Renewable Energy

Chapter outline

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Acronyms

BAU	Business-as-usual
CDM	Clean Development Mechanism
CER	Certified Emission Reductions
CET	Clean energy technologies
CSP	Concentrated solar power
DII	Desertec Industrial Initiative
DRC	Democratic Republic of Congo
ECT	Energy Charter Treaty
EGS	Environmental Goods and Services
EPO	European Patent Office
EST	Environmentally sound technologies
ETS	Emission Trading System
EU	European Union
FDI	Foreign Direct Investment
FIT	Feed-in tariff
GATT	General Agreement on Tariffs and Trade
GER	Green Economy Report
GHG	Greenhouse Gas
HS	Harmonised System
HVDC	High voltage direct current
ICTSD	International Centre for Trade and Sustainable Development
IEA	International Energy Agency
IPRs	Intellectual Property Rights
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
LDCs	Least Developed Countries
MENA	Middle East and North Africa
MWp	Megawatt Power
OECD	Organisation for Economic Co-operation and Development
PV	Photovoltaic
RED	Renewable Energy Directive
RES	Renewable Energy Supply
R&D	Research & Development
SCM Agreement	Agreement on Subsidies and Countervailing Measures
TRIMs Agreement	Agreement on Trade Related Investment Measures
TRIPS Agreement	Agreement on Trade Related Aspects of Intellectual Property Rights
UfM	Union for the Mediterranean
UNCTAD	United Nations Conference on Trade and Development
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNOPS	United Nations Office for Project Services
WBCSD	World Business Council for Sustainable Development
WTO	World Trade Organization

6 Renewable Energy

6.1 Introduction

The challenges posed to the global community and national governments, in terms of energy security, climate change, health impacts and poverty are pressing, making the greening of the energy sector an imperative. The shift to renewable energy — along with major energy efficiency improvements — plays a critical role in addressing some of the most prominent challenges the world is faced with today. The Rio+20 Outcome Document, "The Future We Want" (UN 2012a, paragraphs 125-129), highlights the importance of this transition and emphasises

> "the need to address the challenge of access to sustainable modern energy services for all… [including through] increased use of renewable energy sources and other low emission technologies".

International trade can play a significant role in greening the energy sector. In particular, trade is an important vehicle for renewable energy technology transfer. The Rio+20 Outcome Document (UN 2012a, paragraph 271) also highlights "the role of foreign direct investment, international trade and international cooperation in the transfer of environmentally sound technologies".

This chapter identifies the trends and trade opportunities in the renewable energy sector associated with a transition to a green economy. It explores how developing countries can respond to international demand for sustainable goods and services in this sector.

Some promising trade opportunities in the renewable energy sector that are highlighted in this chapter are:

- Exports of raw materials or components for renewable energy supply products, or of finished renewable energy supply products (e.g. solar panels, wind turbines, and hydrogen fuel cells);
- Exports of energy produced from renewable resources (e.g. solar or wind power);
- Exports of renewable natural resources to produce energy (e.g. feedstock for biofuels, biogas and biomass);
- Cross-border provision of renewable energy services; and
- Selling carbon credits on international markets.

The chapter also reviews some of the challenges that developing countries face in order to participate in the regional and global energy markets and offers suggestions on how to address them.

6.2 Environmental and economic context for greening the economy

This section provides background on the context and current state of renewable energy and reviews current trade patterns in the energy sector.

6.2.1 Context

Energy is the lifeblood of the world economy. Energy interacts with all other goods and services that are vital for economies and the economic and functional reliance on energy is expected to further increase. In particular, global energy demand has been estimated to grow by more than one-third until 2035, with China, India and the Middle East accounting for 60 per cent of this demand increase (IEA 2012a).

As highlighted in the Green Economy Report (GER) (UNEP 2011), the global community and national governments are faced with several challenges with respect to the energy sector. These include:

- **Access to energy:** Currently 1.3 billion people – one in five globally – lack any access to electricity. Twice that number – nearly 40 per cent of the world's population – relies on wood, coal, charcoal, or animal waste to cook their food (IEA 2010a).

- **Climate change and emissions:** Energy-related greenhouse gas (GHG) emissions are the main drivers of anthropogenic climate change, exacerbating patterns of global warming and environmental degradation. Global carbon dioxide (CO_2) emissions from fossil-fuel combustion are reported to have reached a record high of 31.6 gigatonnes (Gt) in 2011 (IEA 2012b).
- **Health and biodiversity:** The processing and use of energy resources pose significant health challenges, pertaining to increased local air pollution, a decrease in water quality and availability, and increased introduction of hazardous substances into the biosphere (UNEP 2010a). For example, the inhalation of toxic smoke from biomass combustion can cause lung disease and is estimated to kill nearly two million people a year (IEA 2010a). Adverse health effects from energy use are aggravated by increasing instances of land degradation and deforestation, leading to a simultaneous loss of biodiversity.
- **Energy security:** The growth in global population and rising incomes will increase energy demand and result in upward pressures on energy prices and growing risks of importer dependency on a limited range of energy suppliers.

Greening the energy sector, including by substantially increasing investment in renewable energy and the share of renewable energy in all economic sectors, provides an opportunity to make a significant contribution to addressing these challenges. This was recently highlighted in the UN's launch of the "Sustainable Energy for All" initiative, as set out in Box 1.

Box 1. The UN's initiative on Sustainable Energy for All

The UN Secretary-General launched in January 2012 the "Sustainable Energy for All" initiative. The importance of the initiative was emphasised in the Rio+20 Outcome Document (UN 2012a, paragraph 129).

The objectives of the initiative are to (i) ensure universal access to modern energy services, (ii) double the share of renewable energy in the global energy mix (from 15 to 30 per cent) by 2030, and (iii) reduce global projected electricity consumption from buildings and industry (energy efficiency) by 14 per cent.

The key for meeting these objectives is to provide sustainable energy for all – energy that is more accessible, cleaner and more efficient. A High-Level Group, composed of representatives from business and public service, will mobilise commitments from governments, the private sector, and civil society partners to take actions that will make sustainable energy a reality for all over the next two decades. Under this initiative, more than US$ 50 billion have already been mobilised from the private sector and investors.

Source: UN 2012b

6.2.2 Current state of renewable energy

There are various definitions of renewable energy. The IEA, for example, defines renewable energy as follows:

> "Renewable energy is derived from natural processes that are replenished constantly. In its various forms, it derives directly or indirectly from the sun, or from heat generated deep within the earth. Included in the definition is energy generated from solar, wind, biomass, geothermal, hydropower and ocean resources, and biofuels and hydrogen derived from renewable resources" (IEA n.d.).

The share of renewable energy is close to 20 per cent of global final consumption. As capacity continues to grow and prices for renewable energy and its equipment continue to fall, this share is likely to further increase. Along with measures to promote energy efficiency, the increase in renewable energy will provide many benefits to both the global economy and individual countries.

The adoption of renewable energy technologies can help reduce the carbon intensity of growth (Sims et al. 2007). By leapfrogging extensive use of conventional energy systems, developing countries can avoid the challenges of unsustainable energy infrastructures and processes that face the developed world.

With the right policy and financial frameworks, a wide range of renewable energy technologies can become accessible to a large potential market, including decentralised populations in developing countries.

Technologies such as solar water heaters, solar photovoltaic (PV) panels, wind turbines, heat pumps, mini-hydro generators, and biogas digesters all have the potential to make a significant contribution towards securing modern energy services for the poor as well as for nascent industries in developing countries. In areas without direct connection to an electricity grid, decentralised energy solutions provide a way to increase access to basic services such as heating, lighting, refrigeration and communication without incurring high infrastructure costs. The use of renewable energy technologies for such off-grid applications can often be a cost-effective approach to increasing energy access.

Furthermore, shifting from fossil fuels to renewable energy sources can contribute to meeting GHG reduction targets. Emissions in 2012 are projected to have been 58 per cent above 1990 levels (Le Quéré et al. 2012). Under business-as-usual conditions, global GHG emissions are predicted to increase to an annual 37 gigatonnes by 2035 (IEA 2012c). The promotion of renewable energy can decisively limit carbon emissions from energy production and use, bearing the potential to save an equivalent of 220–560 gigatonnes of CO_2 between 2010 and 2050 (IPCC 2011).

The IEA's most ambitious mitigation scenario, the "450" Scenario, sees the CO_2 content of the atmosphere restricted to 450 parts per million (IEA 2011a). This would involve CO_2 emissions peaking before 2020 and then falling to 1990 levels by 2035. This projection estimates that 44 per cent of the emissions abatement by 2035 would be realised from energy efficiency measures, 21 per cent from the use of renewable power, four per cent from the adoption of biofuels, nine per cent from the use of nuclear power, and 22 per cent from the use of carbon capture and storage (UNEP 2012a).

The IEA's *Energy Technology Perspectives 2012* illustrates that already the integrated use of existing technologies would make it possible to reduce dependency on imported fossil fuels or on limited domestic resources, decarbonise electricity, enhance energy efficiency, and reduce emissions in the industry, transport and buildings sectors (IEA 2012a). Furthermore, the reduction in GHG and criteria pollutant emissions (such as nitrogen dioxide, sulphur dioxide, and particulate matter) associated with the widespread use of hydrogen fuel cell vehicles is anticipated to result in significant societal benefits by mitigating climate change and reducing health impact costs (OICA 2012).

Investing in renewable energy technologies also creates new employment opportunities. In 2010, more than 3.5 million people worldwide were estimated to be working, either directly or indirectly, in the renewable energy sector and further growth is expected. Estimates suggest that by 2030, 12 million people could be employed in the biofuels sector, 2.1 million in the wind sector and 6.3 million in the solar PV sector (UNEP 2008a).

One of the most significant developments in the renewable energy sector in recent years has been the decline in the cost of various renewable energy technologies. Under these trends, renewable energy prices are increasingly challenging fossil-fuel alternatives. In particular, the cost of generation from solar PV and onshore wind declined 31-35 per cent and 9 per cent respectively between 2011 and 2012. Of the main renewable energy technologies, only offshore wind saw costs increase in 2011 (UNEP 2012a).

In many cases, renewable energy production can already be more cost-effective than fossil fuel alternatives. This is especially the case in locations where fossil fuel reserves are not extractable and countries are therefore forced to import energy to fulfil domestic needs. Once sufficient demand for renewable energy allows for economy-of-scale production in developing countries, its price-effectiveness is likely to further increase (UNEP 2012a).

Technology is key to both increasing access to energy supplies and also decreasing the world's carbon footprint. However, while many renewable energy technologies have witnessed recent technological advancements and cost reductions, renewable energy is not the only unconventional form of energy that has come to the forefront in recent years. Hydraulic fracturing, an upstream gas extraction technology also known as 'gas fracking', enables operators to unlock vast shale gas resources and congests natural gas markets with cheap and abundant supplies, mainly from the United States. Gas fracking has expanded dramatically and unconventional gas is predicted to account for half of the increase in global gas production until 2035 (IEA 2012c). While contributing to global energy security, gas fracking can carry numerous environmental and health challenges, as highlighted in a recent UNEP report (UNEP 2012b).

Even in the renewable energy sector, some technological advancements may have environmental and social impacts. For example, the potential adverse effects from hydropower projects are illustrated in Box 2.

Box 2. Trade-offs that countries face with large hydropower plants

Large hydropower projects have in many instances resulted in villages disappearing under reservoirs, adversely affecting inhabitants and local livelihoods. When making proposals for large hydropower projects, countries have to balance these negative effects with the positive environmental and supply effects of providing electricity from a renewable source.

In Laos, for example, the construction of the Xayaburi hydropower dam puts the Mekong River's rich biodiversity and abundant fisheries and livelihoods – vital to nearly 60 million people – in grave danger (WWF 2012, The Economist 2012).

In Brazil, the world's third biggest dam is due to be constructed on the Xingu River, in the Amazon. While the dam contributes a planned installed capacity of 11,233 megawatts (MW) to the national electricity supply, it could result in the displacement of thousands of indigenous people and have adverse impacts on tropical forests (Fearnside 2012).

In order for hydropower generation to be sustainable and negative impacts to be addressed, careful planning and thorough social and environmental assessments and mitigation are necessary (UNCSD 2011). There are a variety of guidelines available, including from the World Commission on Dams and the International Finance Corporation on social and environmental performance criteria for dams and other renewable energy projects (IFC 2012).

Some renewable energy sources, such as biofuels, are under increasing scrutiny for their potentially adverse impacts on the environment and food security (UNEP 2009). At times of rising food prices and persistently high rates of hunger, the production of biofuels from food crops or use of arable land has become more controversial. Biofuels produced from food crops are often considered as 'first generation biofuels' while biofuels produced from feedstocks that do not create an additional demand for land can be referred to as 'second-generation' or 'advanced' biofuels (EC 2012a). The further development of second-generation biofuels, produced from a wider range of raw materials including waste from pulp and paper mills, is expected to play an important role in addressing the negative impacts of biofuel production on the environment and food supplies. The development and implementation of sustainability criteria, new measurements and guidelines are essential in the increasingly open markets for biofuels.

Furthermore, for the manufacture and trade of rare earths (which can be an input for renewable energy products), it is important that environmental, and health and safety regulations are in place and implemented in order to ensure that extraction of rare earths has neither a negative impact on miners nor on ecosystems surrounding the mines.

6.2.3 Trade, energy and the environment

Energy is critically important to international trade. In particular, energy has a key role in extracting, transforming, manufacturing and transporting for the distribution of goods and services throughout the economy. The price of energy ranks among the main shaping factors of international trade. Furthermore, the interrelationship between energy, trade rules and the environment is rising in prominence in view of climate change, higher energy costs, and new technological developments.

Trade in the energy sector encompasses several different types of trade in goods and services. Distinctions can, for example, be made between trade in energy itself (such as trade in electricity), trade in natural resources needed to produce energy (e.g. trade in fuels such as biofuels, coal, gas and oil and nuclear materials), trade in manufactured products to produce energy (e.g. wind turbines), trade in the raw materials or components to produce energy related manufactured products (e.g. rare earths), cross-border provision of energy services (e.g. providing technical know-how), and trade in carbon credits on international markets.

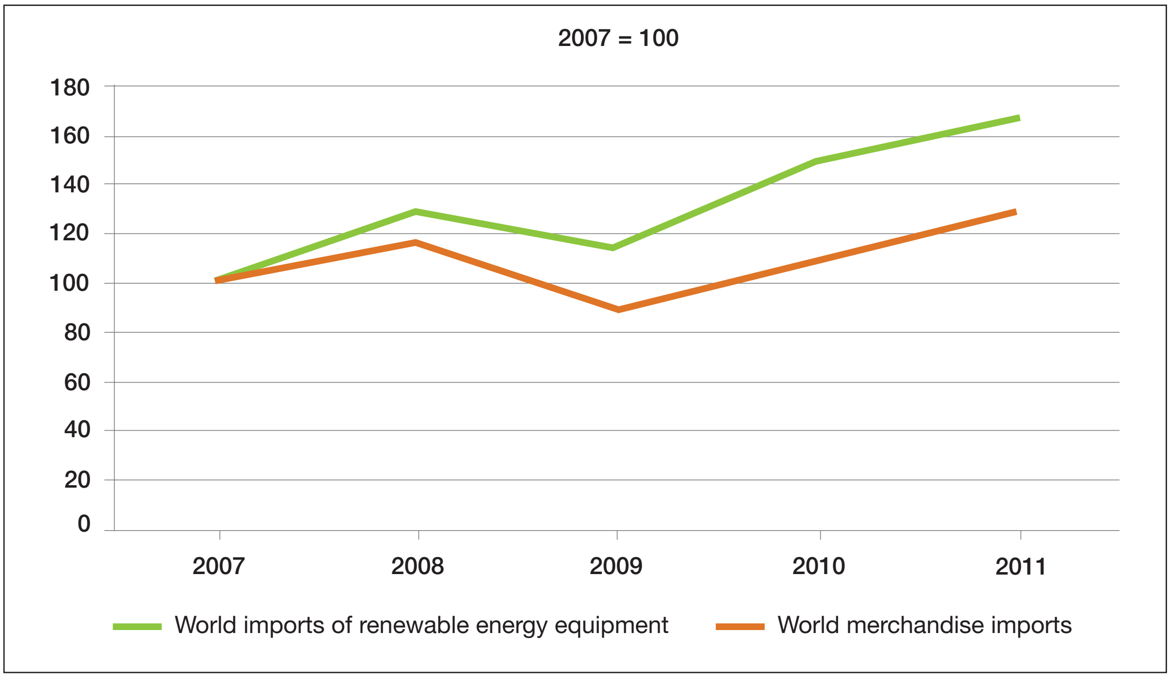
Trade in energy and energy products is estimated to account for more than 20 per cent of world trade by value (CEPR 2010). In terms of trade in the whole energy sector, the biggest market segment is trade in natural resources needed to produce energy. In particular, coal, oil, and increasingly also natural gas are traded around the world, being shipped huge distances by sea to reach markets. Oil as well as natural gas are also traded via pipelines that often cross several borders. In contrast, in the renewable energy sector, trade in natural resources is limited largely to trade in biofuels and biodiesel, mainly due to the problems of transporting and effectively storing renewably sourced energy (see section 6.3). Instead, the bulk of trade in the renewable energy sector is made up of trade in manufactured products and components for manufactured products. As Figures 1 and 2 illustrate, markets and trade in renewable energy products and biofuels have shown significant growth rates.

Figure 1. Markets for renewable energy (RE) technologies (in US$ billions)

	2004	2008	2009	2010	2011
Solar PV (modules, system components, and installation)	7.2	29.6	36.1	71.2	91.6
Wind (new installation capital costs)	8.0	51.4	63.5	60.5	71.5
Biofuels (global production and wholesale pricing of ethanol and biodiesel)	n/a	34.8	44.9	56.4	83.0

Source: Clean Edge, Clean Energy Trends 2012, March 2012

Figure 2. Growth in trade of renewable energy equipment v. merchandise products



Source: OECD (2013) based on data obtained from the UN Comtrade database and the WTO. Imports of renewable energy equipment comprise all products included under "Renewable energy plant" in the WTO's Friends list of environmental goods. The underlying data are nominal US dollars that have been normalised so that 2007=100.

The two most significant national markets for trade in manufactured renewable energy products are the United States and China. Solar energy product exports are the largest component of US-China clean energy trade for both countries. Combined, firms based in the two nations are estimated to have traded more than US$ 6.5 billion worth of products and services in 2011. More than US$ 923 million worth of wind energy goods and services were exchanged between the two countries in 2011. In addition, trade in energy smart technology, such as smart metering and lithium-ion batteries, constitutes more than US$ 1.1 billion worth of equipment traded (The Pew Charitable Trusts 2013).

To a large extent, cross-border trade in energy and related investment is subject to bilateral treaties. However, in order to ensure predictability and legal certainty, enforceable multilateral rules have an important role to play (Trebilcock et al. 2012). Manufactured products for energy production, cross-border energy services and natural resources, to the extent that they may be traded, are covered by the obligations contained in the World Trade Organization (WTO) agreements such as the General Agreement on Tariffs and Trade (GATT) (WTO 2010). These obligations include the most favoured nation principle (i.e. obligation not to discriminate between "like products" imported from different WTO Members) and the national treatment principle (i.e. obligation not to discriminate between domestic and imported "like products.")

The WTO disciplines on subsidies are also very important as the energy sector is heavily subsidised. Indeed, imbalances in the availability of appropriate services and technologies, along with market protections such as subsidies and tariffs, distort international trade in this sector (Jha 2011). In the context of renewable energy, support schemes, which may include local content requirements, have led to disputes at the WTO, as illustrated in Box 3.

Box 3. Renewable energy support programmes and the WTO

Renewable energy support programmes and, in particular, associated local content requirements can be of contentious nature *vis à vis* international trade rules. Indeed, the dispute settlement system of the WTO has recently been addressed by various requests for consultation concerning national renewable energy support programmes and connected local content requirements. Renewable energy support programmes can take various forms, such as for instance feed-in tariff schemes, while local content requirements generally appear as pre-conditions for accessing support programmes, creating incentives to source renewable energy equipment from the domestic market.

In February 2013, for example, the United States requested consultations with India concerning certain measures relating to domestic content requirements and prohibited subsidies under the Indian Jawaharial Nehru National Solar Mission for solar cells and solar modules. The request for consultations contained allegations of breaches of various WTO provisions, including the Agreement on Subsidies and Countervailing Measures (SCM Agreement) as well as national treatment obligations under the General Agreement on Tariffs and Trade (GATT) and the Agreement on Trade Related Investment Measures (TRIMs Agreement).

In late 2012, a WTO panel found a Canadian feed-in tariff scheme, set-up to incentivise national renewable energy production, to be consistent with the SCM Agreement, as the measures at issue did not constitute a "subsidy" within the meaning of that agreement. At the same time, however, the local content requirements included in the Canadian programme were found to be inconsistent with the national treatment obligations included in the GATT and the TRIMs Agreement. The subsequent appeal decision, circulated on 6 May 2013, did not reverse the panel's findings on these issues.

The controversial nature of renewable energy subsidy programmes and related local content requirements is also witnessed by further proceedings on-going at the WTO, including a request for consultations filed by China against the EU in relation to the feed-in tariff schemes of certain EU Member States, and a request for consultations filed by the United States against certain Chinese support programmes in the wind power sector.

Source: World Trade Organization (WTO), Website

Besides posing regulatory issues, trade in the energy sector also presents specific operational challenges. In particular, energy trade is often linked to fixed infrastructure (e.g. transportation pipelines and transmission grids) that is needed to transport oil, gas, and electricity. This necessitates high upfront investments in capital-intensive infrastructure projects and conditions of access to energy transportation networks. In addition, uneven geographical distribution of resources means that some countries are dominated by resource production, while others have none; more than 90 per cent of proven oil reserves are in just 15 countries (WTO 2012). Furthermore, national energy sectors are often dominated by government-owned or government-controlled companies that perform regulatory functions (Selivanova 2007).

Another distinguishing factor for trade in the energy sector is that energy itself and materials to produce energy products do not usually encounter market access problems in their export markets (Selivanova 2007). Trade restrictions in the energy sector tend to be directed more to export barriers and export taxes. Nevertheless, in the renewable energy field, both market access issues and export restrictions have been subject to international consultations. Several market access cases in the WTO have concerned solar panels and biofuels. Concerning export restrictions, the WTO case on rare earths provides an example of how some countries are using export restrictions for public policy reasons, as illustrated in Box 4.

Box 4. WTO consultations on rare earth exports

The shift to an increasing share of renewable energy supply products will have a significant impact on trade in rare earths minerals or metals. Rare earths are important inputs for the manufacture of several renewable energy supply products such as wind turbines and energy efficient lighting. Global demands for rare earth elements have been increasing, with demand (134,000 tonnes per year) largely exceeding global production (124,000 tonnes per year). Global demand is projected to exceed 200,000 tonnes per year by 2014 (UNEP 2012a). This has given rise to international consultations.

On 23 July 2012, at the request of the United States, the European Union (EU) and Japan, the Dispute Settlement Body of the WTO established a Panel to consider China's export restrictions on rare earths as well as tungsten and molybdenum. Complainants argue that China has placed export restrictions, through e.g. licences and minimum export price requirements, on the products at issue in breach of certain WTO provisions as well as China's WTO Accession Protocol (WTO website). In response, in its White Paper Situation and Policies of China's Rare Earth Industry, China claims that its policies concerning the products at issue are aimed at protecting natural resources and achieving sustainable economic development, and that an annual export quota is needed (MIIT 2012).

This case disputes the right of WTO members to limit exports of natural resources for various policy objectives, including environmental protection. This right is safeguarded by WTO rules, but the accession protocols of some members may include so-called "WTO plus" requirements limiting the policy space of such members. As a result, WTO members enjoy different degrees of freedom for regulating exports of natural resources and the relevant rules, including those contained in accession protocols, may need significant improvement (Quin 2012).

As well as the WTO, the Energy Charter Treaty (ECT) plays a role in energy trade governance. In fact, the ECT is the only international treaty setting legal norms specific to energy trade and investment. Comprising over 50 member states, it includes in its membership countries across Eurasia from the EU to former Soviet Union republics to Japan. The ECT incorporates the major rules of the WTO with respect to trade in goods in the energy sector. Moreover, the ECT's trade regime applies WTO rules by reference to trade between its members that have not yet acceded to the WTO. The ECT also deals specifically with issues of transit of energy materials and products via fixed infrastructure (ECT 2001).

Trade also has a key role to play in technology transfer of environmentally sound technologies, as is discussed in section 6.3.5.

6.3 Green economy measures

There are a variety of green economy measures that can lead to enhanced trade in renewable energy or its equipment. Potential measures include fiscal reform of the energy sector, including phasing out subsidies for fossil fuels and providing fiscal incentives for renewable energy, investments in renewable energy and infrastructure, regulations on renewable energy, and the transfer of technology.

The following subsections illustrate examples of green economy measures that present the potential to create or consolidate sustainable trade opportunities in the renewable energy sector.

6.3.1 Investments

Box 5. Key messages from the Green Economy Report (GER)

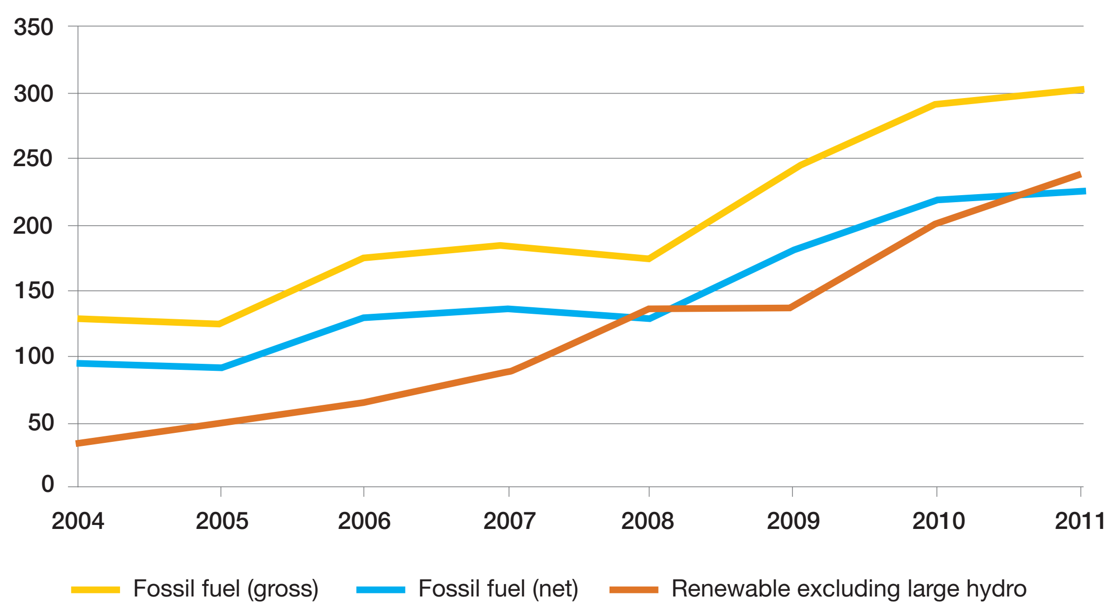
Modelling studies carried out for the GER project estimated that an average annual investment of approximately US$ 650 billion over the next 40 years in power generation, using renewable energy sources and second-generation biofuels for transport, could raise the share of renewable energy sources in total energy supply to 27 per cent by 2050, compared with less than 15 per cent under a business-as-usual (BAU) scenario. Increased use of renewable energy sources could contribute more than one-third of the total GHG reduction of 60 per cent achieved by 2050, relative to BAU.

Source: UNEP 2011

Investments are driving the increasing share of renewables in total energy supply. Hence, investment statistics provide an indicator as to which countries are likely to be strong exporters in the future. Renewable energy investment could be fostered by fiscal incentive measures and preferential grid access measures such as feed-in tariffs which offer investors more stable returns through price guarantees.

Different categories of investment include venture capital and private equity, public markets, asset finance and mergers & acquisitions (UNEP SEFI 2012). Under this conception, global gross investment in fossil fuel generating capacity in 2011 amounted to US$ 302 billion, compared to investments of US$ 237 billion in renewables. If spending on fossil fuel replacement plants is excluded and investment in large hydro included, the investment in renewable power capacity amounts to about US$ 262.5 billion; this is US$ 40 billion higher than the same measure for fossil fuel (UNEP SEFI 2012). When additionally accounting for government and corporate research and development in the renewable energy sector, clean energy investments in 2011 amounted to US$ 302.3 billion. Even though this figure decreased to US$ 268.7 billion in 2012, investments still exceeded the 2004 figures by five times (BNEF 2013a). The global trends from 2004-2011 are shown in Figure 3.

Figure 3. Investment in clean energy v. conventional capacity



Fossil fuel investment is calculated from US Energy Information Administration and IEA data. Renewable energy investment includes asset finance and small-scale projects, but excludes large hydro.

Source: FSFM 2012

Developing economies made up 35 per cent of this total investment in 2011. The largest shares of investments in renewable energy have occurred in Brazil, China and India, which together account for almost US$ 60 billion, or 90 per cent, of developing country investments. In 2011, India displayed the fastest expansion rate for investment in any large renewable energy market, with a 62 per cent increase to US$ 12 billion (UNEP SEFI 2012).

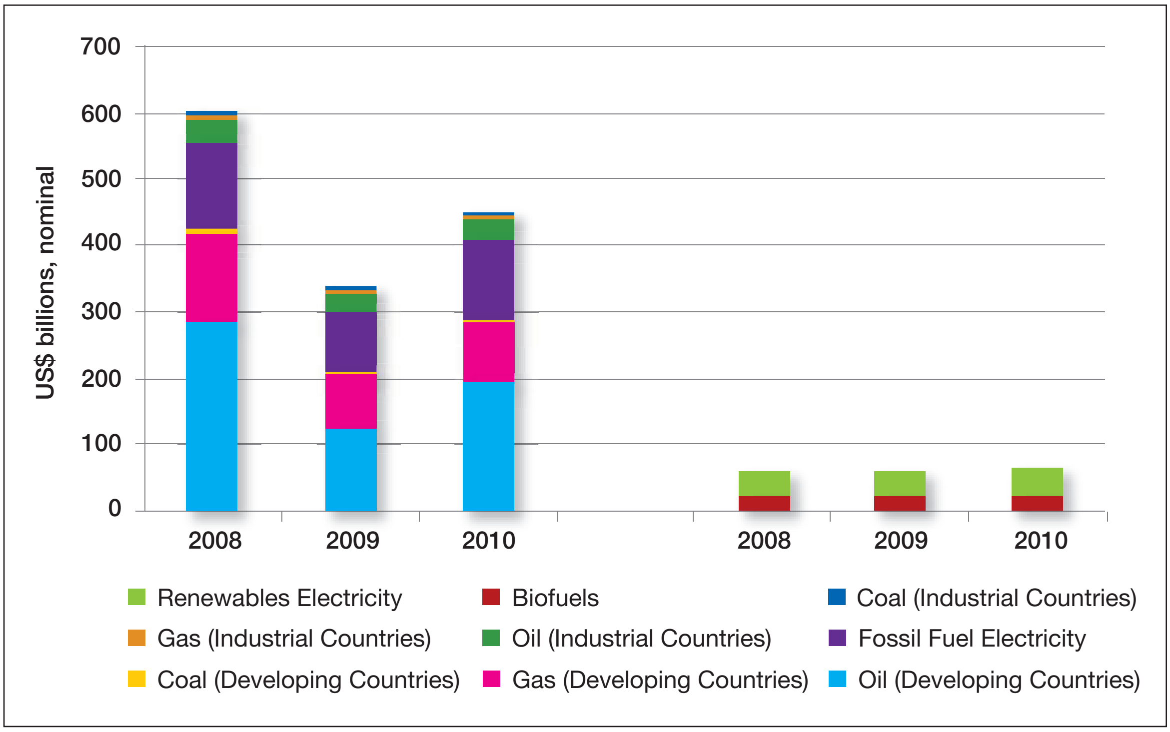
Some 13 per cent of total investment in 2011 took place outside emerging and developed economies. This proportion has been above 10 per cent in each of the last eight years. In 2011, total investment in the Americas, excluding Brazil and the United States, was US$ 7 billion, while in the Middle East and Africa, it was US$ 6.5 billion. In Asia-Oceania, outside China and India, investment amounted to US$ 21.1 billion (UNEP SEFI 2012).

Enhanced cost-effectiveness of renewable energy technologies is promoting accessibility to household and small business markets. This is reflected by the growing demand for small-scale renewable energy finance, particularly in developing countries, which according to the Climate Policy Initiative accounted for approximately 24 per cent of global climate financial flows in 2010-11 (CPI 2011).

6.3.2 The removal of environmentally harmful energy subsidies

A major source of investment for renewable energy can arise from a reform of fossil fuel subsidies. These have, for many years, demonstrated to artificially lower energy prices, encouraging wasteful energy consumption and making renewable and more efficient technology less competitive. According to the IEA 2012 World Energy Outlook, fossil fuel subsidies amounted to US$ 523 billion in 2011, almost 30 per cent more than in 2010 and six times more than subsidies to renewables. It is estimated that phasing out all fossil fuel consumption and production subsidies by 2020 could reduce global primary energy demand by 5 per cent and energy-related CO_2 emissions by 5.8 per cent (IEA 2011a). Figure 4 illustrates the large gap between fossil fuel and clean energy subsidies.

Figure 4. Estimated global energy consumption subsidies for fossil fuels and for renewables in industrial and developing countries, 2008-10



Source: Worldwatch Institute 2013 (compiled from IEA and OECD data)

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6.3.3 Regulations and policies affecting renewable energy

Market development in the renewable energy sector, including in export markets, is largely driven by domestic policies and regulatory requirements. According to the Renewable Energy Policy Network, by early 2011, at least 119 countries had some type of national policy target or support scheme for renewable energy (REN 2011). The targets generally range from a share of 5-20 per cent of renewable energy in the national energy mix.

National energy strategies can draw on different policy tools and regulations to facilitate the deployment of renewable energy and attain specified targets. EU Member States have led the way among developed countries, with the 2009 EU Renewable Energy Directive (RED). The RED mandates a joint share of 20 per cent share for renewable energy in the EU energy mix by 2020 (EC 2009). Since the EU is – and is likely to remain for the foreseeable future – a net importer of energy, the RED has also sparked renewable energy trade cooperation, such as the Desertec initiative.[1] Within the EU, Denmark, has assumed particular leadership in the renewable energy sector. The Danish wind industry employs 25,000 people and wind energy supplies 25 per cent of the country's electricity, with plans to extend this share to 50 per cent by 2050. Denmark also exports renewable energy supply products, namely wind turbines.

In China, renewable energy is the focus of the current Five-Year Plan (2011-2015). The government has pledged to meet 15 per cent of its energy needs from non-fossil fuels by 2020 (KPMG 2011). There is also ambition for renewable energy in Southeast Asian countries. For example, Indonesia, Vietnam, Thailand, Malaysia and the Philippines have targets to install a total of 32GW of renewable power in the period 2011-25, with Indonesia being one of the most ambitious at 12GW, and Thailand and Malaysia offering significant subsidies (FSFM 2012). Geothermal, biomass and waste-to-power are the most predestined renewable energy sectors to benefit from this investment drive in Southeast Asia.

The Chilean government has announced a 20 per cent target for energy from "non-conventional" sources by 2020. Accordingly, Chile has assigned US$ 950 million to a five-year plan, which generates an additional 9 GW of renewable energy until 2020 (Renewable Energy World 2012). South Africa released an Integrated Resource Plan in May 2011. The plan includes a call for the development of 40GW of new electricity generation capacity up to 2030, including 17.8GW from renewable energy. Figure 5 presents the national renewable energy targets for selected states in Africa.

Figure 5. Renewable energy targets in Africa

Country	Renewable energy target	Target year
Cameroon	50% / 80%	2015 / 2020
Cape Verde	50%	2020
Ghana	10%	2020
Madagascar	75%	2020
Mauritius	65%	2028
Niger (the)	10%	2020
Nigeria	7%	2025
Rwanda	90%	2012

Source: UNEP 2012c

1. For further details see section 6.4.

At the international level, the creation of the International Renewable Energy Agency (IRENA) in 2009 indicates a willingness of governments to work collaboratively on expanding the role of renewable energy. Continued international climate negotiations provide a further driver for greening the energy sector. For example, several developing countries have submitted Nationally Appropriate Mitigation Actions (NAMAs) under the United Nations Framework Convention on Climate Change (UNFCCC). NAMAs are voluntary country engagement proposals aimed at reducing or limiting GHG emissions and to facilitate the transition to low-carbon growth for different sectors of the economy. The submissions of NAMAs by developing countries include significant plans for wind, geothermal, biomass and solar projects.[2]

There are also specific requirements for renewable energy in subsections of the economy, for example transport. The EU RED, for instance, requires a ten per cent share of renewable energy in the transport sector by 2020 and the EU's Fuel Quality Directive sets a target to reduce GHG emissions from fuels used in the transport sector by 6 per cent until 2020. The contribution from biofuels to these targets is expected to be significant. To avoid possible negative side effects, such as those discussed in section 6.2.2, both Directives impose sustainability criteria that biofuels and bio liquids need to meet in order to be counted towards the targets and receive support. These sustainability criteria aim to prevent the direct conversion of forests and wetlands and areas with a high biodiversity value for biofuel production. The sustainability criteria also require minimum GHG reductions for biofuels compared to the fossil fuels they replace (up to 50 per cent in 2017, and up to 60 per cent in 2018 for installations that started operating in 2017 or later).[3]

The EU and Japan have furthermore implemented legislation to govern the manufacture of hydrogen vehicles in the transport sector. On hydrogen/fuel-fuel cell vehicles, the United Nations Economic Commission for Europe (UNECE) also has an informal working group that is currently developing proposals for a Global Technical Regulation on hydrogen fuel cell vehicles (UNECE 2012). In addition, there are several voluntary codes and standards developed by international standards-setting organisations, including the International Standards Organization (ISO) (OICA 2012).

6.3.4 Infrastructure for renewable energy trade

A key stumbling block to trade in renewable energy are the technical difficulties of electricity storage and transmission. In view of the mostly intermittent nature of renewable energy supplies and a lack of significant transmission capacities, the location of renewable energy infrastructure is crucial. Being situated near a large consumer base is vital to the success of building up a domestic power generating industry, which could then also serve as the basis for electricity exports.

In respect of storability and transmission, trade in renewable-energy-based electricity is different from trade in tangible goods. Storage technologies are a critical solution for the national integration and trade in energy from variable renewable energy sources, especially wind, solar PV, and some marine-energy technologies. Electricity trade also often requires investment in new transmission lines (interconnectors), particularly if expensive high voltage direct current (HVDC) transmission links are required. Other potential measures to increase renewable energy trade include grid interconnection, demand side management, the diversification of energy portfolios and the availability of back-up capacities.

Despite current issues, the technology to store and transfer electricity is developing. Technological improvements can act as a key driver to exports of renewable energy. For example, so-called "supergrids", which can reach up to 500 km or further, have been proposed by analysts to update and extend transmission grid capacities.

Hydrogen, which can be in two forms – stationary (e.g. in an electric grid connection to provide supplemental power) or portable (e.g. hydrogen fuel cells for the transportation sector) – presents particular infrastructure issues. Hydrogen could become a major component of clean sustainable energy systems in the longer term, particularly as it can provide storage options for intermittent renewable technologies such as solar and wind. Nevertheless, the hydrogen economy remains in its nascent stages and its market is limited to very few countries across the world. So far, only a few developing countries are participating in the hydrogen technology development (Mytelka and Boyle 2008). Building the infrastructure required to make hydrogen

2. See list of NAMAs at http://unfccc.int/meetings/cop_15/copenhagen_accord/items/5265.php.
3. In addition, following a review on the impact of indirect land use change on GHG emissions, in October 2012, the European Commission proposed further legislation to minimise the climate impact of biofuels (EC 2012a).

fuel cell vehicles a feasible alternative to conventional vehicles will entail significant investment costs for both the private and public sector, depending on the country.

6.3.5 Technology transfer of environmentally sound technologies

In many developing countries, the national renewable energy sector faces many barriers to development, due partly to a lack of expertise and limited access to appropriate technologies and knowledge. Especially least developed countries (LDCs) are severely challenged with respect to the science, technology and innovation of renewable energy. LDCs also face the challenge of having to bridge the digital divide and technology gap in support of sustainable development and poverty eradication (UN 2012c).

The Intergovernmental Panel on Climate Change (IPCC) defines technology transfer as:

> "a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change among different stakeholders such as Governments, private sector entities, financial institutions, non-governmental organisations (NGOs) and research/educational institutions" (IPCC 2000).

Environmentally sound technologies (ESTs) are technologies that have the potential for significantly improved environmental performance as relative to other technologies. These potentials include polluting less, using resources in a more sustainable manner, recycling more of their wastes and products, and handling residual wastes in a more environmentally acceptable way than the technologies for which they are substitutes. ESTs are not just individual technologies. They can also be defined as total systems that include know-how, procedures, goods and services, and equipment, as well as organisational and managerial procedures for promoting environmental sustainability (UNEP 2008b).

Technology development of ESTs and its rapid diffusion are considered crucial for tackling climate change and other environmental challenges. Enhancing technology transfer towards developing countries is an integral part of the UN Framework Convention on Climate Change (UNFCCC), as stated in its Article 4. In particular, the UNFCCC Conference of the Parties (COP)-16 in 2010 established a Technology Mechanism, which includes a Climate Technology Centre and Network (CTCN). The CTCN aims to stimulate technology cooperation and to enhance the development and transfer of climate-sound technologies that support climate change mitigation and adaptation. To pursue these aims, the Network will provide technical assistance and support, especially to developing countries. With the designation in 2013 of UNEP as host institution of the CTCN, the mechanism became fully operational.

World leaders at Rio+20 reaffirmed the importance of transferring ESTs to developing countries, as illustrated in Box 6.

Box 6. Rio+20 and technology transfer

Rio+20 recognised, in particular, the important contribution of science and technology to sustainable development. The Rio+20 Outcome Document calls for improving clean technology transfer and diffusion, research and development (R&D), capacity building and stakeholder participation. In particular, paragraph 273 requests relevant UN agencies to identify options for a facilitation mechanism that promotes the development, transfer and dissemination of clean and environmentally sound technologies by, among other things, assessing the technology needs of developing countries, the options to address those needs and the required capacity building efforts.

In response to paragraph 273 of the Outcome Document, the UN Secretary-General made recommendations to the General Assembly for a technology facilitation mechanism. His report provides an overview of proposals and outlines recommendations on the mechanism's functions, format and working methods, as well as a potential global way forward, with a view to achieving an operational technology facilitation mechanism before the end of 2013 (UN 2012d).

Trade and patterns of technology flows

Trade can play a key role in technology transfer. An OECD study concluded that international technology transfer through trade occurs when a country imports higher-quality intermediary goods (i.e. than it can produce itself) to use in its own production processes and that trade indeed serves as a channel for international technology transfer to developing countries. The study also underlined that developing countries enjoy relatively less technology transfer from trade than developed countries (OECD 2005). The role of trade in technology transfer is further illustrated by Glachant (2013) in Box 7.

Box 7. Examples of market channels for technology transfer

- **International trade in intermediate goods.** The import of capital goods, such as machines and equipment, entails technology transfer where such goods embody technologies which can bring productivity benefits in the recipient countries. Although international trade induces little cross-border transfer of knowledge there may be knowledge spillovers in the recipient country. Local firms can reverse-engineer imported products, or acquire knowledge through business relationships (e.g. as customer or distributor) with the source company. As an illustration, China has acquired production technologies to develop a highly performing solar photovoltaic industry by purchasing turnkey production lines from German, US and Japanese suppliers (de la Tour et al. 2011).
- **Foreign direct investments (FDI), including joint ventures.** FDI is an important channel for technology diffusion, such as in the wind industry (Kirkegaard et al. 2009). Several studies find evidence that multinational enterprises transfer firm-specific technology to their foreign affiliates or partners in joint-ventures (e.g. Branstetter et al. 2006). FDI can induce more knowledge transfer than trade in goods, since investment often comprises apart from the technology, also support services, such as management experience and entrepreneurial abilities which can be transferred by training programmes and learning-by-doing. Further, many technologies and other know-how used by affiliates of multinationals are not always available in the open market. Some technologies, even if available in the market, may be more valuable or less costly when applied by the firm that developed them rather than by an outsider (OECD 2005). Local firms may also increase their productivity by learning from nearby foreign firms or becoming their suppliers or customers.
- **Licensing.** Licensing occurs when corporations or public research bodies grant a patent license to a company abroad that uses this license to upgrade its own production. In other words, a firm may license its technology in order to carry out a full knowledge transfer to the licensor so as to enable it to exploit the technology directly. Accordingly, knowledge leaves both the source country and the source company, and remains in the hands of a local third party.

Source: Glachant 2013

It is important to highlight the changing patterns of technology flows and transfers and the growing importance of South-South technology transfer in ESTs. Today's technology flows and transfer differ greatly from those in the early 1990s, when technology flows were mainly between developed countries and the key challenge was to promote greater technology transfer to developing countries. While these flows remain important, South-South clean technology transfer has gained in prominence over recent years. Clean technology flows among technology intensive developing country industries and from developing countries to developed countries have grown faster. Highly publicised examples include ceramic cookstoves, biogas digesters, cement board and jatropha biofuels, and a range of Chinese and Indian FDI activities. In addition, capacity building constitutes an integral part of technology transfer, as it ensures the successful transfer of clean technologies (UN 2012d).

Not only the overall magnitude, but also the nature of cross-border technology flows has changed. Technology flows are increasingly embedded in global trade and FDI flows, thus forming part of international production systems, even though there are significant regional differences. Environmental services, such as waste and water management and the reduction of air pollution and GHG emissions, are also becoming a major source of technology transfer. In terms of the manufacturing and export of clean technology, several developing countries have become world leaders, and some are also emerging as key users (UN 2012d).

Box 8. World leaders in selected climate-relevant technologies

	World leaders	
Technology	*Production and exports*	*Technology use*
Ethanol (from sugar cane)	Brazil	USA, Brazil
Biodiesel (from jatropha)	India	India, Indonesia, EU
Wind energy	China, India	China, Germany
Solar photovoltaic	China	Germany
Compact fluorescent lamps	China, Indonesia	EU
Solar water heaters	Mexico	China
Coal gasification	China	China, USA
Heat pumps	China	Switzerland, EU
Hybrid fuel vehicles	Japan	USA, EU, Japan
Wood waste use	Sweden	Sweden

Source: Brewer 2008, UN 2012d

Nevertheless, participation of the poorest economies in technology flows is as yet negligible. The majority of developing countries continue to face significant technology gaps and barriers to access. A number of policies continue to constrain South-South technology transfer, including market access barriers and intellectual property rights (IPRs). Concerning market access, one recent survey found that import duties and other non-tariff barriers in large developing countries for solar photovoltaic products range from 12 to 18 per cent and 41 to 63 per cent (tariff equivalent), respectively (UN 2012d).

Green patents

The role of technology transfer, and in particular IPRs, in climate change technologies has emerged as a particularly contentious issue in the past few years (UNEP, EPO & ICTSD 2010). Many developing countries argue that IPRs can be a barrier to the transfer of ESTs and have proposed addressing elements of the IPRs regime under international agreements on climate change (Correa 2013). While acknowledging possible exclusionary effects of IPRs, other countries see IPRs as essential to fostering both innovation and the transfer of technologies (Zhuang 2011).

An effective regime of IPRs can balance the different country concerns and enhance transfers of technology internationally. The WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) sets out minimum standards for the protection and enforcement of IPRs. In particular, Article 66.2 of the TRIPS Agreement states that:

> "developed country Members shall provide incentives to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer to least-developed country Members in order to enable them to create a sound and viable technological base."

EST transfers can lead to a faster and cheaper adoption of new technologies for the benefit of developing countries' innovation and long-term competitiveness in the international market for renewable energy production. In the market for renewable energy supply products, companies – which in some developing countries may be state-owned enterprises or joint ventures between a local and a developed-country firm – must generally obtain a license to use a given patent-protected technology. Alternatively, countries can develop the national capacity to research and develop the relevant products independent from a foreign licensor (ICTSD 2007, UNCTAD 2011a).

The number of patents registered in the renewable energy sector in different countries could provide an indication of the dissemination of EST across borders. According to the World Bank, which analysed increases of patents in Asia and Latin America, "the importance of green patenting as measured in absolute numbers in developing regions is rising" (Dutz and Sharma 2012).

Box 9. The role of patents in the transfer of clean energy technologies

Given the importance of the role of IPRs in green growth and development of developing countries, UNEP joined forces in 2010 with the European Patent Office (EPO) and the International Centre for Trade and Sustainable Development (ICTSD) to undertake an empirical study on the role of patents in the transfer of clean energy technologies (CETs) including solar PV, geothermal, wind and carbon capture.

The study provides evidence and key insights towards a better understanding of the challenges related to the massive scale-up of the use and diffusion of CET needed to combat climate change. The study found that five countries – Germany, Japan, the Republic of Korea, the United Kingdom and the United States - are the source of almost 80 per cent of all innovation developed in the field of CET. In addition to the review of 400,000 patent documents, the study contains the first ever survey on licensing.

Source: UNEP et al. 2010

Prominent in the discussion on pro-sustainable development licensing strategies is the debate on patent pools. A patent pool may exist where a given technology is composed of various items whose patents belong to different rights holders, and the latter are willing to pool their rights and licence the use of the patented item through a single agreement (WIPO 2012). This bears important implications for the transfer and the diffusion of EST. The most likely scenario would be that of a producer who intends to conform to a standard through the use of the patented items, and would be incentivised by the possibility of filing a single application for obtaining a license over a variety of patented items. This would facilitate the transfer and diffusion of EST.

Box 10. Pooling green patents

The World Business Council for Sustainable Development (WBCSD) launched a technology-sharing initiative, known as the Eco-Patent Commons, in January 2008. Inspired by the success of the open source software community in pooling knowledge to stimulate innovation, the scheme encourages companies to donate patents for inventions that, while not essential to their own business development, provide "environmental benefits". The registered patents are published on a searchable website and made available for use by anyone free of charge.

Among the first patents to be donated were a recyclable protective packaging material for electronic components from IBM, and mobile phones recycled into calculators and personal digital assistants from Nokia. Since the launch of the Eco-Patent Commons in January 2008, 100 eco-friendly patents have been pledged by 13 companies representing a variety of industries worldwide.

Source: WBCSD 2011, WIPO 2009

6.4 Trends and trade opportunities

The following section addresses trends in international trade in the renewable energy sector and identifies several green trade opportunities. As technology develops in the forthcoming years, further trade opportunities are expected to arise.

6.4.1 Renewable energy supply equipment and its inputs and components

A key and growing market opportunity in the renewable energy sector is the export of renewable energy supply equipment, inputs or components. The global market in low-carbon and energy efficient technologies, which includes renewable energy supply products among other technologies, is projected to nearly triple to US$ 2.2 trillion by 2020 (UNCTAD 2011b). Within the energy sector, global growth in renewable energy sources contributing to world primary energy supply now greatly exceeds growth in fossil fuel based energy sources. Since 1990, annual global growth in solar PV, wind and biofuel supply capacity has averaged 42, 25 and 15 per cent respectively, compared to the rate of only 1.3 per cent for oil. In 2010, US$ 211 billion was invested in renewable energy supply, more than five times the amount invested in 2004, with more than half of these investments in developing countries (UNCTAD 2011c).

Developing countries have seen significant growth in exports of renewable energy supply products – in particular, solar panels, wind hydraulic turbines and solar water heaters – and a number of developing country firms have already gained significant market shares. In 2009, China exported over US$ 10 billion worth in solar panels and cells, more than twice as much as the second biggest exporter and almost 80 times the value China exported only ten years earlier, when it was not even among the top five world exporters (UN 2012e). China is now the world's largest producer and exporter of solar photovoltaics (REN 2011). In 2011, China exported solar panels and key components worth around € 21 billion to the EU (EC 2012b).

India hosts several large solar manufacturers such as Moser Baer Photovoltaic Ltd, Tata BP Solar, Central Electronics Ltd and Reliance Industries. Indian firms manufactured solar PV modules and systems with a total generating capacity of 335 megawatt power (MWp) up to March 2007, of which 225 MWp were reportedly exported (Kalmbach 2011). In the wind energy sector, the Indian company Suzlon Energy is the world's third largest supplier of components to operators, with over six per cent of global market share. For further details on renewable energy trade opportunities and challenges in India, see Box 11.

Box 11. India – exports of renewable energy supply components

India has the world's fifth largest national electricity demand and is expected to become the third largest consumer in the world by 2030 (IEA 2011b). To meet elevated national electricity demands with abundant and sustainable supply, India enforced its national Electricity Act 2003, aimed to increase industry investments in renewable energy supply technology and to grow the national manufacturing sector. In addition, the Central Electricity Regulatory Commission has established tariff orders designed to support renewable energy development while balancing investment interests, electricity needs and climate change issues. These measures have led to an extensive growth in the national production and use of renewable energy.

India's most mature renewable energy sector is wind energy, accounting for 70 per cent of domestic renewable installations, with an annual compound growth rate of 26 per cent (REN 2011). Indian wind power installations make up an increasing share of seven per cent of global wind capacity. While contributing to climate change mitigation and national electrification, renewable electricity generation from wind technology has created 13-15 jobs per megawatt, adding to an overall 15,000 direct jobs.

The nascent Indian exports of wind turbines and components account for 12.2 per cent of global trade in wind technology. The largest wind-related Indian export item is wind-powered electric generating sets[4], the key single-use item identified as being used exclusively for the production of wind energy. The sets featured as India's single largest export item for three consecutive years (2006-08) and reached a total export volume of US$ 651 million in 2008. Overall, exports in renewable energy for the period 2004-08 have witnessed faster average annual growth rates (51.9 per cent) than imports (33.2 per cent). This signals the steady diminution of India's trade deficit (e.g. US$ 810 million in 2008) for products related to renewable energy (EXIM-BoI 2011).

While mainly focusing on wind-related exports, India's renewable energy sector has also achieved strong growth in the export of other renewable energy technologies. For example, between 2004 and 2008, the value of Indian photovoltaic appliance[5] exports grew from US$ 85 million to US$ 529 million, accounting for approximately 40 per cent of overall global PV system and component exports in 2008.

The recent growth in India's renewable energy sector and the enacted policy support schemes and tariff orders for renewables have placed India among the best investment destinations for renewable energy equipment manufacturers and service providers, third only to China and the United States (Ernst & Young 2011). While much has been achieved in terms of national renewable energy facilitation, India faces further challenges and untapped opportunities, especially concerning trade in renewable energy technology. Facilitative renewable energy policy has primarily focused on the needs of India's domestic market while further action is needed to foster exports by yielding the necessary financial guarantees that allow manufacturers to expand investments.

Source: Gaurav Gandhi and Chintan Shah of Suzlon Energy Ltd

4. HS 850231 (Harmonized Commodity Description and Coding System)..
5. HS 854140 (Harmonized Commodity Description and Coding System).

Despite the growing number of renewable energy supply products that can generate new income and enhance trade opportunities, only a few countries have so far benefited to a significant extent. China, Chinese Taipeh, India, Republic of Korea, Malaysia and Singapore account for over 90 per cent of developing countries' exports in renewable energy supply technology. While exports from Brazil, Mexico, Philippines, South Africa, Turkey and Vietnam are increasing, exports from most other developing countries are minimal or absent (UNCTAD 2011b). Nevertheless, there are signs that more developing countries are acquiring the capacity for manufacturing renewable energy supply products (see Box 12).

Box 12. Solar Panels manufactured in Mongolia exported to Japan

The Mongolian company Sankou Solar Mongolia LLC was officially established on 1 January 2011. It manufactures solar panels according to international standards, such as IEC 61215 (Crystalline silicon terrestrial photovoltaic (PV) modules), IEC 61730 (Photovoltaic (PV) module safety qualification), and ISO 9001 (quality management systems).

On 27 November 2012, Sankou began exporting PV modules to Japan. Since then, Sankou has exported 427 kW in PV modules to Japan and received a total order for 2 MWs of solar module technology. In the future, Sankou plans to increase its manufacturing capacity so as to expand exports abroad to Japan as well as the EU and other countries of the world.

Source: Interview with Sankou Solar Mongolia LLC, 11 March 2013

Furthermore, some countries in the Middle East and North Africa (MENA) may also have opportunities to enter regional and world markets in renewable energy supply products. The German Development Institute's report on Egypt, for example, states that:

> "As indicated by the large increases in global trade in the last few years, there is profit to be made in exporting wind turbines and components … [t]his suggests that if Egypt could develop a comparative advantage in wind energy manufacturing, it could service the regional emerging markets; Egypt's wind industry could play an important role in the MENA market (and for regions in Africa), where manufacturing capabilities for wind energy components are limited" (Vidican 2012).

However, MENA states are, as yet, largely dependent on technology and knowledge transfers from developed states. They will need to build up domestic industrial capabilities for renewable energy technology in order to play a more significant and autonomous role in international renewable energy trade.

In any case, it is important to note that renewable energy supply products and services are a heterogeneous group. For example, biofuels, solar thermal and geothermal are all lower-tech technologies or lower-tech energy sources in which several developing countries have either existing expertise, or good chances of developing competitive export streams (Cosbey 2011). Box 13 describes the potential for exports of solar-thermal water heaters by developing countries.

Box 13. Potential for exports of solar-thermal water heaters

There are hundreds of manufacturers of solar-thermal water heaters in the world, including in Argentina, Armenia, Barbados, Brazil, Bulgaria, Chile, China, Cuba, Dominica, Egypt, India, Indonesia, Iran, Jordan, Libya, Lithuania, Macedonia, Malaysia, Mexico, Morocco, Nepal, Pakistan, Philippines, Saudi Arabia, Sri Lanka, Thailand, and the United Arab Emirates.

There is also potential to export these solar-thermal water heaters to other markets that demand such renewable energy supply products. Libya, for example, has planned the development of a joint venture with local and foreign investors for the manufacture of solar water heaters (40,000 units/year), for local and export markets (UNECA 2012). Penetration of solar thermal water heaters into some markets, however, is hampered by subsidised prices for electricity or natural gas, the main energy sources used for water-heating appliances.

Source: Steenblik 2006

Renewable energy supply products are often produced in developed and more industrialised developing countries using intermediate inputs sourced from developing countries. Therefore, trade in intermediate goods is an important entry point into the green economy for developing countries. For example, whereas wind-powered electric generating sets are mostly produced in the developed world and emerging economies, several developing countries are starting to emerge as important suppliers of components (Steenblik 2006).

As well as exports from developing countries to developed countries, there are increasing opportunities for trade between developing countries ('South-South trade'). Many are now adopting renewable energy targets, and accordingly need products and technologies that may not be locally available. Furthermore, developing countries are becoming some of the world's largest and fastest growing markets for environmental goods whereas the markets in most developed countries are mature by comparison (Vossenaar 2010).

A 2011 report from UNCTAD further elaborates on the advantages and opportunities of South-South trade of renewable energy supply products:

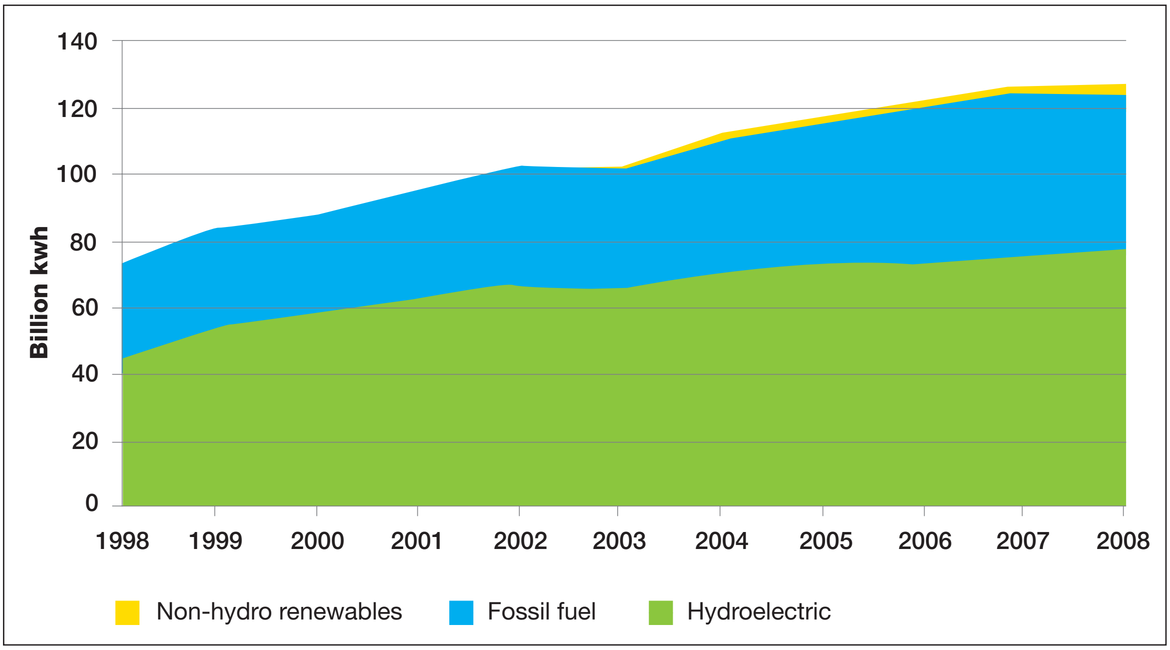
> "…developing-country partners have similar needs for many technologies, at least more so compared with developed-country markets. Solar cooking stoves, for example, are an innovation well suited to developing-country contexts, where there is generally ample sunshine, and they are uniquely adapted to the needs of developing-country consumers, many of whom have been forced to rely on traditional biomass for cooking. The same may be said for solar PV-powered lights and lanterns, the biggest markets for which are poor rural locations without grid access. As such, developing country partners can provide a market for [renewable energy technologies] that have been developed to serve domestic needs or for non-indigenous technologies that have been adapted to serve local needs. Of course this is not equally valid for all [renewable energy technologies]; installation of wind turbines, for example, does not vary among developed and developing countries" (UNCTAD 2011d).

Furthermore, hydrogen fuel cells are emerging as viable renewable energy equipment and are even a potential export opportunity for certain developing countries. While hydrogen fuel cells are labelled as "post-2020 transportation technology" (Meyers 2008), there is great potential for developing countries to engage in green inter-state trade of hydrogen fuel technology and know-how. Brazil and South Africa exemplify different approaches to harnessing trade opportunities. For example, South Africa holds 75 per cent of global platinum reserves and therefore naturally assumes a key role as raw material exporter for fuel cell manufacturing. The country has also announced plans to export high-value products to growing international hydrogen fuel cell markets (Perrot 2013). Furthermore, Brazil invested a considerable sum of US$ 70 million into hydrogen-related technology between 2001 and 2007. In the near future, Brazil aims to scale-up these national investments and export hydrogen fuel buses (Antunes 2010). Hence, hydrogen fuel cells represent a feasible green trade opportunity for developing states. However, in order to become a widely disseminated renewable energy technology, the fuel cells' current cost disadvantage must be mitigated and the technology's durability improved.

6.4.2 Electricity produced from renewable energy sources

In recent years, renewable-energy technologies have grown increasingly competitive with conventional energy supply technologies in terms of electricity generation capacity and unit cost. Many developing countries have a comparative production advantage as they possess abundant renewable energy resources, including solar energy, wind power, geothermal energy, biomass and hydroelectric power (see Figure 6). By scaling up renewable electricity generation, developing countries can therefore enhance national energy access while reducing their dependence on oil and natural gas. This leads to more diversified energy portfolios that are less vulnerable to supply fluctuations and price rises in energy markets.

Figure 6. Electricity generation by source in sub-Saharan Africa



Source: UNEP 2012c

Technology improvements and related cost reductions in renewable electricity generation yield large opportunities for developing countries to tap their vast national resources, not only to meet their domestic energy needs but also to export electricity. In the short term, electricity exports to neighbouring countries are more feasible particularly in view of the high costs of transmitting electricity over long distances. This is especially the case where the necessary electricity transmission infrastructure is currently inadequate (see section 6.3.4). In the medium- and long-term, inter-regional long distance exports of electricity from developing countries could also become an increasingly viable option (see Box 14).

In the following sub-sections, the potential for trade in individual renewable energy sources is outlined.

Hydropower exports

A notable example of national hydropower development can be found in Laos. According to the Lao Department of Energy and Mines, hydropower exports amounted to about 30 per cent of Laos' total exports in 2008 (DEM 2012). Another example is from the Democratic Republic of Congo (DRC), where the Inga Dam is expected to generate more electricity than the DRC could use, thus enabling significant amounts to be exported to neighbouring countries. There is also significant hydropower potential that could be developed in the Nile Basin, elsewhere in the DRC, and Guinea's Fouta Djallon (OECD 2012). There is a growing market for electricity generated from hydro plants as highlighted by research from IRENA on South Africa's future energy needs:

> "In addition to indigenous renewable production, South Africa will import significant amounts of renewable electricity. The Lesotho Highlands Power Project will generate 6 GW of wind power and 4 GW of hydropower, mainly for export to South Africa. This is equivalent to nearly one-quarter of South Africa's total current energy supply. The Grand Inga and other large projects will also find a large export market in South Africa in the coming decades" (IRENA 2012).

However, in several cases hydropower development has come with serious environmental risks and social costs, as discussed in Section 6.2.2.

Wind energy and solar power exports

A key example of the future potential of wind energy exports in Asia is Mongolia's first 50 MW wind farm. This is currently under construction and is set to generate an estimated 5 per cent of the country's electricity needs, while reducing air pollution linked with coal-fired electricity generation. Mongolia could act as a "supergrid" in the Eastern and Central region, supplying neighbouring countries with clean energy (UNEP 2012d). It has the potential to generate 2.6 terawatts of renewable energy per year (Khashchuluun 2012). In Ethiopia, the Adama Wind Power Project, financed by the Export-Import Bank of China, will power Ethiopia's development and also provide a source of revenue from sales to neighbouring countries (Tekleberhan 2012).

The potential amount of power that could be generated by PV systems, concentrated solar power (CSP) plants and other solar energy technology is practically unlimited, especially in developing countries with high solar radiation. Existing CSP plants produce most of the world's energy derived from direct radiation. A decisive advantage of CSP, as compared to other renewable energy technologies such as PV, is the large-scale storability of CSP-captured heat, which allows for base load electricity generation. Solar power, especially CSP, also provides significant economic diversification and trade opportunities in the transition to a green economy for many countries in the Middle East and North Africa (MENA) region that are currently exporting or importing oil. Box 14 gives a detailed account of the potential for solar and wind energy exports from MENA.

Box 14. MENA – green energy exports to Europe

The DESERTEC Foundation aims to create a global renewable energy plan based on the concept of harnessing sustainable power from sites where renewable sources of energy are more abundant, and transferring it through high-voltage direct current transmission to consumption centres. All kinds of renewable energy sources are envisioned, but the sun-rich deserts of the world play a special role. In the EU-MENA region, the intention would be to supply energy from MENA's deserts both to MENA countries and to EU countries.

The pioneering study "Trans-Mediterranean Interconnection for Concentrating Solar Power" (German Aerospace Centre 2006) substantiated that solar electricity imports from CSP produced in MENA countries could provide a renewable energy base load and balance power for a sustainable European energy mix (Trieb et al. 2012). The large potential for solar (and wind) energy in the MENA region is evidenced by the need of a sole 0.2 per cent of MENA territory for CSP plants to supply 15 per cent of the expected European electricity demand in 2050.

In light of this vast natural energy potential, industrial initiatives such as the DESERTEC Industrial Initiative (DII) (DII 2012a) and MedGrid (MedGrid 2012) have started to develop strategic business plans for the MENA region. In addition, the Union for the Mediterranean (UfM) has proposed a Mediterranean Solar Plan to assist with the development of a strategic road map for energy market integration between the two regions. Moreover, Directive 2009/28/EC of the European Parliament on the promotion of the use of renewable energy from renewable sources stipulates that physical imports of clean energy from MENA can count towards the renewable energy targets of EU countries. However, green electricity exports from the MENA region are not expected to begin before 2020 (Trieb et al. 2012).

For MENA countries, the use of widely available renewable energy (i.e. high solar insulation and wind resource) could result in benefits such as enhanced energy security, technology transfer, and income from exports of electricity as well as parts, components and services, private sector development and job creation. Moreover, large-scale deployment of renewable energy in the MENA region is likely to contribute towards reducing costs and increasing the economic competitiveness of renewable energy relative to conventional fuels (DII 2012b). Energy demand in the MENA region is increasing at an annual rate of 6-8 per cent and expected to double by 2020 and to triple by 2030 (IEA 2010a). While covering this increasing domestic demand, electricity generation from renewable sources is estimated to allow for exports to Europe.

Trade opportunities: Due to its large renewable energy resource availability and its relatively smaller domestic market, Morocco has the potential to act as frontrunner for renewable energy development in the MENA region. In June 2011, the Moroccan Agency for Solar Energy signed a Memorandum of Understanding with the DESERTEC Industrial Initiative, agreeing on the development of a large solar project aimed at demonstrating the feasibility of exporting solar electricity to Europe. DII also cooperates with UfM in advancing the Mediterranean Solar Plan, with an emphasis on stimulating electricity exports (DII 2012a). Morocco is estimated to have the capacity to produce almost five times the amount of power needed to satisfy its domestic demand. As a result, the potential for energy exports is sizable.

Egypt is also developing export capabilities of renewable energy parts, components and services for the African market. Egypt's capacity for green electricity exports is limited by a high domestic electricity demand due to large population and economic growth. An optimal energy system in Egypt would require the country to import power when needed and export it when the production exceeds domestic demand (DII 2012b). In view of domestic demand constraints and the substantial national manufacturing potential, Egypt focuses on developing capabilities for exports of renewable energy supply technologies (Vidican 2012).

As a result of these prospective developments, European countries could import up to 20 per cent of their electricity needs from North Africa, at a significantly lower cost (DII 2012b). Aside from electricity exports, renewable energy developments also offer opportunities for building capabilities in manufacturing energy system parts and components and in service provision along the value chain for solar and wind energy technologies, as exemplified by Egypt (Vidican 2012, World Bank 2011).

Challenges: The process of facilitating cross-regional electricity trade faces many challenges in terms of infrastructure needs, investment costs, know-how and technology development, and political agreement at the regional and cross-regional level.

Perhaps the most pressing challenges relate to the clarification of political and institutional framework conditions, necessary for enabling exports of green electricity from MENA to Europe. These include the import price of electricity, the establishment of a new inter-regional feed-in-tariff for green electricity from the MENA region, and the share of electricity generated in MENA assigned for exports to Europe. Moreover, the harmonisation of policy regimes for renewable sources of energy across the region, along with robust national strategies for renewable energy development, is critical for enabling such an unprecedented cross-regional project.

The infrastructure for electricity exports is critical. This includes the HVDC lines that will need to be built and the lines for overland transmission. In addition, the development and upgrade of regional grid connections within the MENA region is crucial with regard to the export of renewable energy (Fritzsche et al. 2010). The costs of such large-scale cross-regional project are high and require the use of innovative financing instruments.

Another set of challenges relate to technology transfer and acquisition of know-how on renewable energy technology in the MENA region. As knowledge on renewable energy technologies is concentrated mostly in Europe, technology transfer mechanisms are needed, for example, through joint ventures, technology acquisitions, or public-private partnerships. In addition, training programmes at the professional and vocational levels will have to be put in place to support the process of national capability building.

While assessments of gaps in the provision of skills for the renewable energy sector exist (MEMEE 2012), a thorough assessment of the job creation potential is largely missing in these countries. Job creation from localising manufacturing and services and technological upgrading in the private sector is critical for improving economic development and competitiveness objectives in the MENA region. The Moroccan Energy Strategy presents a relatively conservative job creation scenario, whereby 13,300 jobs in the renewable energy sector could be created by 2020 (MEMEE 2011). In Egypt, the implementation of the national wind energy targets is estimated to generate 75,000 green jobs by 2020 (El Sewedy 2009). Overall, rough estimates show that, by 2050, up to one million jobs could be created as a result of large scale renewable energy developments in the MENA region (DII 2012b).

Ways forward: From a technical point of view, the export of green electricity from MENA to Europe appears realistic. Solar and wind energy potentials are high enough, costs and environmental impacts are limited, and the technology and materials are available. Yet, several challenges need to be overcome. As a priority, it is necessary to put in place the political and institutional framework conditions in both MENA and Europe to enable large investments and to develop a consistent regulatory framework for green energy imports from MENA that would ultimately offer higher security to investors.

Besides enabling electricity exports, investments in renewable energy developments also offer opportunities for socio-economic developments in the region, integrating measures to expand energy access, increase local value added in terms of jobs, private sector competitiveness, and technological upgrading.

Investments in technological adaptation of mature technologies to local environmental conditions also offer entry points for MENA countries to acquire and enhance innovation and entrepreneurial capabilities. As such, renewable energy deployment projects offer vast possibilities for technology transfer and upgrading and for the integration of domestic companies in the supply chain of solar and wind energy technologies. In addition, harnessing renewable energy potential can largely contribute to CO_2 emissions reductions in those MENA countries that are, currently, heavily reliant on fossil fuel combustion.

Partnerships across different actors within and across the MENA and EU region are critical for realising the identified benefits from clean energy trade. Inter-regional cooperation can address many crucial aspects, from finance and knowledge development to policy harmonisation and regulation in order to foster green energy exports.

Source: Dr Georgeta Vidican (Senior Researcher German Development Institute, Bonn; Assistant Professor Masdar Institute of Science and Technology, Abu Dhabi)

Geothermal energy

Another source that may be exploited for export opportunities is geothermal energy. Although development is still in an early stage, Kenya is hoping to become the first African country to export geothermal energy (UNEP 2010b). In the Caribbean, West Indies Power Holdings is developing a geothermal site in Nevis and is negotiating with the World Bank regarding the Caribbean Interconnect Project, which would supply other islands with geothermal power via submarine cables (Cleantech 2009). The European Investment Bank is also backing a Caribbean geothermal energy scheme. This includes a EUR 1.1 million grant to enhance detailed planning and to study the feasibility of exporting electricity generated by geothermal energy from Dominica to its neighbours, Martinique and Guadeloupe. This scheme has the potential to develop a 20 MW geothermal power generation plant for local use and a subsequent plant of up to 120 MW for electricity export (EU 2012).

6.4.3 Biofuels

Notwithstanding the potential negative impacts of biofuels on land-use patterns and food security (see section 6.2.2), several green trade opportunities exist for countries producing biofuels, particularly when biofuels adhere to 'second-generation' criteria.

Many developing countries are well placed to seize trade opportunities in the biofuel sector due to more advantageous climate conditions and lower labour costs. Biofuel production costs are relatively low in many developing countries, where tropical conditions prevail. Biofuels, unlike most forms of renewable energy, can be produced and then traded on a large scale, as they require relatively minor technological know-how.

Given the expanding demands for transport fuels of a growing and increasingly wealthy world population, demand for sustainable biofuels is likewise expected to grow and create export opportunities for some developing countries (UNCTAD 2009). In 2007, more than seven billion litres of bioethanol were traded internationally, up from 1 billion litres in 2000 (Oosterveer and Mol 2010). Until now, however, the contribution of many developing countries to the global biofuels trade has remained fairly small. This is partly due to the technological and institutional challenges in producing these goods but also because of import requirements and tariffs in developed countries limiting market access of many developing countries (Steenblik 2007, FAO 2008, Coelho 2005).

Second generation fuels technology uses agricultural and forestry residues, rather than food products or produce from agricultural land, for fuel production and could therefore avoid many of the adverse consequences of first generation biofuels. This will require that second generation fuels use only moderate amounts of agricultural residues, or are based on crops such as halophytes that do not compete for arable land. A recent survey by the Bloomberg New Energy Finance (BNEF 2013b) estimates cellulosic ethanol, a specific variant of second generation biofuels, to reach cost parity with conventional biofuels by 2016. This could substantially relieve the current shortage in arable land for food production.

It has been estimated that by 2030, ten per cent of the world's agricultural and forestry residues could cater roughly 50 per cent of global biofuel demand (IEA 2010b). The IEA notes that in developing countries such as Cameroon and Tanzania there is a high potential for using residues from agriculture and forestry for the production of second-generation biofuels; the major limiting factors are scattered smallholders that complicate logistics, limited financing, poor infrastructure, and a shortage of skilled labour. To help overcome these limitations, foreign direct investments can play a role in financing the production and infrastructure of second-generation biofuels (IEA 2010b).

Another trade opportunity in the renewable energy sector is the export of sustainably sourced biomass for use as a fuel. For more information on this trade opportunity, see the Forests chapter of this report.

6.4.4 Cross-border provision of renewable energy services

The development and deployment of renewable and energy efficiency technologies depend on a wide range of services, including energy and construction consultancy services. These and other services are traded internationally. In addition, significant foreign direct investment is channeled into the energy services sector (Glachant 2013). For more information on the services aspect of renewable energy, see the section on trade in environmental goods and services in the Introduction and the Manufacturing chapter.

6.4.5 Exporting carbon credits on international markets

Under certain circumstances, renewable energy projects that reduce or avoid emissions relative to a BAU baseline can have this emissions differential securitised into carbon credits. These can be sold to governments or companies in industrialised countries and consequently used by them for compliance with emissions reduction commitments under the Kyoto Protocol or under domestic emissions trading schemes such as the EU's cap and trade mechanism, the Emissions Trading System (ETS).

Under the Clean Development Mechanism (CDM) of the Kyoto Protocol, emission-reduction projects in developing countries are able to earn carbon credits, which once accepted under the UNFCCC's approval mechanisms, are termed certified emission reductions (CERs). Each CER is equivalent to one tonne of CO_2. CERs can be traded and sold, and used by industrialised countries to meet a part of their emission reduction targets under the Kyoto Protocol.

According to the World Bank, the carbon market could earn poorer nations more than US$ 25 billion every year (Nijuru 2009). However, given the fall in prices for CERs in 2011-12, and a lack of clear future demand for such credits, the opportunity may be smaller than those earlier predictions.

Developing countries can, therefore, export GHG reductions generated in their countries to developed countries. In particular, the deployment of renewable energy technologies (or tree planting[6]) opens new export opportunities and revenue streams as developing countries become eligible for carbon crediting on international carbon markets. The Gold Standard is a key example of a standard for carbon offsets.[7]

Companies that sell clean cooking stoves, domestic biogas and green charcoal/biochar[8] can earn credits, as can those involved with small-scale hydroelectricity, light-emitting diodes (LEDs), solar water heaters and water purification and industrial companies in the cement, biodiesel and sugar sectors. Some firms are already taking advantage of these opportunities. The Kenyan firm East African Portland Cement, for example, began a project in 2010 that would enable it to sell CERs for US$ 1.7 million annually. Another example of a Kenyan sugar company that is making use of exporting CERs is described in Box 15.

6. See the Forests chapter of this report.
7. For further information, see http://www.cdmgoldstandard.org/.
8. For information on biochar see Carbon Gold (n.d.), The Telegraph (2013).

Box 15. Kenya – example of carbon credit trade opportunities in the renewable energy sector

To pursue a new roadmap for sustainable growth and energy production, the Kenyan government is advocating a shift from the present, carbon-intensive development model to a low-carbon pathway (UNEP 2012e). This is evident in the renewable energy sector, which is seen by the Kenyan government as a key sector for sustainable growth.

The rationale behind the national facilitation of renewable energy is manifold. Increasing economic activities and a rising national population lead to a higher domestic energy demand in Kenya, which is mostly satisfied by imports of foreign energy. The high cost of energy imports significantly slows economic growth in the country (World Bank 2012). Imported crude petroleum, for instance, accounts for about 25 per cent of the national import bill. The problem of high energy costs is supplemented by the unreliability of energy supply infrastructure. On average, Kenyan companies lose nearly 10 per cent of their production because of power outages and fluctuations (UNEP 2006). Sustainable, affordable and reliable domestic energy for all citizens is, therefore, declared a priority factor in national policy (RoK 2012).

Securing investments in new renewable energy projects, however, is often challenging. An opportune way for Kenya to attract renewable energy financing is through generating and exporting carbon credits.

Sector overview: In 2008, Kenya initiated plans to actively promote renewable energy and energy efficiency investments by implementing national feed-in tariffs (FITs) for different renewable electricity sources (UNEP 2010c). Investment guarantees under the FIT are expected to promote financing in renewable energy and carbon credit projects (UNEP 2012f). In 2012, Kenya had 32 carbon projects in the pipeline for carbon credits from the Clean Development Mechanism (CDM). On the African continent, Kenya is one of the forerunners in the attraction of CDM projects, second only to South Africa (UNEP 2012g).

Project Example – the Mumias Sugar Company project: The Mumias Sugar Company project generates renewable energy through the combustion of biogas which is available as a waste component of factory production. The project generates 35 MW of electricity of which 10 MW are consumed by the factory itself, and the balance is sold to the national electricity grid (UNFCCC 2012a).

From an emission reductions standpoint, combusting biomass for electricity generation has a dual benefit: It produces renewable energy while avoiding methane emissions, which would result from landfilling the biomass. The project is expected to save nearly 1.3 million tonnes of CO_2 emissions over a 10-year period (2008 - 2018).

Revenues from CERs are a key element of the financing strategy of the renewable energy project at Mumias Sugar Company. CER income is expected to increase the project's internal rate of return by two per cent (UNEP 2012f). Mumias Sugar has entered into a ten-year agreement (2009–2019) with the Japanese Carbon Finance Company Limited (JFC), selling its CERs on a long-term basis and thereby generating significant revenue.

Challenges: As the example of Mumias Sugar shows, CERs can be an important way to mobilise financial resources for renewable energy, energy efficiency, and other types of low-carbon projects. The CDM can open new export opportunities and revenue streams, to increase further as more countries initiate or participate in emissions trading systems.

However, while assessing manifold opportunities, the challenges and uncertainties regarding CDM projects must not be overlooked. To attract investors, a robust, bankable business plan is needed. The perceived risk of investment also depends on the overall economic environment of a country, which can be crucial for the supply of private capital.

An additional barrier concerns the complexity of CDM projects and their accreditation process. The actual registration of the project can be lengthy and transaction costs for the CDM procedures, plus the registration fee, can make the initial phase expensive.

There is also uncertainty about the development of CER prices, as the first period of emission reduction commitments of the Kyoto Protocol recently expired. This uncertainty has decreased CER prices, which lowers CDM investment incentives and threatens project owners with bankruptcy. Though future demand for international offsets may emerge from a new multilateral climate regime post-2020, prices are expected to remain low in the short and medium term (Scotney et al. 2012). However, some predict that the price for CERs will recover in the longer term and stabilise at around US$ 10 per tonne of CO_2 (CDC 2012).

Ways forward: To increase the benefit of CDM projects, well-functioning institutional structures are imperative. In particular, clear rules regarding the granting of approvals to the projects within pre-determined timelines could help reduce the risk for private investors. For their part, investors can contribute by integrating multiple revenue streams in one project, thereby increasing the viability and resilience of the business model.

At the same time, projects must align with local development needs, as perceived by public institutions and local communities. Therefore, local communities and the public have to be integrated in CDM procedures and their political influence over CDM policy has to be strengthened to promote sustainable development (GCD 2011).

Source: Iain Henderson (UNEP FI)

According to research undertaken by the UNEP Finance Initiative (UNEP FI), there remains much untapped potential for CDM projects to promote renewable energy and other types of low-carbon technologies in developing countries.

The uptake of CDM projects, especially in Africa, has been limited (Brittlebank 2012); UNEP FI observes a general geographical disparity among the regions that are making use of the opportunity of CDM exports:

> "Africa may come third in the absolute number of CDM projects in the pipeline, but considering its size, it scores worst of all regions of the world as measured by certified emission reductions (CERs) in the pipeline per capita…To date more than 4,200 CDM projects are in the global pipeline. They are expected to generate 2.9 billion CERs by 2012. However, the current distribution of projects is uneven, with 75 per cent of registered projects located in the Asia Pacific and less than 1 per cent in sub-Saharan Africa…" (UNEP 2012c).

In any case, proposals for further developing and utilising such trading schemes and project-based mechanisms need to be carefully scrutinised to ensure that they are facilitating environmental goals and meet additionality criteria. In this context, the Gold Standard is one of the mechanisms that can ensure environmental credibility.

Box 16. New CDM Loan Scheme

A new loan scheme was launched at the African Carbon Forum in April 2012 aimed at supporting CDM projects in LDCs, particularly those in Africa. The CDM Loan Scheme will provide interest-free loans for CDM projects in LDCs as well as countries that have fewer than ten registered CDM projects. The scheme is run jointly by the UNFCCC, the UNEP Risoe Centre and the United Nations Office for Project Services (UNOPS). The loan scheme will be extended to projects that meet a number of criteria including:

- A high probability of registration with the UNFCCC;
- A reasonable outlook to generate at least 7,500 CERs per year for projects in LDCs and 15,000 CERs per year for projects in other developing countries; and
- Documentation that is developed with an experienced CDM consultant.

The CDM Loan Scheme received applications from 42 projects in 23 countries in Latin America and the Caribbean, Asia and Africa. With 29 projects, Africa accounts for the bulk of applications. The types of projects submitted were equally varied. There were 22 applications for programmes of activities, covering mainly cook stove and small-scale biogas projects. Applications for 11 large-scale projects covering a wide range of technologies and sectors, including transport, methane avoidance and renewable electricity, were also received.

Source: CDM Loan Scheme, Website

6.5 Enabling conditions

The list below offers concrete suggestions for actions from governments, the private sector and other stakeholders to create enabling conditions conducive to creating and taking advantage of existing and potential trade opportunities that arise from or are associated with a transition to a greener economy. The identified policy tools are tailored to address the main challenges in renewable energy trade, as outlined in this chapter. These include the need for increased technology and infrastructure investments, energy-related tax and subsidy reform schemes, the utilisation and furtherance of international cooperation frameworks and an improved stakeholder dialogue.

6.5.1 Public investment and spending

- **Encourage innovation, research and development (R&D) and training.** Public support for R&D is essential for supporting high-risk research with a long-term outlook. In developing countries, R&D in renewables may warrant a focus on building capacity to facilitate technology transfer, including between developing countries.[9] For example, R&D joint ventures can adapt technologies to local market conditions and support national private-sector players that install, manufacture, operate and maintain the technologies.
- **Expand grid access to facilitate export opportunities for renewable electricity.** Renewable energy supply plants should be located strategically, thus close to demand centres and conducive to integration in the national grid. By increasing renewable electricity generation and expanding electricity transmission capacities, developing countries can enhance national electrification. The extension of regional grid capacities could also facilitate trading of power among neighbouring countries, thereby supplying low-cost power while reducing carbon emissions and exposure to volatile oil prices (World Bank 2009).
- **Support nascent green sectors.** Green sector growth can be facilitated by the provision of time-bound green subsidies such as low-interest loans, feed-in tariffs, investment incentives, exemption from certain regulations, stewardship jobs, and support for green small and medium enterprises. Such support must be carefully designed to avoid dependence or otherwise ineffective and unintended outcomes and conflict with WTO rules.[10]

6.5.2 Market-based instruments and subsidy reform

- **Use appropriate taxes and market-based instruments to promote green investment and innovation in renewable energy supply.** Significant price distortions can discourage green investments or lead to failure of scaling up such investments. In a number of economic sectors, negative externalities, such as pollution, health impacts or loss of productivity, are typically not reflected in costs, thereby reducing the incentive to invest in more sustainable goods and services. A potential solution to this challenge is to internalise the cost of an externality via a corrective tax, charge or levy. In some cases other market-based instruments such as tradable permit schemes may be more appropriate.
- **Put in place incentive mechanisms for renewable energy technologies.** Governments can improve the risk-return profile of renewable energy by assuming some of the financial risk. A wide suite of public incentive mechanisms such as national targets and feed-in tariffs are available. Each type of incentive mechanism has advantages and disadvantages. Hence, the choice of the incentive mechanism to be used will depend on the local circumstances of the country, the energy sector concerned, and the nature and ambition of the corresponding national renewable energy targets (UNEP 2012c).
- **Phase out fossil fuel subsidies.** The considerable cost of renewable energy projects and technology incentives raises financial and political difficulties. Large sections of the population in developing countries are poor and cannot afford the additional costs of renewable energy

9. An example of public support of R&D in the renewable energy sector is the Desertec University Network, which was established by the Desertec Foundation and the Tunisian National Advisory Council for Scientific Research and Technology. The network aims at fostering renewable energy experts in MENA countries and, in the long-term, make MENA states autonomous renewable energy producers (Desertec 2012).
10. For further information, see UNEP (2008b).

deployment. However, in many developing countries this cost problem could be mitigated by tapping readily accessible sources of government funding, particularly the significant flows of public subsidies to fossil fuels. Switching the flow of subsidies from fossil fuels to renewable energies is easily justifiable because of the positive social and environmental externalities from renewable energy use. Therefore, if financial resources need to be raised nationally, this should and can be done without placing the financial burden on the poorer segments of society (UNEP 2012c).

6.5.3 National regulatory frameworks

- **Devise a renewable energy strategy to foster exports.** A review of countries' strengths and opportunities at the national level can help identify export prospects. It is important to recognise that scaling up renewable energy generation in a country has the potential to facilitate new export opportunities in those technologies, particularly where comparative cost, knowledge or technology advantages exist. In addition, investment promotion plans are needed in order to attract the necessary capital to unlock trade potential.
- **Establish and maintain an enabling policy framework for renewable energy.** The development of reliable and predictable market conditions, transparent regulatory frameworks, and clear long-term commitments is critical to the development of the sector. Such commitments could be manifested by targets for investment in additional capacity and penetration rates within the energy mix. Setting targets to achieve these goals can send a strong signal to potential investors (UNEP 2011).

6.5.4 International frameworks

- **Build on climate change negotiations.** International trade in renewable energy supply equipment and renewable energy will most likely benefit the post-2015 negotiations under the UNFCCC. In this regard, the Rio+20 Outcome Document highlights the importance of increasing the share of renewable energy for addressing climate change (UN 2012a, paragraph 128).
- **Enable green trade opportunities in energy by reaching an international agreement to liberalise trade in environmental goods and services (EGS).** Lowering tariff and non-tariff barriers from goods such as wind turbines, solar panels, hydrogen fuel cells and energy-efficient light bulbs, to services such as environmental engineering, will likely lead to new green trade opportunities and real increases in trade (ICTSD 2009). The WTO's Doha Round includes negotiations on the liberalisation of trade in EGS (WTO 2001). EGS liberalisation should be sensitive and responsive to developing country concerns and provide a certain degree of flexibility and policy space.
- **Negotiate a framework for sustainable biofuel trade.** An internationally accepted framework for determining what kinds of biofuels qualify as sustainable would enable governments and industry to implement measures to accelerate the required technology development and uptake. This could include a global road map for second-generation biofuels and international standards with respect to the sustainability of biofuels.

6.5.5 Enhancing dialogue and capacity building

- **Promote green trade financing for renewable energy.** A global programme of green trade financing for developing countries would be helpful to create synergies between international and national initiatives (UNFCCC 2012b). This would respond to the Rio+20 Outcome Document, which calls on UN agencies to assess the technology needs of developing countries, explore options to address them, and foster related capacity building (UN 2012a, paragraph 73).

- **Promote the dissemination of green technologies.** Openness to trade and investment could enable domestic actors to engage in catch-up innovation. The potential that cooperation among developing countries offers in overcoming many of the technological challenges could be further explored through dialogue between governments, intergovernmental organisations and/or regional development banks. The launch of the Green Climate Fund offers an ideal platform for cooperative engagement among stakeholders (UNFCCC 2010).

This chapter has illustrated the manifold challenges and opportunities at the intersection of trade, energy, and the transition to a green economy. As highlighted in the Rio+20 Outcome Document, the renewable energy sector has a significant role to play in encouraging a transition to a green economy and in addressing the challenge of access to sustainable modern energy services for all. International trade can play a significant role in the greening of the energy sector, in particular, by acting as a vehicle for technology transfer for renewable energy and by responding to demand for sustainably sourced energy. This demand has led to several trade opportunities, including exports of raw materials and components for renewable energy supply products and finished products, exports of energy from renewable sources, exports of renewable natural resources to produce energy and the selling of carbon credits on international markets.

However, in order for developing countries to benefit fully from these opportunities, many obstacles must be overcome. Creating suitable enabling conditions, including public and private sector investments, regulation, market-based instruments, R&D, and instalment of appropriate infrastructure, can help to address the main challenges to more sustainable trade in renewable energy. Facilitative measures should be conducive to the further development and use of renewable energy and must adhere to proper international frameworks. There is also a pressing need to phase out harmful fossil fuel subsidies and remove barriers that hamper the widespread diffusion of climate friendly technologies.

6.6 Further resources

6.6.1 Websites for additional information

Green Economy Report Renewable Energy chapter:
http://www.unep.org/greeneconomy/Portals/88/documents/ger/GER_6_RenewableEnergy.pdf

UNEP Division of Technology, Industry and Economics:
http://www.unep.org/dtie/Branches/Energy/tabid/29686/Default.aspx

UNEP 2012, "21 Issues for the 21st Century – Results of the UNEP Foresight Process on Emerging Environmental Issues":
http://www.unep.org/publications/ebooks/foresightreport/Portals/24175/pdfs/Foresight_Report-21_Issues_for_the_21st_Century.pdf

UNDESA Department of Economic and Social Affairs:
http://www.un.org/en/development/desa/climate-change/renewable-energy.shtml

UNECE Hydrogen and Fuel Cell Vehicles - Subgroup safety (HFCV-SGS):
https://www2.unece.org/wiki/pages/viewpage.action?pageId=3178603

UNFCCC, Second synthesis report on technology needs identified by Parties not included in Annex I to the Convention:
http://unfccc.int/resource/docs/2009/sbsta/eng/inf01.pdf

UNIDO 2012, Facilitation mechanisms to promote the development, transfer and dissemination of clean and environmentally sound technologies:
http://sustainabledevelopment.un.org/content/documents/1293unido.pdf

United Nations Commodity Trade Statistics Database:
http://comtrade.un.org/

CDM Policy Dialogue. (2012). Available at:
http://www.cdmpolicydialogue.org/report/rpt110912.pdf

WIPO Green:
https://www3.wipo.int/green/green-technology//resources/green_technology/greenSearchBL.xhtml

Transfer of Environmentally Sound Technologies, Case Studies from the GEF Climate Change Portfolio:
http://www.thegef.org/gef/sites/thegef.org/files/publication/GEF-TechTransfer-lowres%20final.pdf

WTO Dispute Settlement Gateway:
http://www.wto.org/english/tratop_e/dispu_e/dispu_e.htm

WTO Trade and Environment:
http://www.wto.org/english/tratop_e/envir_e/envir_e.htm

The Future of Trade: The Challenges of Convergence Report of the Panel on Defining the Future of Trade convened by WTO Director-General Pascal Lamy (24 April 2013):
http://www.wto.org/english/thewto_e/dg_e/dft_panel_e/future_of_trade_report_e.pdf

CDM Loan Scheme:
http://cdmloanscheme.org/

The International Renewable Energy Agency (IRENA):
www.irena.org/

Energy Charter Secretariat:
http://www.encharter.org/

International Sustainable Energy Organisation for Renewable Energy and Energy Efficiency (ISEO):
http://www.uniseo.org/

Tyndall Centre for Climate Change Research:
http://www.tyndall.ac.uk/index.html

International Emissions Trading Association (IETA):
http://www.ieta.org/

Fuel Cell & Hydrogen Energy Association:
http://www.fchea.org/

International Biochar Initiative:
http://www.biochar-international.org/contact

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