations.

4.3. For the EU RE industry

The third set of recommendations is addressed to the EU RE industry. The recommendations, on the basis of the work carried out on RE in emerging and developing countries, are as follows:

- a. *Focus on a number of high potential markets.* The RECIPES study has identified market potentials and opportunity levels per RE technology in the 15 countries. In our view, it is crucial to focus on a number of countries with high potential markets, analyse more in detail how the specific situation in these countries develops, and then work out the business model that would enable doing business in these countries (full export, full local production, or models in-between e.g. local marketing presence and/or local assembly). Success factors are a strong commitment from local government and market actors, as well as persistence and long-term commitments.
- b. *Put continuous monitoring of market conditions in place.* Different market parameters (e.g. RE potential, availability of specific support programmes, key actors - potential partners, clients, competitors, etc. -, conditions for capital investments, political and economic conditions, cultural particularities, etc.) need to be well known before it is possible to take the strategic decision to invest in these markets. The renewable energy sector is a very dynamic one; conditions and market circumstances therefore need to be monitored on a continuous basis, as they can change very quickly. In our view, industry should therefore organise a continuous information flow about potential future markets, at company or sector level.
- c. *Work out and constantly review strategies for leadership and expansion.* The RE industry is a young and dynamic industry that is in continuous transformation and that is involved in major challenges such as keeping up with the high market growths and dealing with increasing globalisation. Market circumstances can change quickly so attention is required to work out and constantly review strategies for successful leadership and expansion. Doing business in emerging and developing countries requires leadership and perseverance.
- d. *Play an active role at the global level.* RE markets are increasingly global. Leaders in the industry should have this global perspective and play an

active role at this level, e.g. through international sector organisations or other international structures. This is also a way to keep in touch with high potential markets, in emerging and developing countries as well as in other developed countries.

- e. *Create local partnerships.* Technology providers increase their chances of success when ensuring solid partnerships with local partners (knowledge and capacities are built to ensure that maintenance and other service tasks can be carried out properly). Working with local partners also can decrease implementation costs.
- f. *Consider implementation activities as part of the job.* It is important to integrate implementation activities and costs in the project set-up (training, setting-up, integration in local social context, financing structure). Failure of RE projects is in most cases linked to inadequate implementation and not meeting user needs. Failure damages the image of RE and labels it as second best.

4.4. Follow-up: how to put RECIPES into practice

RECIPES has resulted in a mine of valuable information; key is therefore to make sure that this information is used. Participants to the stakeholder validation workshop identified the need for follow-up. In our view, follow-up should be organised along three lines of action:

- a. *Facilitate dialogues about project results.* The main follow up is in our view to facilitate dialogues about the results of the RECIPES project, for instance dialogues within a country between its energy actors, dialogues of development aid representatives with country representatives, and dialogues within existing networks like REEEP. The EC might wish to support this, for instance by organising local workshops, or by using the RECIPES results within cooperation programmes.
- b. *Extend and update the work.* Another follow-up is to enrich the study with other country studies, especially with a focus on poor countries that are of special interest for the EC's international cooperation programmes. A regular update of the data could also be done and so serve as a barometer for EU policymakers and EU RE industry.
- c. *Feed results into existing networks.* The JREC will establish a mechanism to report to the CSD on a regular basis, including a review mechanism (likely to be conducted by the IEA or UNEP or both). Currently a network option is being discussed: a network of organisations with complementary knowledge that could provide this update. REN21 would be part of this network; RECIPES could also be part of it. This suggestion was done during the RECIPES stakeholder validation workshop of 7 December 2006.

Annexes

Annex A – Outcome stakeholder validation workshop

Several mechanisms were built into RECIPES to validate the results¹⁸. One of these mechanisms was the stakeholder validation workshop organised on 7 December 2006. Representatives of the EC, UNEP, NGOs, renewable energy industry, country representatives, consultants and academia attended this workshop.

The overall feedback was very positive. The attendees acknowledged the contribution of the project to the debate on RE in emerging and developing countries, and considered that a mine of valuable information was brought together. The focus on applications rather than general technologies was seen as an important input. The overall conclusion, the RE volume doubles under the reference scenario and triples under the maximum scenario, was deemed to be very realistic. The comparison with other studies was found to add to the value and credibility of the work.

A number of issues were brought up during the workshop, by the participants and by the workshop reporter, Mr. Eric Martinot of the Tsinghua University / REN21, who expressed his opinion on the work done. The key issues were:

- a. *RE definition.* It was found awkward that the RECIPES definition of RE did not include large hydro, while in some cases, depending on the specific situation, it could be regarded as RE. The RECIPES team explained that RECIPES focussed on new RE sources but also dealt with large hydro because of its importance for emerging and developing countries. The results for large hydro are presented separately. Other international work (e.g. IEA) uses the same approach.
- b. *Reliable figures on biomass.* It was remarked that it is difficult to obtain reliable figures for traditional and modern biomass. The RECIPES team confirmed this. The team collected biomass figures and used them in the country analyses, while indicating the high degree of uncertainty. The information did not enable the team to develop country-specific scenarios for 2020 for biomass.
- c. *Moving target.* Several participants indicated that up-to-date information on the current use of RE is not always available in their country, and also that spectacular growth rates have been achieved in the past few years. The collection of RE figures is therefore a moving target. The RECIPES team explained that the data were updated during the study, especially the RE data that in most cases date back to 2005 or 2004 instead of the initial 2003.

¹⁸ For more information on these mechanisms we refer to the introduction of this report.

Furthermore, the scenario approach used in the study is an appropriate way to deal with moving targets since it enables to apply different growth rates in the diverse scenarios.

- d. *Additional parameters for RE.* It was suggested to include additional indicators for RE and so avoid the high emphasis on primary energy related indicators. The RECIPES team acknowledged that additional indicators can lead to a better understanding of the RE situation in emerging and developing countries, but also explained that international work (IEA, US EIA) strongly relate RE projections to primary energy, and that the RE targets of half of the 15 RECIPES countries are expressed as a percentage of TPES. The RECIPES team looked into the possibilities to include additional indicators, and was able to present results for the indicator ‘share of RE in power generation’ in section 1.5 of this report. Reliable information could not be presented for the other suggested indicators: RE percentage of low temperature heat production, RE share of transport fuels, number of households having access to electricity through extended use of RE.
- e. *Method used to express RE%.* It was found unclear which method the RECIPES team used to express the RE%. In RECIPES the RE volume used to calculate the RE% is the output of a RE technology without any hypothetical substitution or calculation of equivalence, so the RE volume is not expressed in avoided primary fossil energy use. IEA, Eurostat and UN use the same method. REN21 and BP use the ‘substitute method’ that expresses RE in avoided use of fossil fuels, and that leads to higher RE percentages, especially for electricity production. The RECIPES team improved concerned texts in the ‘definitions’ section of this report.
- f. *Socio-economic survey.* It was acknowledged that a survey was probably the best choice, as a survey was not done yet in this field, and little info is available on socio-economic impacts of RE in EDCs. It was expressed that, with socio-economic aspects, it is all about the specific impacts in a specific situation – it is impossible to cover this in a single study. Regarding the conclusion ‘RE contributes more to socio-economic development than non-RE technologies’, it was mentioned that socio-economics are not an exact science: it is a political debate, and should be presented as such. The RECIPES team improved chapter 2 on these points: the team better explained the scope and methodology used, and presented the results as a starting point for further work.
- g. *Socio-economic survey: energy costs.* The results regarding energy costs were considered odd: the experts in emerging and developing countries scored fossil energy as having the highest energy costs, although only in some specific cases the costs of RE are lower than the costs of fossil. The RECIPES team found a higher variation in the answers regarding energy costs, but could not find a conclusive reason for this. A sensitivity analysis showed that the scoring on the ‘energy cost’ criterion did not fundamentally

change the overall conclusions. These conclusions were thus maintained while the above-mentioned elements were highlighted in section 2.2 of this report.

- h. *Actual market volumes and business models.* Several remarks concerned chapter 3. There was a call for a clear message whether developing countries are worth attention, and if so, which countries. There was furthermore a call for actual market volumes. Both aspects were improved in chapter 3. The risk analysis included was considered well done and valuable for business decision makers. Finally there was a call for more information on the different business models that RE industry can use in emerging and developing countries: export versus local assembly or production, use of intellectual property rights. The RECIPES team acknowledged that research into business models for doing business in emerging and developing countries could be of high interest for RE industry. However, the team did not look into this issue as it is beyond the scope of RECIPES. Some information on business models currently applied by RE industry was included in sections 3.3.1 to 3.3.7.
- i. *Follow-up.* The participants identified a clear need for follow up. The main question raised was: how to use the collected information in the best way? It was mentioned that the JREC is establishing a mechanism to report to the CSD on a regular basis, including a review mechanism. It is under discussion how the update task will be carried out. One of the options is to have it conducted by a network of organisations with complementary knowledge: REN21 would be part of this network; RECIPES could also be part of it. This suggestion is included in section 4.4 about RECIPES follow-up.

RECIPES Workshop – List of attendants

Name	First name	Mr / Ms	Organisation / Company	Country
Agbemabiese	Lawrence	Mr	UNEP	INT
Cognaud	Paul	Mr	Partners for Innovation	Belgium
Ducos	Verity	Ms	CEA	Netherlands
Evrard	Eric	Mr	Prospect CS	Belgium
Ferweda	Jaap-Jan	Mr	Windvision	Belgium
Green	Tamsine	Ms	Earthscan	United Kingdom
Hanekamp	Emiel	Mr	Partners for Innovation	Netherlands
Harmeling	Sven	Mr	Germanwatch	Germany
Hart	Terence J.	Mr	IT Power India	India
Kankam	Stephen	Mr	Vrije Universiteit Brussels	Ghana
Karsch	Peter	Mr	Partners for Innovation	Netherlands
Labrousse	Michel	Mr	ESENERG	France
Martinot	Eric	Mr	Tsinghua University	China
Allan	Alexander	Mr	EUBIA - European Biomass Industry Association	EU
Rollo	Valentina	Ms	ARE/EPIA/EREC - Rural Electrification Agency	EU
Rossetti	Domenico	Mr	European Commission	EU
Schäffler	Jason	Mr	Nano Energy	South Africa
Sonnemans	Els	Ms	EBM consult	Netherlands
Túlio Scarpelli Cabral	Marco	Mr	Brazilian Mission to the European Communities	Brazil
Tumiwa	Fabby	Mr	Working Group on Power Sector Restructuring	Indonesia
Vagonyte	Edita	Ms	AEBIOM - European Biomass Association	EU
Vanderstricht	Félix	Mr	Aquadev	Belgium
Vissers	Peter	Mr	Partners for Innovation	Belgium

Annex B – Selected references

Sources of information for this report and the underlying country reports are highly diverse. All sources for the country reports are listed in the annexes of the country reports. International and publicly available publications were used to check data from these sources.

Sources to which is explicitly referred in the present report are listed below. A more extensive publication list is available on the RECIPES website.

Selected references:

- AON (2006): ‘World Political and economic risk map’
- CEIP (2005): “Drivers for an international biofuels market”, Clingendael Institute, December 2005
- Dickson M / Fanelli M (2004): “What is geothermal energy?”, Istituto di Geoscienze e Georisorse, CNR, Pisa, Italy, February 2004
- EC JRC IES (2006): “PV Status report 2006”, August 2006
- EGEC European Geothermal Energy Council (2004): “Market perspectives 2000” and “Geothermal operators 2000”, www.geothermie.de
- EPIA (2004): “EPIA roadmap”, June 2004
- EPIA / Greenpeace (2006): “Solar generation – solar electricity for over 1 billion people and 2 million jobs by 2020”, September 2006
- EREC (2002), ‘European Renewable Energy Export Strategy’
- EREC (2004): ‘Renewable Energy scenarios to 2040’
- Ernst & Young (2006): ‘Renewable Energy Country Attractiveness Indices’, UK
- ESMAP (2005): “Advancing bio-energy for sustainable development; guideline for policymakers and investors”, joint UNDP/World Bank, April 2005
- ESTIF (2003): “Sun in action II – a solar thermal strategy for Europe”, April 2003

- EUBIA (2006): ‘Bioenergy – Diversified systems to convert biomass resources into heat, power and transportation fuels’, brochure, 4 pages, July 2006
- EurObserv’ER (2005): “Geothermia barometer”, December 2005
- EurObserv’ER (2006): “Biofuels - Biogas - Photovoltaic - Small hydro power - Solar thermal - Solid biomass - Wind energy” barometers, February – December 2006
- EWEA / Greenpeace (2004): ‘Wind Force 12’
- GTZ/WWI (2006): “Biofuels for transportation. Global potential and implications for sustainable agriculture and energy in the 21st century”, May 2006
- IEA (2002): ‘World Energy Outlook 2002. Energy and Poverty’
- IEA (2003a): ‘Renewable energy... into the mainstream’
- IEA (2003b): ‘Creating markets for energy technologies’
- IEA (2004a): ‘World Energy Outlook 2004. Global Energy Trends: Reference Scenario’
- IEA (2004b): “Biofuels for transport. An international perspective”, May 2004
- IEA (2006a): ‘World Energy Outlook 2006
- IEA (2006b): Statistics and outlooks figures – www.iea.org
- IEA / OECD (2003): ‘Creating markets for energy technologies’
- IEA SHCP (2006): “Solar heat worldwide”, Solar Heating & Cooling Programme March 2006
- IMET (2005): “White paper; the Global Bio-energy Partnership”, Italian Ministry for the Environment and Territory October 2005
- Martinot E. (2002), ‘Renewable Energy markets in Developing Countries’
- REN21 (2005): Global Status Report 2005
- REN21 (2006): Global Status Report 2006 update
- Sachs, Jeffrey D. (2005): ‘Investing in Development. A Practical Plan to Achieve the Millennium Development Goals’, UN Millenium Project, New York
- Shell International (2001): ‘Energy Needs, Choices and Possibilities, Scenarios to 2050’, Shell Global Business Environment

UNDP (2000): ‘Sustainable Energy strategies – materials for decision makers’

UNDP (2004): ‘World Energy Assessment; overview 2004 update’, New York

UNDP/GEF (2006) – Global Environment Facility – www.thegef.org

UNEP (2006): ‘Special Focus on RE in Africa’, personal communication Lawrence Agbemabiese, UNEP REED programme

US DoE EIA (2006): ‘International Energy Outlook 2006’

WEC Energy Data Centre (2006): World Energy Council: scenarios to 2050

Annex C – Emerging and developing countries (INCO list)

The 114 countries of the INCO list: ACP (African, Caribbean and Pacific), Asia and Latin America (INCO work programme)

AFRICAN (48)		ASIA (18)
Angola	Swaziland	Bangladesh
Benin	Tanzania	Bhutan
Botswana	Togo	Brunei
Burkina-Faso	Uganda	Cambodia
Burundi	Zambia	China
Cameroon	Zimbabwe	India
Cape Verde		Indonesia
Central African Republic	CARIBBEAN (16)	Lao (People's Democratic Rep. of)
Chad	Antigua and Barbuda	Malaysia
Comoros	Bahamas	Maldives
Congo (Republic)	Barbados	Mongolia
Congo (Democratic Rep. of)	Belize	Nepal
Côte d'Ivoire	Cuba	Pakistan
Djibouti	Dominica	Philippines
Equatorial Guinea	Dominican Rep.	Singapore
Eritrea	Grenada	Sri Lanka
Ethiopia	Guyana	Thailand
Gabon	Haiti	Vietnam
Gambia	Jamaica	
Ghana	Saint Kitts and Nevis	LATIN AMERICA (17)
Guinea	Saint Lucia	Argentina
Guinea-Bissau	Saint Vincent and Grenadines	Bolivia
Kenya	Suriname	Brazil
Lesotho	Trinidad and Tobago	Chile
Liberia		Colombia
Madagascar	PACIFIC (15)	Costa Rica
Malawi	Cook Islands	Ecuador
Mali	East Timor	El Salvador
Mauritania	Fiji	Guatemala
Mauritius	Kiribati	Honduras
Mozambique	Marshall Islands	Mexico
Namibia	Micronesia, Federal States of	Nicaragua
Niger	Nauru	Panama
Nigeria	Niue	Paraguay
Rwanda	Palau	Peru
Sao Tome and Principe	Papua New Guinea	Uruguay
Senegal	Solomon Islands	Venezuela
Seychelles	Tonga	
Sierra Leone	Tuvalu	
Somalia	Vanuatu	
South Africa	Western Samoa	
Sudan		

Annex D – Reports available on www.energyrecipes.org

Thematic and overall reports

- RECIPES final report – March 2007
 - Report on RE market potential in emerging and developing countries
 - Report on social, economic and environmental performance of energy technologies in emerging and developing countries
 - Annex: questionnaire of the RECIPES survey
 - Annex: results of the survey
 - Report on the opportunities and barriers for EU industry

Methodology and background information

- Country Data Form
- List of Sources
- Methodology Report

Country reports

Reports from 15 in-depth country studies

- Argentina RE potential
 - Argentina - Part A – Country info
 - Argentina - Part B – Energy and policy
 - Argentina - Part C – Country Maps
 - Argentina - Part D – RE Projects
 - Argentina - Part E – Scenario tables
- Brazil RE potential
 - Brazil - Part A – Country info
 - Brazil - Part B – Energy and policy
 - Brazil - Part C – Country Maps
 - Brazil - Part D – RE Projects
 - Brazil - Part E – Scenario tables
- Cameroon RE potential
 - Cameroon - Part A – Country info
 - Cameroon - Part B – Energy and policy
 - Cameroon - Part C – Country Maps
 - Cameroon - Part D – RE Projects
 - Cameroon - Part E – Scenario tables
- China RE potential
 - China - Part A – Country info
 - China - Part B – Energy and policy
 - China - Part C – Country Maps
 - China - Part D – RE Projects
 - China - Part E – Scenario tables
- Colombia RE potential
 - Colombia - Part A – Country info
 - Colombia - Part B – Energy and policy

- Colombia - Part C – Country Maps
- Colombia - Part D – RE Projects
- Colombia - Part E – Scenario tables
- Ghana RE potential
 - Ghana - Part A – Country info
 - Ghana - Part B – Energy and policy
 - Ghana - Part C – Country Maps
 - Ghana - Part D – RE Projects
 - Ghana - Part E – Scenario tables
- India RE potential
 - India - Part A – Country info
 - India - Part B – Energy and policy
 - India - Part C – Country Maps
 - India - Part D – RE Projects
 - India - Part E – Scenario tables
- Indonesia RE potential
 - Indonesia - Part A – Country info
 - Indonesia - Part B – Energy and policy
 - Indonesia - Part C – Country Maps
 - Indonesia - Part D – RE Projects
 - Indonesia - Part E – Scenario tables
- Mexico RE potential
 - Mexico - Part A – Country info
 - Mexico - Part B – Energy and policy
 - Mexico - Part C – Country Maps
 - Mexico - Part D – RE Projects
 - Mexico - Part E – Scenario tables
- Niger RE potential
 - Niger - Part A – Country info
 - Niger - Part B – Energy and policy
 - Niger - Part C – Country Maps
 - Niger - Part D – RE Projects
 - Niger - Part E – Scenario tables
- Pacific Islands RE potential
 - Fiji - Part A - Country info
 - Kiribati - Part A - Country info
 - Vanuatu - Part A - Country info
 - Pacific Islands - Part B - Energy and policy
 - Pacific Islands - Part C - Country Maps
 - Pacific Islands - Part D - RE Projects
 - Pacific Islands - Part E - Scenario tables
- Peru RE potential
 - Peru - Part A – Country info
 - Peru - Part B – Energy and policy
 - Peru - Part C – Country Maps
 - Peru - Part D – RE Projects
 - Peru - Part E – Scenario tables

- South Africa RE potential
 - South Africa - Part A – Country info
 - South Africa - Part B – Energy and policy
 - South Africa - Part C – Country Maps
 - South Africa - Part D – RE Projects
 - South Africa - Part E – Scenario tables
- Thailand RE potential
 - Thailand - Part A – Country info
 - Thailand - Part B – Energy and policy
 - Thailand - Part C – Country Maps
 - Thailand - Part D – RE Projects
 - Thailand - Part E – Scenario tables
- Uganda RE potential
 - Uganda - Part A – Country info
 - Uganda - Part B – Energy and policy
 - Uganda - Part C – Country Maps
 - Uganda - Part D – RE Projects
 - Uganda - Part E – Scenario tables

Reports 114 countries

- Africa
 - RECIPES country info Angola
 - RECIPES country info Benin
 - RECIPES country info Botswana
 - RECIPES country info Burkina Faso
 - RECIPES country info Burundi
 - RECIPES country info Cameroon
 - RECIPES country info Cape Verde
 - RECIPES country info Central African Republic
 - RECIPES country info Chad
 - RECIPES country info Comoros
 - RECIPES country info Congo
 - RECIPES country info Cote d'Ivoire
 - RECIPES country info Djibouti
 - RECIPES country info Equatorial Guinea
 - RECIPES country info Eritrea
 - RECIPES country info Ethiopia
 - RECIPES country info Gabon
 - RECIPES country info Gambia
 - RECIPES country info Ghana
 - RECIPES country info Guinea-Bissau
 - RECIPES country info Guinea
 - RECIPES country info Kenya
 - RECIPES country info Lesotho
 - RECIPES country info Liberia
 - RECIPES country info Madagascar
 - RECIPES country info Malawi
 - RECIPES country info Mali

- RECIPES country info Mauritania
- RECIPES country info Mauritius
- RECIPES country info Mozambique
- RECIPES country info Namibia
- RECIPES country info Niger
- RECIPES country info Nigeria
- RECIPES country info Republic South Africa
- RECIPES country info Rwanda
- RECIPES country info Sao Tome and Principe
- RECIPES country info Senegal
- RECIPES country info Seychelles
- RECIPES country info Sierra Leone
- RECIPES country info Somalia
- RECIPES country info Sudan
- RECIPES country info Swaziland
- RECIPES country info Tanzania
- RECIPES country info Togo
- RECIPES country info Uganda
- RECIPES country info Zambia
- RECIPES country info Zimbabwe
- Asia
 - RECIPES country info Afghanistan
 - RECIPES country info Bangladesh
 - RECIPES country info Bhutan
 - RECIPES country info Brunei
 - RECIPES country info Cambodia
 - RECIPES country info China
 - RECIPES country info India
 - RECIPES country info Indonesia
 - RECIPES country info Laos
 - RECIPES country info Malaysia
 - RECIPES country info Maldives
 - RECIPES country info Mongolia
 - RECIPES country info Nepal
 - RECIPES country info Pakistan
 - RECIPES country info Philippines
 - RECIPES country info Singapore
 - RECIPES country info Sri Lanka
 - RECIPES country info Thailand
 - RECIPES country info Vietnam
- Carribean
 - RECIPES country info Antigua and Barbuda
 - RECIPES country info Bahamas
 - RECIPES country info Barbados
 - RECIPES country info Belize
 - RECIPES country info Cuba
 - RECIPES country info Dominica
 - RECIPES country info Dominican Republic

- RECIPES country info Grenada
- RECIPES country info Guyana
- RECIPES country info Haiti
- RECIPES country info Jamaica
- RECIPES country info Saint Kitts and Nevis
- RECIPES country info Saint Lucia
- RECIPES country info Saint Vincent and Grenadines
- RECIPES country info Suriname
- RECIPES country info Trinidad and Tobago
- Latin America
 - RECIPES country info Argentina
 - RECIPES country info Bolivia
 - RECIPES country info Brazil
 - RECIPES country info Chile
 - RECIPES country info Colombia
 - RECIPES country info Costa Rica
 - RECIPES country info Ecuador
 - RECIPES country info El Salvador
 - RECIPES country info Guatemala
 - RECIPES country info Honduras
 - RECIPES country info Mexico
 - RECIPES country info Nicaragua
 - RECIPES country info Panama
 - RECIPES country info Paraguay
 - RECIPES country info Peru
 - RECIPES country info Uruguay
 - RECIPES country info Venezuela
- Pacific
 - RECIPES country info Cook Islands
 - RECIPES country info East Timor
 - RECIPES country info Fiji
 - RECIPES country info Kiribati
 - RECIPES country info Marshall Islands
 - RECIPES country info Micronesia
 - RECIPES country info Nauru
 - RECIPES country info Niue
 - RECIPES country info Palau
 - RECIPES country info Papua New Guinea
 - RECIPES country info Samoa
 - RECIPES country info Solomon Islands
 - RECIPES country info Tonga
 - RECIPES country info Tuvalu
 - RECIPES country info Vanuatu