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SOUTH-SOUTH TRADE IN RENEWABLE ENERGY

A TRADE FLOW ANALYSIS OF SELECTED ENVIRONMENTAL GOODS

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List of acronyms

AC	Alternating current
AD	AD
ADB	Asian Development Bank
APEC	Asia-Pacific Economic Cooperation
ATM	Automated teller machine
AWEA	American Wind Energy Association
BNDES	Banco Nacional de Desenvolvimento Econômico e Social, Brazilian Development Bank
BNEF	Bloomberg New Energy Finance
BoS	Balance of systems
c-Si	Crystalline silicon
CAGR	Compound annual growth rate
CBTF	Capacity Building Task Force on Trade, Environment and Development of UNEP and UNCTAD
CDM	Clean Development Mechanism
CET	Common External Tariff of MERCOSUR
CFL	Compact fluorescent lamp
CIF	Cost, insurance and freight
CITES	Convention on International Trade in Endangered Species
COMTRADE	UN Comtrade data
CSP	Concentrated solar power
CVD	Countervailing duties
DIW	Deutsches Institut für Wirtschaftsforschung, German Institute for Economic Research
E&SE Asia	East and South-East Asia
EG	Environmental good
EGS	Environmental goods and services
EPIA	European Photovoltaic Industry Association
ESHA	European Small Hydropower Association
ESMAP	Energy Sector Management Assistance Program of the World Bank
EU	European Union
EU27*	All 27 EU states
EVSL	Early Voluntary Sector Liberalisation
EWEA	European Wind Industry Association
FAO	Food and Agriculture Organization of the UN
FDI	Foreign direct investment
FiT	Feed-in tariff
FOB	Free on board
GDP	Gross domestic product
GE-TOP	Green Economy and Trade Opportunities Project of UNEP
GHG	Greenhouse gases
Gt	Gigatonne
GW	Gigawatt
GWEC	Global Wind Energy Council
HS	Harmonized System of the WCO
HTS	Harmonized Tariff Schedule of the US
ICTSD	International Centre for Trade and Sustainable Development
IEA	International Energy Agency of the OECD
IFOAM	International Federation of Organic Agricultural Movements
ILO	International Labour Organization
IRENA	International Renewable Energy Agency
ITA	Information Technology Agreement of the WTO
ITC	International Trade Centre
ITF	International Task Force on Harmonization and Equivalence in Organic Agriculture
KW	Kilowatt
LAC	Latin America and the Caribbean
LCR	Local content requirement
LED	Light-emitting diode
MENA	Middle East and North Africa
MERCOSUR	Mercado Común del Sur, Southern Common Market
MFN	Most Favoured Nation
MII	Ministry of Industry and Information Technology of China
MNRE	Ministry of New and Renewable Energy of India
MW	Megawatt
MWh	Megawatt hour
NEA	National Energy Administration of China
NGO	Non-Governmental Organization
NSM	Jawaharlal Nehru National Solar Mission of India
OECD	Organisation for Economic Co-operation and Development
PC	Personal computer
PPA	Power purchase agreement
PV	Photovoltaic (solar)
PVPS	Photovoltaic Power Systems Programme of the IEA
RE	Renewable energy
REN21	Renewable Energy Policy Network for the 21st Century
Rio+20	United Nations Conference on Sustainable Development 2012
RPS	Renewable portfolio standard
SHP	Small hydro power
SWH	Solar water heating / solar water heaters
TF	Thin film (solar)
TL	Tariff line
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
US$	United States Dollar
USITC	United States International Trade Commission
WCO	World Customs Organization
WEO	World Energy Outlook of the IEA
WISE	World Institute of Sustainable Energy
WITS	World Integrated Trade Solution tool
WTO	World Trade Organization
WWEA	World Wind Energy Association
y-o-y	Year-over-year

Acknowledgments

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This study was undertaken by Mahesh Sugathan and René Vossenaar, based on extensive review of reports of government and industry associations, literature research and the compilation and analysis of a large volume of data on trade and other relevant variables.

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Foreword

South-South trade is today the most dynamic segment of the international trading system, out-pacing growth in global trade. Trade in environmental goods and services (EGS) is an important component of this growth, and represents an opportunity for developing countries to increase trade, while also successfully transitioning to a greener economy.

South-South trade in EGS brings many benefits to developing countries, including access to more appropriate and affordable goods, new jobs, regional cooperation and access to global value chains. The EGS market – estimated to grow up to US$ 1.9 trillion by 2020 – offers developing countries an unprecedented opportunity to successfully drive the green economy transition.

A significant contributor to South-South EGS trade, renewable energy technologies now represent one of the fastest growing markets in the world. They are critical to reducing greenhouse gas emissions, enhancing rural and off-grid energy access, and improving energy security. Research shows that these technologies can also generate more quality jobs in developing economies than fossil fuel industries.

By looking at trade flows across selected environmental goods, such as solar PV and wind energy, this report makes clear that with the right policies, enormous social, economic and environmental opportunities are in reach as countries expand South-South trade.

Indeed, many low-income countries are already making great advances in the expansion of EGS markets. In 2013, developing countries collectively added 20.7 GW of new wind installations – 14.6 per cent more than in 2012, accounting for over 58 per cent of new capacity added globally.

Several countries, including Ethiopia, Kenya, Morocco, Saudi Arabia and South Africa, have announced long-term plans for installing large quantities of commercial-scale wind power, while others like Bangladesh, China, India, Indonesia, Nigeria, United Arab Emirates and Viet Nam have emerged as important markets for solar PV cells and modules.

This report reveals how South-South trade can be a catalyst in the production and trade of many environmental goods and services. It highlights the need for targeted investments, enabling policies and capacity building that enhance the ability of developing countries to participate in sustainable value chains and support the global transition to a low-carbon, resource-efficient, green economy. Such action will also contribute to low-cost, clean and abundant energy worldwide.

Achim Steiner
UN Under-Secretary-General and Executive Director of the UN Environment Programme (UNEP)

Executive summary

This study analyses trends and opportunities for trade among developing countries (i.e. South-South trade) in selected environmental goods, in order to assess the contribution such trade can make to a green economy transition. The term 'developing countries' includes all countries and territories listed as developing economies in the UNCTAD Handbook of Statistics (UNCTAD, 2012).

The study focuses on South-South trade flows in several RE products and their components, including solar photovoltaic (PV) cells and modules, wind turbines, hydroelectric turbines, biomass feedstock, solar water heaters and solar lighting equipment, as well as other select environmental goods. The latter include water filtering and purification equipment and environmentally preferable products, such as organic agricultural goods.

South-South trade in environmental goods and services (EGS) is critical to the transition to a green economy for a number of reasons. First, South-South trade allows developing countries to export EGS to the dynamic markets of other developing economies, providing new opportunities for participation in global value chains. Second, South-South trade can allow access to more appropriate and affordable goods for developing countries, responding to similar technology needs and prevailing local conditions (UNDP, 2013). Third, properly managed South-South trade in EGS can stimulate employment growth in industries where developing countries have a comparative advantage, such as organic agriculture (UNEP, 2010b). Finally, South-South trade is important as regional economic cooperation expands globally, facilitated by regional trade and investment agreements that allow developing countries to increase regional production and trade of EGS.

Renewable energy (RE) technologies are particularly important for the contribution that South-South trade in EGS can make to the green economy transition. RE technologies are critical for reducing greenhouse gas (GHG) emissions, enhancing rural and off-grid access to energy, improving energy security and disseminating sustainable technologies. The job generation potential of RE is particularly high compared with fossil fuel-based energy sources, especially in the manufacturing and services activities related to solar PV and wind-powered energy.

Before describing the methodology adopted in this South-South trade flow analysis in EGS, it is important to note three trends that clearly underlie this study. First, global prices for EGS and, in particular, for RE technologies have been falling. As the cost of producing RE increasingly approaches the cost of fossil fuel energy production, investment in RE is likely to increase. Second, government policy, including fiscal incentives, feed-in tariffs and minimum use requirements, has had a major impact on EGS market and trade trends in recent years. In the RE sector, fluctuations in government policy have both stimulated and, more recently, also repressed demand for new installations. Third, trade policies remain critical to EGS deployment worldwide. The reduction or elimination of trade restrictions among developing countries facilitates South-South access to lower cost EGS, but also introduces trade competition. In order for trade liberalisation to contribute to the transition to a green economy, trade liberalisation efforts would require flanking policies such as taxation or regulation to ensure the positive economic, social and environmental benefits of trade.

Hybrid solar and wind-powered street light . Photo: Argonne National Laboratory

Conceptual and methodological issues

The paper mainly uses international trade statistics compiled in the UN Comtrade data(COMTRADE) and reports by industry associations as well as research papers. For a global trade analysis, products have to be classified in terms of Harmonised System (HS) subheadings, because global trade statistics are available only at this level. HS subheadings, however, tend to provide for trade in a broader range of products than those associated with the deployment of the environmental technologies being analysed. In only a few cases, such as wind-powered generating sets (HS 850231), do six-digit HS subheadings exclusively or predominantly cover "environmental goods." In other cases, using HS subdivisions can only be used as a proxy for estimating trade in RE goods, but may at times lead to erroneous conclusions. Similarly, it is difficult, if not impossible, to accurately estimate South-South trade flows in environmental goods when the same HS subdivision provides for trade in both environmental and non-environmental goods. Therefore, for the purposes of this trade analysis, certain criteria have been applied for the selection of HS subheadings. In particular, selected HS subdivisions are assumed to be a reasonable proxy of trade in the RE products being analysed.

Thus, estimating South-South trade in most RE products based on HS subheadings and for all developing countries as a group remains a challenging if not impossible task. This concerns in particular trade in solar PV cells and modules – the most heavily traded RE goods – which are classified under the same HS subheading (HS 854140) as other photosensitive semiconductor devices and light-emitting diodes (LEDs). The study shows that, in the period 2009-2012, solar cells accounted for 73 per cent of China's global exports in the subheading, but for only 30 per cent of its exports to other developing countries. This suggests that using the subheading as a proxy for South-South trade in solar PV cells may be more challenging than in the case of global trade. To help address this issue, the paper makes extensive use of available national tariff line (TL)-level trade data on RE products. It therefore presents a more reliable analysis for a small group of key developing countries that have included PV-specific tariff lines in their national tariff schedules.

In all, only nine HS subheadings were identified for the analysis of trade in RE products, covering the solar PV, wind, hydro and biomass sectors. The paper also presents figures on trade in water filtering and purification equipment as an example of trade in "environmental protection" products. In order to put the analysis in perspective, figures are also shown for total merchandise trade, trade in manufactured products and trade in certain broad categories of environmental goods other than RE products.

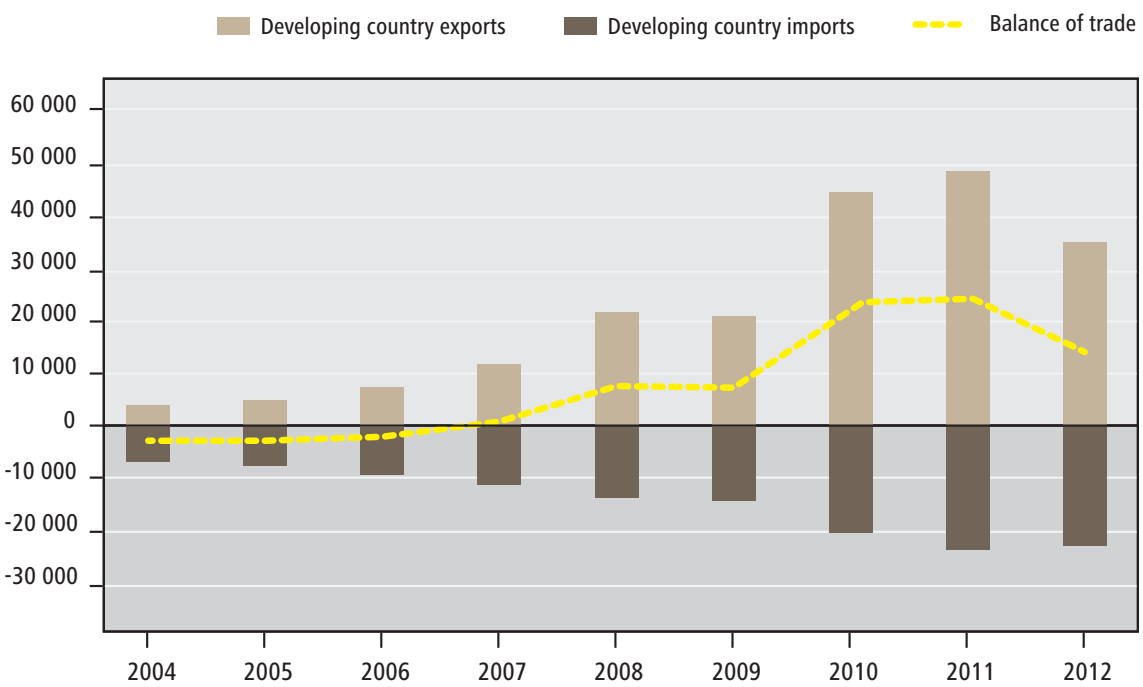
Trends in global and South-South trade in environmental and renewable energy goods

The trends analysis focuses on the period 2004-2012. Growth rates shown in Chapters 2 and 3 mostly cover the period 2004-2011. Inclusion of earlier data might distort the trends analysis, as there was insignificant trade in RE products in the early 2000s. More recent trade data is affected by sharp declines in prices, uncertainties in incentive schemes and antidumping and CVD actions. At the time of writing, 2013 trade data were available for only a limited number of countries. The analysis presented in Chapter 4 is based on relevant information available at the time of drafting.

The paper highlights several key aspects of general South-South trade, observed in the period 2004-11 (unless otherwise indicated):

- South-South trade has grown faster than global trade. With the growing economic importance of developing countries, overall South-South trade has grown faster (15.9 per cent per year on average)[1] than global trade (excluding intra-EU trade) in manufactured products (9.7 per cent). Additionally, South-South trade in the RE goods analysed in this paper grew slightly faster (29.4 per cent) than global trade (excluding intra-EU trade) in the same sectors (26.7 per cent). These include solar PV cells and modules, wind-powered generating sets, hydraulic turbines and

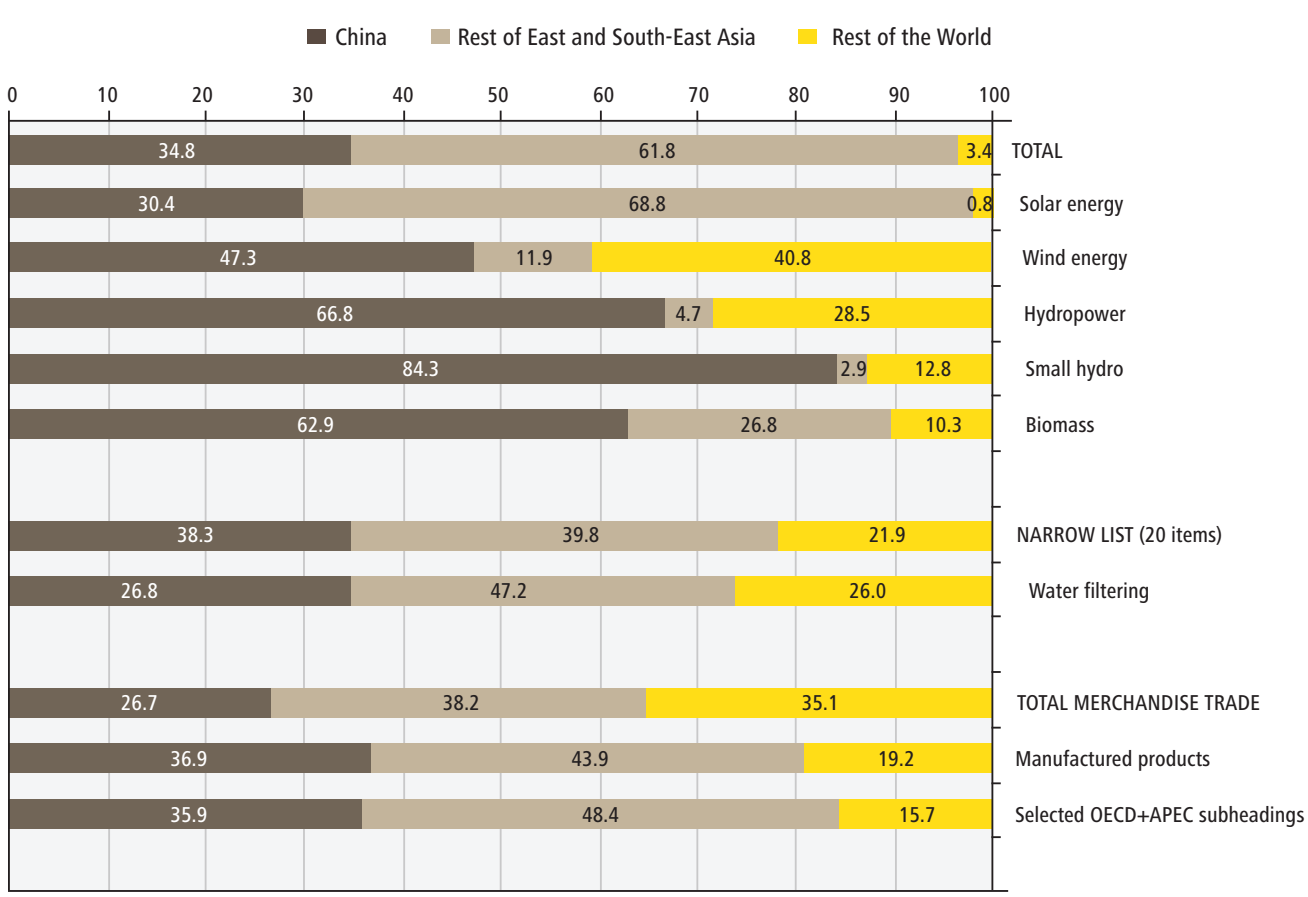
FIGURE 1 DEVELOPING COUNTRIES' BALANCE OF TRADE IN SELECTED RENEWABLE ENERGY (RE) PRODUCTS, 2004-2012 (US$ MILLIONS)*



Source: UN Comtrade data.

* Derived from Tables 2 and 3, based on HS subheading selections detailed in Annex 1. These include some non-related goods and exclude some related goods. See also Section 1.5, Methodology.

FIGURE 2 PARTICIPATION OF CHINA AND OTHER DEVELOPING COUNTRIES IN SOUTH-SOUTH EXPORTS, 2008-2012 (%)*



Source: UN Comtrade data.

* Derived from Tables 1 and Annex 5. RE subsectors are based on selected HS sub-headings detailed in Annex 1. These include some non-related goods and exclude some related goods. See also Section 1.5, Methodology.

products associated with RE generation from biomass. It must be emphasized, however, that trends shown for South-South trade in solar PV cells and modules are significantly affected by the inclusion of unrelated products in the same HS subheading (HS 854140). Whereas most of the increase in developing countries' exports in the period 2004-2011 was triggered by import demand in developed country markets (rather than South-South trade), PV-specific trade data for 2013 show a surge in Chinese exports of solar PV cells and modules to other developing countries.

- Global trade in RE goods outpaced trade in manufactures. Globally, manufactures trade grew only 9.7 per cent while trade in selected RE goods, measured at the level of HS subheadings, grew by 26.7 per cent. South-South trade in manufactures grew by only 15.9 per cent from 2004-2011, while South-South trade in most RE categories, as measured in the study, seems to have grown faster than global trade in the same categories. Similar patterns exist for narrower product categories, including selected environmental protection products and water filtration, in which South-South trade grew at 20.9 per cent and 23.1 per cent, respectively. It is impossible to assess the growth of global South-South trade in solar cells and modules vis-à-vis the growth of global trade in these products during the period 2004-2011.

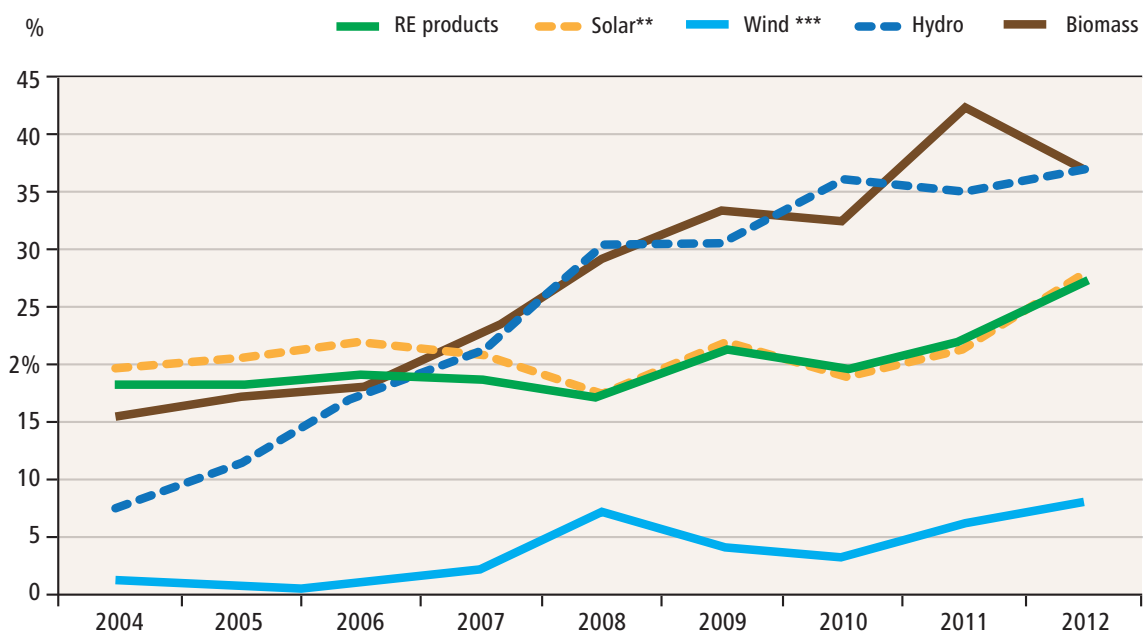
- Developing countries have become net exporters of RE goods identified in this paper. In 2007, developing countries went from net importers to net exporters of these RE goods (see Figure 1). This trend appears to have been driven entirely by trade in solar PV and other products in HS 854140. In the case of wind-powered generating sets, hydraulic turbines and products used in biomass-based energy generation, the value of their imports appeared to be larger than the value of their exports based on trade in the HS subheadings identified in this paper. Particularly relevant during the period 2004-2011 was the rapid increase of developed- country solar PV imports from developing countries (in particular in Asia), driven largely by lower manufacturing costs and developed country installation incentives. In recent years, however, developing country exports to developed countries (with the notable exception of Japan) fell significantly due to falling prices, scaled-back incentives for RE installation in the developed world (in particular Europe) and the initiation of antidumping (AD) and countervailing duty (CVD) in the United States and the European Union.

- Asian developing countries are the largest players in South-South trade. Asian countries make up the majority of South-South trade (see Figure 2). Developing countries in East and South-East Asia accounted for a very large share of South-South trade in selected products associated with the solar PV, biomass and small hydro sectors. Asian developing countries are also the principal destination markets of South-South trade (in the case of wind turbines, however, Latin American countries accounted for the largest portion). A similar picture, although less pronounced, is shown for water filtering and purifying machinery.

- South-South trade makes up a larger portion of some categories of RE global trade than others. While South-South trade in wind-powered generating sets makes up only around six per cent of global trade in that category in the period 2009-2012, South-South trade in the HS subheadings selected as proxies for trade in products associated with biomass-based energy generation and hydropower make up 45 per cent of such global trade (see Figure 3). Overall South-South trade (measured at the level of HS subheadings) in RE products made up more than a quarter of all global trade in RE in 2012 (around one fifth in the period 2009-2012).

- A number of positive developments provide favourable conditions for enhanced South-South trade in RE products. These include falling prices of RE technologies and equipment, faster growth in RE investment in developing countries (compared with developed countries) and the growing importance of developing country markets as drivers of trade in RE products (see Chapter 4). For example, in the

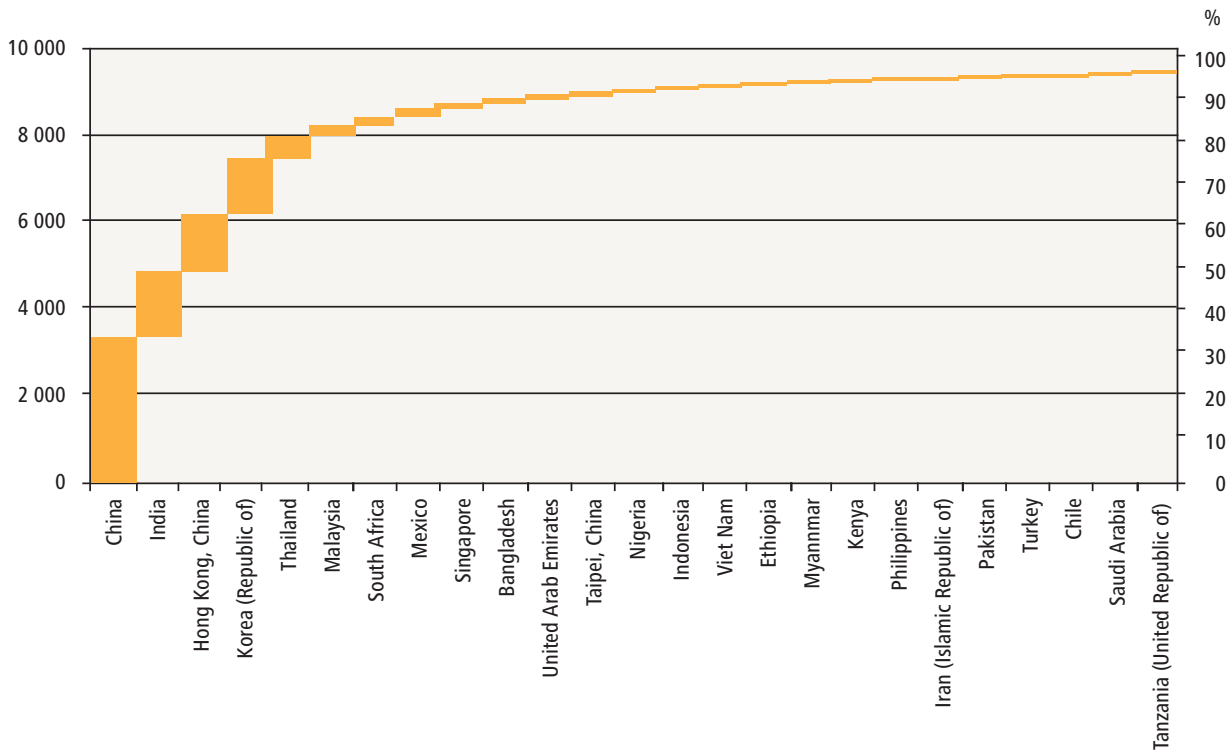
FIGURE 3 SOUTH-SOUTH TRADE AS A SHARE OF GLOBAL TRADE (% OF TOTAL GLOBAL TRADE)*



Source: UN Comtrade data.

* Excludes intra-EU trade. Derived from Tables 2-3, based on HS subheading selections detailed in Annex 1. See also Section 1.5, Methodology.
** Including other photosensitive semiconductor devices and LEDs.
*** Excluding some wind-related components.

FIGURE 4 SOLAR PV CELLS AND MODULES EXPORTED TO DEVELOPING COUNTRY MARKETS, 2009-2012 (US$ MILLIONS, % OF TOTAL)*



Source: ITC Trade Map data.

*Derived from Table 13 and elaborated on the basis of exports from PV-specific national tariff lines in China, Chinese Taipei, India, Thailand and the United States.

last four years (2010-2013), developing countries added more new wind energy installations than developed countries. Whereas China accounted for most of these additions, a relatively large number of developing countries have small but dynamic wind markets. Similarly, in 2012, new solar PV capacities added in developing countries were more than 60 per cent higher than in 2011, whereas in the European Union they were almost a quarter lower. Preliminary data indicate that developing countries collectively accounted for well above one third of new solar PV capacity additions in 2013, with particularly strong growth in China. Finally, in the wake of recent price declines, strong growth (from a low base) is also expected in RE installations in other developing regions, in particular in Latin America and Africa.

Solar PV and other products in HS 854140 have dominated South-South trade in RE. These products make up the majority of South-South trade in RE in value terms. Most of this trade has been driven by intra-regional trade in East and South-East Asia, both by growing demand for solar PV for energy generation and by demand for solar PV components along a value chain.

Solar energy products

The study reveals several key points on global trade in solar PV products:

- The global solar PV market has grown rapidly. In the period 2004-2011, global annual solar PV capacity additions increased at an average annual growth rate of more than 80 per cent. The value of global trade increased rapidly and given that prices have been falling, the increase in volume terms was even faster. In 2012, however, the size of the market remained relatively stable, as a sharp contraction in capacity additions in the European Union was compensated by strong growth in the United States, China, Japan and India, and other developing countries. New solar PV capacity installed globally during 2013 was almost a quarter larger than in 2012, despite a further decline in Europe.

- The solar PV industry has been affected by overcapacity, resulting in continuous reductions of prices of solar PV cells and modules and negative or very low profit margins. The global solar PV market stagnated in 2012. Whereas global solar PV manufacturing capacity has continued to increase in recent years, the margins have become increasingly tight. The solar PV industry is clearly in a consolidation phase, with large companies gaining market share. New entrants in developing countries have to compete with large-scale, integrated and low-cost producers in China. In India, for example, incentives under the Jawaharlal Nehru National Solar Mission and various state-level incentive schemes helped to increase the size and stability of the solar PV market, but have not resulted in significant progress towards building up a low-cost, high-quality solar manufacturing sector.

- With falling solar PV module prices, other parts of the value chain are increasingly important. The manufacture and supply of certain Balance of System (BoS) components (such as mounting structures) as well as downstream services (such as installation) are becoming increasingly important parts of the solar PV system value chain. Since new market entrants from developing countries may find it difficult to compete (in particular in the manufacturing of solar PV cells), developing country companies could focus on specific parts of the manufacturing chain such as module assembly and the manufacture of certain BoS components. Some developing countries may successfully engage in South-South operations in emerging regional markets.

- In terms of trade measures, solar PV panels face little or no tariff barriers with most countries providing duty-free access to their markets. However, key components such as inverters face relatively high tariffs in certain developing countries. In recent years, AD and CVD actions have been initiated in the United States, the European Union as well as certain developing countries. Local-content requirements (LCRs) are also used in countries, such as

India and South Africa, to stimulate and expand local manufacturing capacity.

- South-South solar PV trade has so far been largely confined to East and South-East Asia. A large part of this has been driven by trade in intermediate products for incorporation into predominantly Chinese exports to developed country markets. It has also been driven by end-market demand for solar PVs in rapidly-growing markets of Asian developing countries. Intra-regional trade in RE supply goods in other developing regions is still in its infancy, due to low levels of demand.

- China's role in South-South solar PV trade has been significant, both as an exporter and importer. Chinese exports have provided low-cost RE goods (e.g., solar PV cells and modules) to emerging solar PV markets, both in Asia and other developing regions. Trade statistics for PV-specific national tariff lines show that in the period 2009-2012, developing countries absorbed only around 6 per cent of Chinese global solar PV exports, in value terms (as most exports went to developed-country markets). Developing countries may absorb a growing portion of Chinese exports of solar PV modules as they increasingly invest in solar PV power, driven by lower prices of solar PV modules, and as Chinese manufacturers look for new markets in developing countries. Indeed, the share of developing countries as a destination for Chinese global solar PV exports increased to 23 per cent during 2013. China also contributed to South-South trade as an importer. For example, some countries in East and South-East Asia have been exporting intermediate products to be incorporated into China's exports to developed country markets. In addition, end-market demand in China itself is growing rapidly, providing market opportunities for other Asian developing countries. In fact, China was a net solar PV importer from other developing countries in the period 2009-2011, largely on account of imports from other developing countries in East and South-East Asia, but became a net exporter in 2012.

- A number of developing countries are emerging as small but potentially significant importers of solar PV cells and modules. The most important markets are China, India and some other countries in East and South-East Asia. Other emerging markets include Bangladesh, Indonesia, Nigeria, South Africa, United Arab Emirates, and Viet Nam. Ghana, Kenya, Myanmar, Philippines and Tanzania emerged as dynamic markets during this period (see Figure 4). This trend was revealed by mirror data based on the exports of key traders reporting PV-specific national tariff lines in 2009-2012.

Wind energy products

The study reveals several key points on global trade in wind energy products:

- Global annual wind capacity additions increased rapidly. Worldwide wind capacity additions increased by 22 per cent per year on average during the period 2006-2011. Developing countries accounted for much of these additions, growing at more than 40 per cent per year on average (from a small base) and raising their participation in global capacity additions from 26 per cent in 2006 to 55 per cent in 2011. Global annual capacity addition experienced lower growth in 2012 and less capacity was added in 2013 than in the previous year, largely due to uncertainties concerning the renewal of the Production Tax Credit in the United States. The value of world trade in wind-powered generating sets increased rapidly until 2008, but subsequently declined due to several factors, which include the decline in the price of wind-turbines, increased domestic manufacturing in key markets and the increasing role of foreign direct investment (FDI) vis-à-vis direct exports.

- South-South trade in wind turbines was relatively small. South-South trade in wind-powered generating sets remained small (relative to global trade, even when intra-EU trade is excluded) through 2007, accounting for only around 2 per cent of developing country imports in 2004-2006, but has mostly been above 20 per cent since 2008. Cumulative

South-South trade in wind-powered generating sets accounted for US$ 1.3 billion in the period 2008-2012 (US$ 270 million per year on average). Large wind companies based in developing countries (in particular India and China) have played a major role in increasing manufacturing and export capacity. The prominent position of Chinese companies has been gained largely through domestic sales, although these companies have increasingly become more active in export markets with strong export growth in recent years.

- **Domestic measures may be affecting South-South trade in wind power equipment.** Most favoured nation (MFN) -applied tariffs for wind-powered generating sets are still relatively high. This is particularly true in a number of developing countries, especially those that have significant wind markets and have been interested in building up domestic manufacturing capacity, for instance Brazil (14 per cent), China and Korea (both 8 per cent). Smaller countries that import wind turbines usually apply low or zero tariffs. Local-content measures often tied to domestic incentives are also used in a number of developing countries such as Brazil, South Africa and Turkey to bolster domestic manufacturing capacity. China ended its LCRs in 2009.

- **Opportunities for South-South trade remain.** Despite falling values of global and South-South trade in wind-powered generating sets from peak levels in recent years, opportunities for South-South trade continue to arise for a number of reasons. These include the emergence of new developing country markets, significant export capacity of developing country wind companies and the successful participation of developing countries in value chains by manufacturing components. Some risks nevertheless exist, such as a possible decline in demand as developing countries build up domestic manufacturing capacities and the dependence of wind markets on government policies.

Policy implications for trade and the green economy transition

South-South trade opportunities in RE and other environmental goods are clearly rising quickly, and are likely to accelerate in coming years. In order to benefit from this increasing trade, countries could consider taking the following concrete steps.

Trade policy initiatives

- **Actively identify opportunities for South-South trade in RE products, installation, innovation and diffusion.** RE products are increasingly being supplied to developing countries by other developing countries, due to increasing global cost competitiveness and shared needs. Cost-effective innovation can lead to the design of low-cost environmental goods that bolster South-South trade. Some examples include small off-grid solar PV systems, solar lighting, community wind turbines, small hydro and water filtering. Countries could seek to improve South-South trade cooperation for the installation, innovation and dissemination of RE technologies.

- **Design appropriate incentives for RE that do not distort South-South trade in environmental goods.** Incentives, including government subsidies, may have implications for international trade, including South-South trade. Incentives aimed at encouraging the use of RE-based electricity, by creating demand for associated goods and services, could have a positive impact on trade as part of such demand will be met by imports. For example, incentives in key developed country markets have stimulated trade in renewable-energy products, such as solar PV cells and wind turbines.

  Governments could also provide incentives, including through subsidies, intended to boost domestic manufacturing capacities to help ensure that the use of renewable-energy-based electricity results in benefits to the domestic economy (in terms of employment and industrial development). Such incentives could have direct and indirect impacts

on trade. Many incentives, such as the provision of infrastructure and financial assistance, could indirectly support trade, including South-South trade. Subsidies that are provided across sectors and which do not specifically benefit one sector or industry would not be considered incompatible with WTO subsidy rules. However, certain types of subsidies and other support measures to boost domestic manufacturing may have negative effects on trade, distort global markets, causing trade tensions and potentially undercutting the competitiveness of industries in other developing countries. In certain cases, trade-policymakers could consider time-limited exemptions from WTO subsidy rules to enable developing countries to build up a certain degree of domestic manufacturing capacity.

- Bolster support for environmental goods that are particularly suited to South-South trade. For many developing countries, imports of water purification equipment, a sector characterized by growing South-South trade, could be a vital component of their transition towards a green economy. Organic agriculture is another environmental goods sector where developing countries have immediate potential for increasing production and export. Successful development of the organic sector requires sustained government and private sector support and the involvement of various stakeholders in policy and strategy formulation. Standards, mutual recognition and labelling initiatives, both globally and regionally, could facilitate South-South trade in environmental goods.

- Implement a trade policy regime favourable to local RE potential, including relaxed barriers to trade in intermediate goods. The reduction or elimination of import duties and non-tariff barriers on RE goods, including components, could promote the domestic availability of affordable RE products. Inverted duty structures, where components face higher import tariffs than final products, could discourage the development of local manufacturing capacity. Where a certain level of tariff protection for finished products is considered desirable for some time to help boost local manufacturing capacities (where domestic markets are large enough to economically justify local production), tariffs on final products could be reduced gradually to provide an incentive to manufacturers to reduce costs and become internationally competitive. Trade agreements including those at the regional level could facilitate South-South trade, if designed accordingly.

- Support revision of the Harmonised System codes for trade in environmental goods to assist policymakers in making better informed decisions. The fact that most environmental goods are classified under HS subheadings that include unrelated products complicates trade analysis and negotiations. Future HS revisions could pay special attention to creating specific subheadings for key RE goods, in particular solar PV equipment.

Investment initiatives

- Promote new RE installations in order to increase domestic generating capacity, on-grid and off-grid, leading to cheaper, more secure and more abundant electricity supplies. Declining global costs of RE equipment, in particular solar PV cells and modules, are making investments in RE more attractive. In many countries, 'off-grid' RE projects in solar, wind and hydro are already cost-competitive with conventional sources. Appropriate targets, incentives and flanking environmental and social policies are helpful tools to take advantage of current favourable conditions for RE generation.

- Implement appropriate policies to harness green economy benefits from RE installations. Apart from improved electricity supply and greater energy security, RE investment brings a range of additional green economy benefits. These include reductions in fossil fuel production and imports, cleaner production, rural electrification and new employment opportunities in downstream services, such as RE installation, operation and maintenance. Policies are recommended that encourage both RE deployment and sustainable trade.

- Take advantage of green economy-related financial assistance initiatives. Incentives will be important in enabling the deployment of environmental goods and services. This is particularly true in countries where governmental and financial support are insufficient. Such incentives include financing mechanisms such as the Clean Development Mechanism (CDM) and the 'Green Fund' at the United Nations Framework Convention on Climate Change (UNFCCC), among others. Export finance initiatives launched by regional development banks could also bolster South-South RE deployment.

- Strategically consider investments for developing domestic manufacturing capacity suited to global RE value chains. Countries seeking to build up a certain degree of export manufacturing or downstream service capacities can focus on parts of the global value chain where local companies may be competitive, such as solar PV components, module assembly, and parts of the BoS segment. In many countries, the introduction of RE technologies will initially depend on imported equipment, but as markets become more significant, local manufacturing and export capacity could become competitive.

- Improve national and regional grid capacity to support increased renewable electricity production and trade. Countries with excellent RE resources (e.g., solar radiation, wind and hydropower potential) could export renewably generated electricity by investing in improved grid capacity. Some regions, including the Economic Community of West African States (ECOWAS), have begun building institutional support through regional mechanisms such as the West African Power Pool (WAPP).

- Invest in domestic downstream skills development for an adequate human talent pool. Many economic benefits from downstream services can accrue in the RE sector, especially in installation, maintenance and removal. Investing in a skilled RE labour force will not only provide more quality jobs, but prepare the wider economy for the RE transition. A skilled domestic RE labour force could be key in attracting further investment in the RE sector, including for the development of domestic manufacturing and export capacity.

Solar-powered houses of Yak herders in Bhutan . Photo: Creative Commons/Graham King

1 Setting the context: Green economy and South-South trade in environmental goods

1.1 Objectives and structure of the paper

Trade remains a crucial driver of a transition to a green economy. Global markets for trade in environmental goods and services – including RE goods in particular – are rapidly rising, creating new trading opportunities for countries worldwide. Meanwhile, according to the World Bank, trade between developing countries, or "South-South" trade, has become "the most dynamic segment of global trade in the last decade" (World Bank, 2013).[2]

The objective of the study is to examine South-South trade flows in selected environmental goods and their implications for a green economy transition in developing countries.[3] In particular, on the basis of available data, the study focuses on trade flow analysis of RE goods, including solar PV, wind, hydro and biomass. The paper is an important component of the UN Environment Programme's (UNEP) on-going research and policy development in the area of Green Economy and Trade.

Specifically, the study aims to:

- clarify the volume and direction of South-South trade in RE supply goods, particularly solar PV and wind energy goods, on the basis of a trade flow analysis drawing on available data from COMTRADE, ITC Trade Map and recent market developments;

- highlight conceptual and methodological issues involved in a trade flow analysis of environmental goods in general (including RE goods);

- analyse trade and market trends and developments in additional broad categories of products that include certain environmental goods used agriculture, industry and services;

- derive conclusions and policy implications relevant to national and international policymakers, civil servants, researchers, private sector representatives, and other developing country stakeholders who have an interest in promoting the green economy transition through increased South-South trade in environmental goods; and

- suggest focus areas for future research in South-South trade in environmental goods.

The paper is organized as follows:

- Chapter I raises the importance of trade in the green economy transition and sets the stage for the paper's South-South trade flow analysis of certain key sub-categories of RE goods. It also discusses issues of classification of RE and other environmental goods in international trade statistics (in particular the Harmonized System) and the limitations of applying a trade flow analysis in the specific case of South-South trade in such products.

- Chapter II presents some broad trends in South-South trade in manufactured exports and broader categories of environmental goods, including RE goods. The chapter provides some preliminary context the subsequent analysis of trade in selected RE goods.

- Chapter III analyses recent global and South-South trade trends in selected RE products associated with the solar PV, wind, hydro and biomass sectors, based on COMTRADE. Given the limitations of using

COMTRADE statistics for an analysis of South-South trade in solar PV cells and modules, it also uses national PV-specific trade statistics of key developing country exporters to better understand recent trends in South-South trade in this important sector.

- Chapter IV discusses recent trends in global RE markets and, in particular, the solar PV cell and wind turbine markets, based on an analysis of general market trends, global installations and investment, trade barriers and domestic support measures.

- Chapter V discusses policy implications for developing countries, including the role of South-South trade in RE goods as a potential driving force for the green economy transition. It also summarizes the paper's findings and presents areas for future research.

Finally, the Annexes present detailed statistical tables linked to various sections of the paper.

1.2 International trade and the green economy transition

In its working definition of the concept, UNEP has defined a 'green economy' in the context of the three pillars of sustainable development - environment, society, and economy. "A green economy is one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities" (UNEP, 2011).

The United Nations Conference on Sustainable Development (Rio+20) Outcome Document, "The Future We Want," reaffirmed the role of "international trade as an engine for development and sustained economic growth" (UN, 2012, paragraph 281). It further re-emphasized the focus on the opportunities, rather than the risks of trade and environment linkages, by pointing to green economy as "one of the important tools available for achieving sustainable development" (UN, 2012, paragraph 56). The document noted the important role of trade in the dissemination of environmentally sound technologies. Thus, Heads of State at Rio+20 clearly recognized green economy as a means to achieve progress on sustainable development.

Trade and trade policy can play a positive role in bringing benefits to the environment, society and economy, both nationally and internationally. A country's trade policy can contribute towards a green economy transition by encouraging or discouraging certain exports to foreign markets or by influencing the conditions of import access to domestic markets. For example, lowering tariff barriers and addressing non-tariff barriers to environmental goods can lower their domestic cost.[4] Well-designed trade policy must be accompanied by sound domestic policies and regulation, including on social and environmental management. Trade policy can then help enable optimal use of the world's resources, conserving biodiversity, enabling the switch to cleaner energy and fuels and providing access to the technology and expertise needed to grow sustainably.

Sound domestic policies are also important for creating new markets for environmental goods and services. Pollution regulation measures, for example, can create demand for pollution-control goods. Similarly, certification initiatives could help create markets for products that enable biodiversity conservation. Regulatory and taxation policies can also ensure that economic benefits from trade reduce rather than exacerbate social inequities. Once green markets and industries are in place through sound domestic policies, trade and investment flows could help drive their further expansion.

1.3 Green economy trade opportunities in environmental goods

Rising global trade in environmental goods and services, including RE, is a golden opportunity for the transition to a green economy. In one study, global market demand for environmental goods and services is projected to rise from US$ 584 billion in 2004 to between US$ 1,200 and US$ 1,900 billion in 2020 (DIW, 2009). In another study, the global market in low-carbon and energy-efficient technologies alone is projected to nearly triple by 2020

(UNCTAD, 2011). These expanding markets are opening new economic opportunities worldwide, including in developing countries, which could provide a key means to address the three pillars of sustainable development. UNEP's Green Economy and Trade Opportunities Project (GE-TOP) report reveals the complex, bi-directional nature of trade's role in the transition to a green economy, addressing both the opportunities and the enabling policies needed to make green trade work (UNEP, 2013). The GE-TOP report identifies sustainable trade opportunities for developing countries in six economic sectors highlighted in the Rio+20 Outcome Document including agriculture, fisheries, forests, manufacturing, RE and tourism (see Box 1).

Green economy opportunities are bi-directional, arising both for trade as well as from trade. In the first case, domestic policy frameworks, including incentives and regulations create demand for environmental goods. Such frameworks also include trade policies such as tariffs and non-tariff measures that directly affect conditions of access for goods and services. Global demand for environmental goods is driven by new consumption patterns, productivity gains, improving fuel efficiency, and countries' more stringent commitments to environmental and health regulation (DIW, 2009). This demand is creating new opportunities for trade by establishing new green global markets.

In the second case, green economy opportunities can arise from trade. Access to cost-effective technologies through imports as well as the use of sustainable production methods in manufacturing for domestic and external markets can help 'operationalise' a green economy. A number of countries, such as China, Kenya and Korea are building manufacturing capacity for environmental goods as part of their green economy strategies (UNCTAD, 2011).[5] In these strategies, both exports and imports play an important role. For example, imports can facilitate access to cost-effective water-purification technologies thereby facilitating the supply of clean drinking water, whereas imports of solar panels allow the importing country to harness solar energy for electricity generation. International trade is a critical tool for accessing the markets, goods and services that drive the green economy transition.

1.3.1 Renewable energy products

RE products are a sub-set of the broader category of environmental goods. Perhaps no other category of environmental good has received as much attention in recent years. RE goods are key examples of how the green economy transition can be beneficial for as well as benefit from trade.

The study focuses on RE supply products, i.e. products that help generate electricity from solar, wind, hydro, tidal, geothermal and biomass sources. These include solar cells and modules, hydroelectric turbines and wind turbines. RE products also include products that do not generate electricity, but are powered by renewable sources of energy, such as solar water heaters (see Box 6), solar pumps and solar lighting. Another category of RE products is biofuel, which is derived from biomass. Whereas this trade analysis focuses on RE supply products, the terms "renewable energy goods" or "products" are also used.

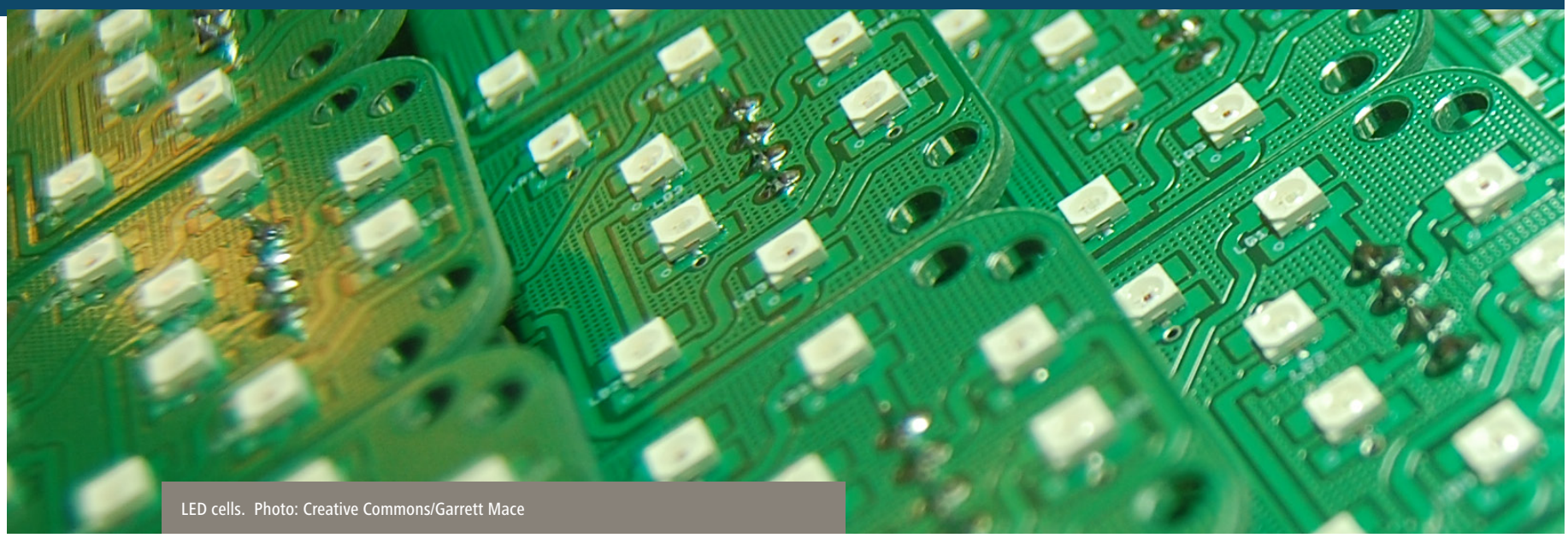
The RE goods sector is key to emerging trade opportunities in the green economy transition for a number of reasons. First, RE goods are critical for addressing climate change. Climate change is a social, environmental and economic problem that is global in scope and unprecedented in magnitude. As the Intergovernmental Panel on Climate Change (IPCC) has noted, energy supply by burning of coal, natural gas, and oil for electricity and heat, is the largest single source of greenhouse gas emissions. In order to limit climate temperature rise to a maximum of 2 degrees Centigrade (36 degrees Fahrenheit), a threshold identified as critical to avoiding the worst environmental damage, global energy-related emissions in 2020 must not be greater than 32 Gigatonnes (Gt). This will entail massive decarbonisation of energy sources (including electricity) (ICTSD, 2011). According to the International Energy Agency (IEA), fossil fuels comprised 68 per cent of the power sector in 2011. As the source of two-thirds of global greenhouse gas

BOX 1 GREEN ECONOMY TRADE OPPORTUNITIES IN DEVELOPING COUNTRIES

The UNEP (2013) report, Green Economy and Trade: Trends Challenges and Opportunities, uses case studies and literature reviews to analyse emerging opportunities in six economic sectors of particular interest to developing countries. South-South trade can catalyse these industries. The six sectors include agriculture, fisheries, forestry, manufacturing, RE and tourism. Some findings include:

Agriculture: Sustainable farming methods can increase productivity, facilitate access to international supply chains, and respond to the rising global demand for more sustainable and organic produce. Many large multinational companies have also made sustainability commitments, which will have an impact on the business choices of upstream supply chain partners. In addition, the global market for organic food and beverages is projected to grow to US$ 105 billion by 2015, from the total value of US$ 62.9 billion in 2011. Organic agricultural production is a dynamic sector. So far, developing country exports have been directed mainly to developed-country markets. Whereas South-South trade is limited, it offers significant opportunities. There are success stories based on factors such as clear government support (i.e. Uganda), a responsive private sector and a multi-stakeholder approach involving partnerships between farmers, farmers' groups, non-governmental organizations (NGOs), organic agriculture associations, governments and certifying bodies. Important progress has been made in the implementation of regional organic standards, for example in East Africa and in Central America (including the Dominican Republic). Some governments are including organic agriculture in incentive programmes for non-traditional exports. Policies aimed at bolstering domestic markets in developing countries may eventually result in enhanced South-South trade in organic agricultural products. Regional cooperation could also help to generate commercially-viable volumes of supply for export to developed-country markets. Regional standards and mutual recognition initiatives as well labelling initiatives could facilitate South-South trade.

Fisheries: Globally, fish and fish products are the most extensively traded food commodity, and exports have expanded greatly over the past 35 years, rising from US$ 8 billion in 1976 to an estimated US$ 125 billion in 2011. Eighty per cent of world fish resources are overexploited or at their biological limit, and the top ten commercial species are still being harvested far beyond science-based sustainability levels. While a reduction of



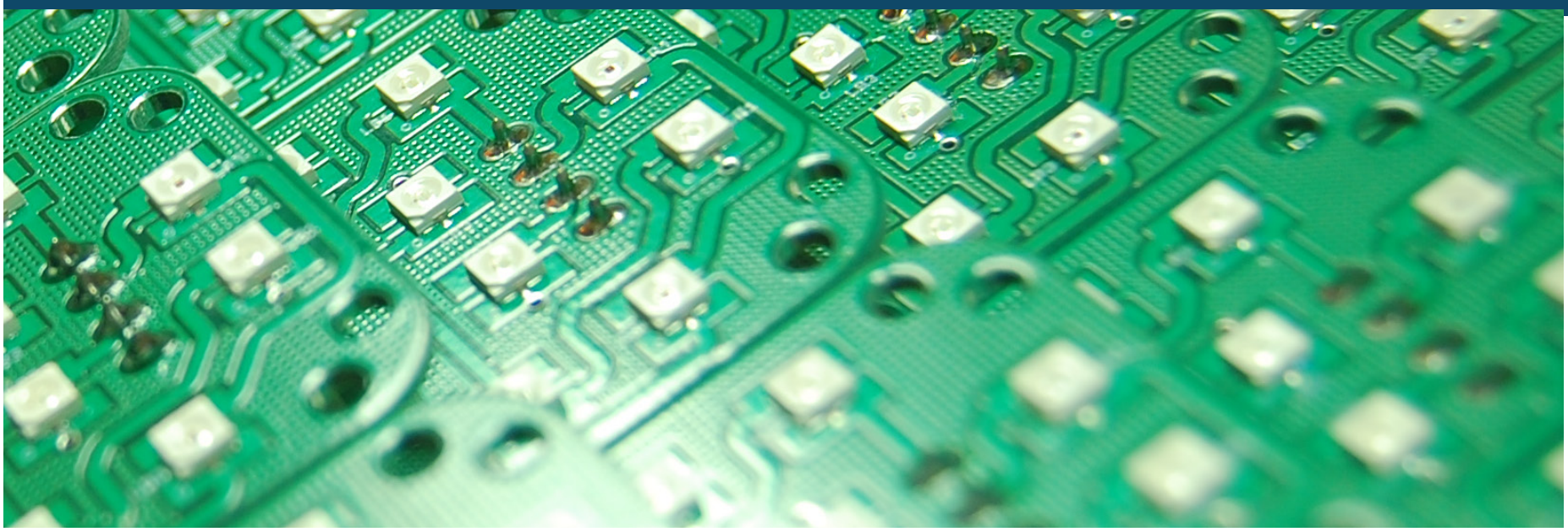
LED cells. Photo: Creative Commons/Garrett Mace

fishing effort remains a necessity, increased trade in fish and fish products certified for sustainability can improve the overall fisheries management systems, while increasing productivity of the resource and adding value to final products.

Forestry: Sustainable forest management, including through certification, has the potential to expand the relative share of trade in sustainable wood products and non-timber forest products. As of early 2013, the total area of certified forest worldwide amounts to approximately ten per cent of global forest resources. Sales of certified products are worth over US$ 20 billion per annum. Depending on the operation, price premiums for certified wood, particularly from the tropics, can range from 15 to 25 per cent. Developing countries are also selling forest carbon offsets in international markets, including through international mechanisms such as the Clean Development Mechanism and REDD+.

Manufacturing: Products with environmentally friendly designs and companies that comply with sustainability standards for products and processes have an advantage in international markets. Many suppliers are rendering their practices more sustainable in order to secure their positions within international supply chains. This is illustrated for example by the 1,500 per cent increase in global ISO 14001 certifications on environmental management awarded between 1999 and 2009. In addition, some developing countries are taking the lead in investing in sustainable manufacturing practices (i.e. remanufacturing) and products with an environmentally friendly design (e.g., ecolabelled textiles and energy efficient electronics).

Tourism: The fastest growing sub-sector in sustainable tourism is ecotourism, which focuses on nature-based activities. Many developing countries appear to have a comparative advantage in ecotourism, due to their natural environments, cultural heritage and opportunities for adventure holidays. In addition, certification in the tourism sector is also experiencing increasing trends, as many tourism structures and sites recognise the attractiveness and potential price premiums that may follow the achievement of sustainability certification. Protected areas in Costa Rica, for example, receive more than one million visitors each year, generating entrance-fee revenues of more than US$ 5 million, while Mexico's protected areas record 14 million visitors per year, creating more than 25,000 jobs.



BOX 2 EMPLOYMENT OPPORTUNITIES IN RENEWABLE ENERGY

Investing in a green economy can create new employment opportunities. For example, in 2012, more than 5.7 million people worldwide were estimated to be working, either directly or indirectly, in the RE sector (REN 21, 2013) and further growth is expected. Estimates suggest that by 2030, either directly or indirectly, 12 million people could be employed in biofuels-related agriculture and industry, 2.1 million people could be employed in wind and 6.3 million in the solar PV sector (UNEP, 2008a). According to one study, all RE technologies have higher labour intensity than fossil energy technologies (Wei, Patadia and Kammen, 2010).

Taking solar PV as an example, job generation potential over the lifecycle of an installation is very high compared to both fossil fuels and other RE sources (Kirkegaard et al., 2010). The majority of jobs along the solar value chain are created in the downstream stages of system integration, installation, construction, sales, and maintenance, all of which must be conducted domestically. Thus, important employment opportunities also exist in countries with ample solar radiation but without domestic manufacturing capacity. In addition, jobs relating to smaller solar PV systems may have a significant impact on employment across the developing world (ILO, 2013).

With regard to wind energy, according to a report by the European Wind Industry Association (EWEA, 2009), manufacturing accounts for a large portion of employment created by new wind capacity installations. In Europe, per megawatt (MW), manufacturing was estimated to have created 12.5 jobs (7.5 direct plus 5 indirect jobs), compared with 1.2 jobs created by wind installation and 1.3 indirect jobs created by related activities such as utilities, consulting, research, and financial services. As cumulative wind capacity expands, operating wind farms will become an increasingly important source of employment, especially in countries that do not themselves manufacture wind turbines and related equipment.

A 2012 International Labour Organization (ILO) report further indicates that in emerging economies more jobs are created per MW than in Europe. In China, the number of jobs was estimated at 30-35 jobs per MW in manufacturing and installation and 1.5-2 jobs per MW in operations and maintenance. In India, the numbers were estimated at 37.5 jobs per MW in manufacturing and installation and a surprisingly high five jobs per MW in operations and maintenance (ILO, 2012). These figures are, however, likely to change as productivity changes.

emissions, the energy sector (including electricity) will be pivotal in determining whether or not climate change goals are achieved (IEA, 2013).

Second, the Rio+20 Outcome Document emphasizes the "need to address the challenge of access to sustainable modern energy services for all… [including through] increased use of RE sources and other low emission technologies." International trade, together with foreign direct investment and international cooperation, is noted for its role in the transfer of "environmentally sound technologies" (UN, 2012, paragraphs 125-129, 271). The Document supports the Sustainable Energy for All initiative, launched in 2012 by the United Nations (UN) Secretary-General, which includes among its goals doubling the share of RE in the global energy mix by 2030 (from 18 per cent in 2010 to 36 per cent in 2030). Several national governments have made RE trade a key part of their sustainable development strategies (UNEP, 2013). In the developing country context, it is important to note that large portions of solar PV imports into many developing countries may be related to off-grid applications. Global solar PV trade is largely dominated by developments in grid-connected installations, but in many developing countries solar PV applications are still mostly applied off-grid. It has been argued that

BOX 3 REMANUFACTURING, TRADE AND GREEN ECONOMY

Remanufacturing is a process of bringing used products and individual product components to a 'like-new' functional state. Remanufacturing enables producers to recover a substantial portion of the material and components in a used product in its original manufacturing state, thereby reducing the costs of making a new product. This process enables environmental benefits compared with manufacturing a new product by generating lower greenhouse gas (GHG) emissions and less toxic and other waste. Compared with starting a fresh manufacturing operation, remanufacturing also requires lower capital costs and results in lower prices (generally up to 30 to 40) for consumers.

Remanufacturing can be applied to any product that can be disassembled, cleaned and have components replaced or repaired. This makes it an attractive option for new business ventures in developing countries, delivering environmental benefits, building manufacturing expertise and potentially providing export opportunities to developing country markets. Remanufacturing is becoming a major part of industrial strategy in many countries and there is already an active intra-regional trade in remanufactured products in Africa, such as export of toner cartridges from Kenya and PCs and mobile phones from Nigeria.

Remanufacturing of certain RE products such as wind turbines may provide South-South trade opportunities. However, since some countries apply certain restrictions to imports of used products, it is important to ensure that remanufactured products are treated as "new" (rather than "used") products. If remanufactured goods qualify as new products, they may not need additional quality and safety requirements, giving them a cost-savings and market access advantage over traditional refu

LED bulbs . Photo: Creative Commons/Tudor Barker

Source: UNEP (2013).

off-grid solar PV applications in rural areas in many developing countries are already fully cost competitive with alternative power supply options, such as diesel-fuelled power generators or extensions of the public electricity grid (Kirkegaard et al., 2010) and that they do not require subsidies (Werner et al., 2011).

Third, trade in RE products, both exports as well as imports, offers new opportunities to countries at all levels of development. Some RE sectors, in particular solar PV, are very trade-intensive and have witnessed rapid export growth, including from developing countries. Countries can participate in various stages of the global value chain, from raw materials extraction to multiple manufacturing steps to assembly, installation, maintenance and disposal services. At each stage, trade allows economies to grow by adding value, including through production for exports, and to gain better access to goods and services that facilitate the use of cleaner technologies and more efficient production processes. Countries with a comparative advantage in renewable electricity generation can export their energy surplus abroad. Imports of RE products can also help in the pursuit of greater energy security and cutting down on expensive fossil-fuel imports.

Fourth, trade and investment accompanied by training and technology flows in the RE sector can also bring economic benefits such as productivity gains and employment benefits (see Box 2).

Demand for RE is usually driven by incentives, including those that help renewable sources of energy to become price-competitive with conventional energy sources such as fossil fuels. Fossil fuel prices are distorted due to subsidies, which amounted to US$ 544 billion in 2012 (IEA, 2013). Given climate mitigation and environmental considerations, such cost reductions are also necessary to allow RE to compete with other energy sources that are experiencing falling price trends, such as natural gas. Cost reduction may contribute to greater deployment of RE technologies, particularly in developing countries with little ability to provide subsidies. Efficiency gains and the achievement of economies of scale in the manufacturing of RE goods will, in turn, facilitate reduced costs of RE generation.

While many developing countries are investing in RE generation, manufacturing and exports of RE supply products have been largely concentrated in a small number of countries. Other developing countries could seek to increase their participation in environmental global value chains and obtain economic benefits from investment in RE generation, which in turn will provide incentives for further investment.

1.3.2 South-South trade and the role of developing countries

As noted previously, South-South trade has become "the most dynamic segment of global trade in the last decade" (World Bank, 2013). The rising importance of South-South trade is a key aspect of this study's focus on environmental goods and RE trade.

South-South trade offers unique opportunities for developing countries to benefit from trade for four reasons, based on their socioeconomic commonalities. First, developing countries have similar needs in terms of technologies and their adaptation to local conditions. South-South trade opportunities exist for equipment and services used in small-scale and off-grid solar PV, wind and hydropower application, including solar lighting (see Box 4). Second, South-South trade offers new opportunities for developing countries to participate in global value chains, exporting value-added products to the dynamic markets of other developing countries. Third, South-South trade, including imports, offers developing countries access to more affordable products and capital goods (UNDP, 2013). These could include innovative products catering to the needs of developing countries. For example, the 'solar-powered' ATMs developed in India could be usefully deployed in many countries in sub-Saharan Africa (Economist, June 2013). Fourth, proximity and common conditions in countries in the same region provide opportunities for regional South-South trade, including in environmental goods. Regional markets may help developing countries achieve the scale economies they need to engage in manufacturing, including in the context of existing regional integration schemes.

Traditionally, high value trade in manufactured products moved from industrial to developing countries (North-South directionality), while trade in primary products, many of which were relatively lower-value compared to manufactures, moved from developing to industrialized countries (South-North directionality). As evidence mounts that developing countries increasingly trade amongst themselves, that picture is changing. While Northern economies continue to play an important role in green trade, South-South cooperation could play an increasingly important role in the elaboration of green economy strategies and successes by developing countries (see Box 3).

1.4 The importance of flanking environmental and social policies

All countries require flanking policies to help ensure that trade in environmental goods contributes to the green economy transition in each of the three pillars of sustainable development. Stringent environmental regulations, product-related standards and in most cases some kind of incentives for RE generation will create positive conditions for green markets that also encourage trade.

BOX 4 SOLAR LIGHTING

Solar lighting has many sustainable development benefits, in particular for developing countries with relatively large populations without access to electricity. From a trade and green economy perspective, a potential benefit of solar lighting projects is the reduced need to import kerosene or provide kerosene subsidies.

The usual requirements of other off-grid solar PV systems (e.g., a PV module, an energy converter, a charge controller and a rechargeable battery) also apply to solar lighting projects. In addition, specific requirements for solar lighting include solar lamps and appropriate lighting fittings.

Since there are no specific HS subheadings for solar lighting appliances, it is difficult to track South-South trade. Solar lamps have been traded mostly under HS 940540 (Other electric lamps and lighting fittings) and HS 940550 (Non-electric lamps). Portable solar lamps may also be traded under HS 851310 (Portable electric lamps designed to function by their own source of energy (for example, storage batteries)). None of these HS subdivisions, however, specifically provide for trade in solar lamps. China is by far the largest exporter in all three HS subheadings. Although China has no specific national tariff lines for solar lamps, it is without doubt the largest exporter of solar lamps as well.

India has created a specific national tariff line (94055040) for solar lamps. In the period 2009-2012, Indian imports increased 75 per cent per year on average to US$ 8 million in 2012 (when 97 per cent was imported from developing countries and 87 per cent from China alone). In 2012, Indian exports amounted to over US$ 5 million, of which US$ 3.8 million went to developing countries, in particular Jordan, Kenya and Sri Lanka (Indian exports to Africa were worth US$ 2 million). Some other developing countries, in particular Jordan, Mauritius and Sri Lanka, also have some national tariff lines, but imports reported (mainly from China) are small according to ITC Trade Map. Solar lighting nevertheless represents clear opportunities for South-South trade.

Some developing countries have implemented trade policy measures specifically targeted at solar lighting. In 2011, India introduced a lower MFN tariff duty of five per cent for solar lamps, leaving the rates for all other lamps classified under HS subheading 940550 (which also includes petroleum-burning lamps, such as kerosene lamps) at 10 per cent. This represents an incentive in favour of solar lamps. (Similarly, Malaysia has a higher rate for petroleum-based lamps than for "other" lamps.) Indian imports of solar lamps increased rapidly in recent years, but it is hard to know whether reduced import tariffs have contributed to this.

For the economy, lowering trade barriers can further expand nascent green markets as well as green industries by increasing access to environmental goods, eventually leading to higher economic growth. Trade can also increase competition in some sectors and stimulate manufacturers of RE equipment and components to reduce costs and become internationally competitive. However, many developing country policymakers worry that opening up to low-cost imports of environmental goods may result in economic costs to the local economy, such as depressed employment and industrial development.

Developing country policymakers also must consider which policies are necessary to help ensure that green trade leads to net economic benefits. This may include fiscal support or financial incentives that encourage green industries with the highest long-term economic potential. It would also involve broader economic policies, such as supportive infrastructure and low-

cost credit, to promote demand for and access to environmentally-friendly consumer goods.

On the social front, flanking policies like taxation may be required to ensure that green economic activity, including that associated with trade, increases rather than impedes social equity. Increased trade competition can result in job losses in some industries, requiring policies to facilitate labour transitions and address income disparities. The quality of green jobs is also important. Consistent training to enable and improve the skills required for a green economy will help create better-quality jobs.

For the environment, more stringent regulation and enforcement may be needed when increasing production of green goods. Such regulations can ensure that environmental degradation from production of green goods does not offset the ultimate environmental benefits of their use. For instance, diverse regulatory, fiscal and other policy measures are needed to control for pollution in manufacturing, including environmental goods such as solar panels and wind turbines.

It is therefore important to emphasize that, while trade can facilitate a green economy transition, it must be driven by sustainable production and consumption patterns in order to achieve balanced results in each of the three pillars (UNEP, 2013).

1.5 Methodology

This paper is based on extensive review of reports of government and industry associations, literature research and the compilation and analysis of a large volume of data on trade and other relevant variables, including global capacity additions, value chains, incentives, and trade barriers. As part of its analysis, the paper uses a trade flow analysis to assess the size and direction of South-South trade in selected RE goods, based on data from COMTRADE[6] and ITC Trade Map[7]. A trade flow represents the monetary value or quantity of goods shipped from one country to another.[8]

Any global trade analysis must be based on COMTRADE, which is the only system that contains comparable data on exports and imports across (almost all) countries. For a global trade flow analysis, it is therefore necessary to classify the products or group of products being analysed in terms of HS subheadings (see Box 5). Any specific application of global trade analysis requires the availability of HS subheadings that adequately capture trade in the product categories being analysed.

A key problem in analysing trade in RE (and many other environmental) products is the limited HS subheadings that exclusively or predominantly include such products.[9] Where a specific RE product represents only a (mostly unknown) portion of all trade in a particular HS subheading, it is unavoidable for a global trade analysis to select the whole subheading (for which trade of all countries can be measured) as a "proxy" for trade in the specific RE being analysed (for which trade cannot, in most cases, be measured).[10]

In such instance, trade in unrelated products is included that may considerably affect the analysis of trade in environmental goods.[11] Another issue is that many goods may have both environmental applications and other non-environmental uses (dual use).[12] Including subheadings under which dual use goods are classified in a trade analysis may significantly overestimate environmental trade flows.[13] Researchers must therefore carefully select the specific HS subheadings to be included in their analysis and cautiously interpret the results. The criteria used for such selection may differ depending on the objectives of the analysis. For a preliminary analysis of trading opportunities in environmental goods, such criteria could be less stringent (to permit larger product coverage). For a more in-depth analysis of global trade in environmental goods more stringent criteria are required to ensure a more accurate and transparent analysis.

This section starts with a discussion on the classification of RE and other environmental goods in terms of HS subheadings. It follows with a discussion of the appropriateness of using certain HS subheadings as proxies for trade in RE products in specific applications,

BOX 5 SYSTEMS FOR CLASSIFYING TRADED PRODUCTS

HS subheadings

The Harmonized Commodity Description and Coding System, also known as the Harmonized System (HS), is an internationally standardized system for classifying traded products. The HS was developed by the World Customs Organization (WCO). Under the HS Convention, contracting parties are obliged to base their tariff schedules on the HS. The HS classifies products using four-digit headings and six-digit subheadings. Global trade statistics are available only at the six-digit level and can be found in COMTRADE, which collects uniform data on all reported international trade flows worldwide.

National tariff lines

National (and regional) tariff schedules include tariff lines, which extend the six-digit subheadings by adding additional digits, which are, however, not internationally harmonized. Tariff line codes and the corresponding product descriptions can therefore differ from one country to another. Tariff lines may capture certain environmental goods more narrowly and may also be updated more frequently to take into account developments in environmental technologies. Some RE goods (e.g., solar PV cells and solar water heaters) are clearly defined in certain national tariff schedules. In most cases, however, existing national tariff lines are still too broad to unambiguously capture specific RE goods. Tariff lines that specifically cover RE products are available only for certain countries. Trade in these tariff lines has been analysed mostly using the ITC Trade Map.

Quay crane on docks, Sri Lanka. Photo: World Bank/Dominic Sansoni

in particular the analysis of South-South trade. It also discusses how supplementary information on trade in national tariff lines available in the tariff schedules of certain key countries can be used to complement the global trade analysis and better understand its implications.

1.5.1 Renewable energy goods selected for analysis

Products closely associated with specific RE supply sectors, e.g., solar PV, wind, hydro and biomass, are classified under 11 different HS subheadings. The trend analysis for the wind sector is based on trade in wind-powered generating sets (HS850231). The list also includes solar water heaters (SWHs), although they do not produce energy. Two HS subheadings (HS 730820 and HS 841919) have been excluded from the trade-flow analysis because of data issues; they are included only in the tariff analysis.

In addition, 9 HS subdivisions provide for "cross-cutting" technologies, mostly intermediate products that are essential for the deployment of one or more RE technologies. For example, AC generators are essential in various RE technologies. These HS codes largely provide for multiple-use products that also have applications in other areas that are unrelated to the deployment of RE technologies. These HS subheadings have been included only in the tariff analysis and have been excluded from the trade analysis.

1.5.2 Classification of environmental goods

Whereas there is no agreed definition of what is covered by the environmental goods sector, a number of lists of environmental goods have been developed for analytical purposes and in trade liberalisation initiatives. In particular, the Asia-Pacific Economic Cooperation (APEC) group developed a list of environmental goods for tariff liberalization purposes (communicated to the WTO in 1999), as one of 15 sectors for early voluntary sectoral liberalisation (EVSL) by APEC economies. Similarly, the Organisation for Economic Co-operation and Development (OECD) developed an illustrative rather than exhaustive list particularly for use in analysing levels of tariff protection. According to OECD's working definition, the environmental goods and services industry "consists of activities which produce goods and services to measure, prevent, limit, minimise or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco-systems. This includes cleaner technologies, products and services that reduce environmental risk and minimise pollution and resource use" (OECD, 1999). Lists of environmental goods have also been debated in the context of WTO trade negotiations on environmental goods and services in the Doha Round[14] and a more recent APEC initiative (see chapter 5).

Environmental goods are not defined as a sector in the HS nomenclature.[15] Rather, environmental goods have been classified,on a product-specific basis under a large range of HS subdivisions (which in most cases also include non-environmental goods). Combining the APEC and OECD lists, Steenblik (2005) introduced the "APEC+OECD" list of environmental goods which classifies environmental goods under 200 unique HS subheadings.

This paper does not seek to define a list of RE and other environmental goods in terms of HS subheadings. Instead, it identifies HS subheadings that may be used as reasonably-reliable proxies for trade in products associated with the deployment of RE technologies. Particularly relevant in the context of this paper is a study mapping technologies and associated goods in RE supply carried out for ICTSD by the Energy Research Centre of the Netherlands (ECN) (Lako, 2008); in a follow-up study, the RE supply products identified were classified under 85 different HS codes (Wind, 2008).

1.5.3 HS subheadings and their limitations in assessing trade in environmental goods

A trade flow analysis based on COMTRADE has many advantages, in particular its almost global coverage of trade statistics with uniformly defined time series (i.e. calendar years) and common classification criteria. Practically all countries use HS to classify traded products

BOX 6 SOLAR WATER HEATERS

Solar water heating (SWH) is one of the simplest and least expensive ways to harness RE. SWH systems are often built in developing countries. The value of international trade in SWHs is modest as it accounts for only a small (and uncertain) portion of trade under the provisions of HS 841919 (Non-electric water heaters), which represented around US$1 billion of annual trade in the period 2010-2012.

COMTRADE data show Mexico as the largest exporter in HS subheading 841919 with almost all exports going to the US market. However, US import data reveal that SWHs accounted for less than one per cent of total imports from Mexico in the subheading. The United States is the world's largest importer in the subheading, but SWHs accounted for only 7.5 per cent of its total imports in the period 2010-2012. These data show that using HS 841919 as a proxy for trade in SWHs easily leads to erroneous conclusions. The SWH sector has therefore been excluded from the global trade analysis in this paper.

Some characteristics of South-South trade can nevertheless be highlighted. China is by a considerable margin the largest global SWH market and SWH manufacturing and exporting country. As of 2010, China has a separate tariff line for SWHs (84191910) that shows that SWHs accounted for 96 per cent of China's total South-South exports in HS 841919 in the period 2010-2012 (two thirds of China's global exports of SWHs, in value terms, went to developing country markets). Chinese exports account for the lion's share of South-South SWH trade.

Contrary to South-South trade patterns in some other RE products (which are mostly dominated by intra-regional Asian trade), China's SWH exports are far more evenly distributed among developing regions with Asia, Latin America and Africa each receiving around one third of China's SWH exports (see Annex 17). In addition to the largest single-country export markets, e.g., China, India, Mexico and South Africa exported SWHs to many other countries in each region, principally Korea and Turkey (in Asia), Kenya, Mauritius and Tunisia (in Africa), and Brazil and Chile (in Latin America). Although China is clearly the largest SWH exporter, there are other experiences of intra-regional South-South trade such as exports from Barbados to other Caribbean countries. These exports are worth around only US$ 270,000 annually and represent around one fifth of combined exports from Barbados, China and the United States to the Caribbean. Brazil has exported SWHs to Argentina, but exports have been declining in value terms.

Some developing countries are implementing trade policy measures, such as high import duties, to support the development of SWH markets and domestic manufacturing. HS 841919 has the highest tariff rate among 20 RE-related HS subheadings in 90 selected developing countries (see Figure 16). Around 30 developing countries now have specific national tariff lines for SWHs, including Jordan, Mauritius and many Caribbean countries (the Common External Tariff of the Caribbean Community also includes specific tariff lines).

and report trade statistics. HS is also widely used in trade negotiations.

However, for reasons described in the preceding paragraphs, a trade flow analysis of trade in RE products based on HS subheadings also has important limitations. In most cases, HS subheadings are too broad to unambiguously or predominantly cover RE products. In such cases, trade in unrelated products is included, which may considerably affect the analysis of trade in RE products and lead to erroneous conclusions.

This concerns in particular trade in solar PV cells and modules – the most heavily traded RE category considered here – that are classified as part of HS subheading 854140.[16] Unfortunately, this subheading also includes other photosensitive semiconductor devices and light-emitting diodes (LEDs) which are unrelated to

trade in solar PV. Since global trade statistics are available only at the level of HS subheadings, it is unavoidable to use HS 854140 as a proxy for trade in solar PV cells and modules despite its inclusion of unrelated products. In all, only nine HS subheadings were identified for the systematic analysis of trends in trade in RE products. A larger number of HS subheadings were included in the analysis of import tariffs.[17]

1.5.4 Using national tariff lines for analysing trade

The paper extensively analyses available national tariff line-level trade information on specific RE products, such as solar cells, even though only a limited number of countries have designated RE-specific tariff lines in their national (or regional) tariff schedule. This analysis has two objectives. First, it provides useful insights that can be taken into account in the selection of HS subheadings to be used as proxies for a global trade analysis (and in the interpretation of the results of such analysis).[18] Second, it allows for a more accurate and transparent analysis of trade in specific RE products, even though the analysis is based only on trade flows (imports and exports) reported by a limited number of countries. In some cases, information on exports of key countries is used as mirror statistics for imports by trading partners that do not themselves report trade on the same product.[19]

Solar water heaters in Tunisia. Photo: EricGoldhagen

2 Global and South-South trade flows in environmental and manufactured goods

In order to put trade trends in RE products into perspective, this chapter analyses some characteristics of South-South trade in manufactured products, which include RE goods and other environmental goods. The chapter therefore allows a perspective of the wider trends that may be influencing RE trade.

As the data in Table 1 make clear, there are two important general trends relevant to South-South trade in environmental goods. First, with the growing economic importance of developing countries, South-South trade relations have increased. Between 2004 and 2011, South-South trade in manufactured products increased faster (15.9 per cent per year on average)[20] than global trade (excluding intra-EU trade) in manufactured products (9.7 per cent).[21]

Second, developing countries in Asia have played a principal role in South-South trade, especially in manufactured products. For example, exports from developing countries in East and South-East Asia accounted for 81 per cent of South-South trade in manufactured products accumulated in the period 2008-2012. China alone accounted for 37 per cent (see Table 1 and Annex 5 for more details). Asian developing countries also played a dominant role as destination markets for South-South exports, although less than as exporters (see Table 1; for more details please see Tables 21 and 22).

The same scenario can be observed in South-South trade in goods associated with the RE sectors defined in the study, e.g., solar PV energy, wind energy, hydropower (see Box 9) and biomass.[22] First, South-South trade in these products grew faster than global trade (excluding intra-EU trade) in the same sectors (Table 1). Second, Asian developing countries dominated South-South trade, both as exporters and importers (see Figure 5). Only in the case of wind-powered generators did another region, Latin America, dominate developing country imports from other developing countries with nearly half (49 per cent) of the total. However, these imports originated mostly from China and India (see Table 7) – intra-regional trade accounted for only 11 per cent of Latin American imports.

Third, global trade in the HS subheadings used as proxies for trade in goods associated with the deployment of technologies in each of the selected RE sectors has increased faster than trade in total manufactured goods. In all these cases, developing countries' shares in global exports have increased.

As an example of trade in equipment associated with more traditional segments of the environmental goods and services industry, Table 1 shows global and South-South trade in water-filtering or purifying machinery and apparatus (HS 842121) (see also Box 7). In addition, 20 HS subheadings were selected for analysis (see Annex 2) whose environmental uses were relatively easier to identify, although many of the HS-codes may also include goods with non-environmental end-uses.[23] In both cases, growth rates for global and South-South trade were slightly higher than for manufactured products in general. The same indicators were estimated for (i) total merchandise trade, and (ii) a large group of 132 selected HS subheadings.[24] As shown, trade in these 132 subheadings also increased faster than for manufactured products as a whole, but not as fast as in RE goods.[25]

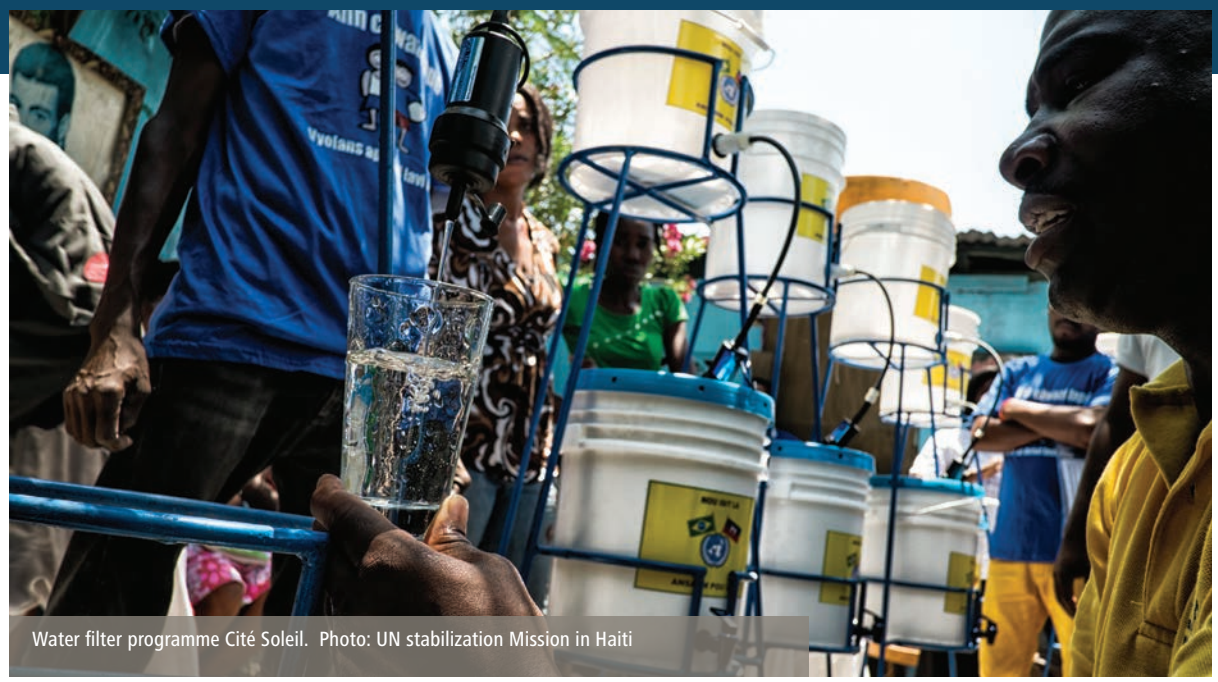
BOX 7 WATER FILTERING AND PURIFYING MACHINERY

The global water-treatment equipment and water supply market is valued at nearly US$ 50 billion. According to the Freedonia Group (an international business research company), it is set to reach US$ 65 billion by 2015 (David and Torsekar, 2012). Several factors contribute to growing demand for such technologies, including (a) industrialisation, urbanisation and population growth; (b) increasing demand and low supply of water in many locations; and (c) greater stringency of water and wastewater related regulations, particularly in developing countries. For instance, China's 12th Five Year Plan mandates more extensive wastewater treatment and lower-levels of pollution.

Improved access to clean water and more effective treatment of wastewater not only makes sense from an environmental point of view, but also has beneficial impacts on health, productivity and the overall quality of life. Greater access to clean water and improved waste water treatment also contributes further to the fulfilment of the Millennium Development Goals, of which Goal 7A calls for halving, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation. While the world as a whole has met this target five years ahead of schedule, certain regions continue to face challenges. In 2011, 768 million people remain without access to improved drinking water, of which 40 per cent live in Sub-Saharan Africa and 2.5 billion people still lack access to improved sanitation facilities.

Increased demand also generates international trade. Technologies used in this sector are diverse and range from highly sophisticated equipment (based on ultraviolet and ozone disinfection) to simple household residential filtration systems. Given that a large number of products used in water treatment systems such as pipes and pumps may have multiple end-uses, the trade analysis presented focuses on one case example where the end-use is much clearer, i.e. water-filtering or purifying machinery and apparatus (HS 842121). The United States, Japan and the EU are dominant exporters (Annex 14), but developing country exports and South-South trade have increased must faster than global exports, excluding intra-EU trade (Annex 15).

Global demand for water-filtering or purification equipment generated imports worth around US$ 5 billion (excluding intra-EU trade) in the period 2010-2012 (Annex 30). The top importers were primarily OECD economies, in particular the United States and the EU. China was the largest developing country importer, followed by Mexico, Saudi Arabia and Algeria (Annex 30). Developing countries accounted for 45 per cent of global imports (excluding intra-EU trade) and South-South trade for 15 per cent . Interestingly, African developing countries are relatively important importers, accounting for nine per cent of global imports and 19 per cent of total developing country imports. As shown in Table 1 and Annex 31, in the period 2004-11, South-South trade increased much faster than global trade (excluding intra-EU trade).



Water filter programme Cité Soleil. Photo: UN stabilization Mission in Haiti

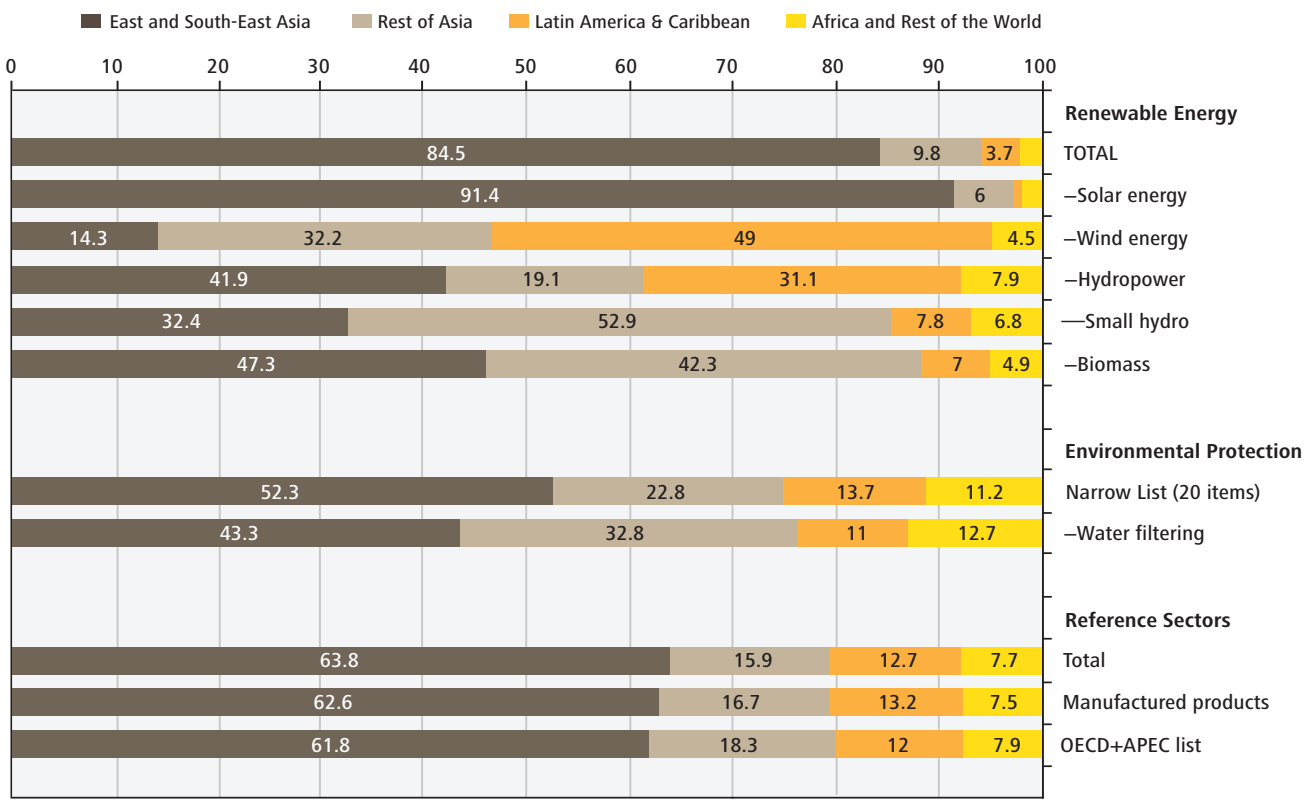
TABLE 1 SOUTH-SOUTH TRADE, TRENDS (2004-2011) AND REGIONAL DISTRIBUTION (2008-2012)

CATEGORY AND SECTOR	CAGR IN THE PERIOD 2004-2011 ((SUM OF EXPORTS AND IMPORTS) (%)		PARTICIPATION IN SOUTH-SOUTH EXPORTS, ACCUMULATED IN THE PERIOD 2008-2012 (%)		SOUTH-SOUTH EXPORTS BROKEN DOWN BY MARKETS OF DESTINATION (DEVELOPING REGIONS) 2008-2012 (%)		
	Global trade (excluding intra-EU trade)	South-South trade	East and South-East Asia	China	Developing Asia	Latin America & Caribbean	Africa
Renewable energy (RE) products							
Total*	26.7	29.4	96.6	34.8	94.2	3.7	2.0
–Solar*	27.4	28.6	99.2	30.4	97.4	1.1	1.5
–Wind energy	29.1	73.5	59.2	47.3	46.5	49.0	4.5
–Hydropower	19.7	42.8	71.5	66.8	61.0	31.1	7.5
––Small hydro	24.5	44.4	87.2	84.3	85.3	7.8	6.5
–Biomass	17.2	33.2	89.7	62.9	88.1	7.0	4.7
Environmental-protection products							
Narrow list (20 items)	11.6	20.9	78.1	38.3	75.1	13.7	11.0
–Water filtering	11.6	23.1	74.0	26.8	86.9	11.0	12.7
Reference sectors							
Total merchandise trade	11.8	18.3	64.9	26.7	79.7	12.7	7.5
Manufactured products	9.7	15.9	80.8	36.9	79.2	13.2	7.4
Selected subheadings of the OECD+APEC list**	11.4	19.3	84.3	35.9	80.8	12.0	7.7

Source: UN Comtrade data, using WITS (6 February 2014)

*HS 854140, e.g., including trade in solar cells and modules, other photosensitive semiconductor devices and LEDs.
**A total of 132 six-digit subheadings relevant for different categories of environmental protection products of the combined APEC+ OECD list (Steenblik, 2005) excluding (a) subheadings selected as proxies for trade in RE products (b) mineral products; and (c) subheadings that were significantly affected by the 2007 Revision of the HS. This list can provide only a preliminary (and unreliable) indication of South-South trade in environmental goods because environmental goods often account for only a small portion of all trade in these subheadings.

FIGURE 5 SOUTH-SOUTH EXPORTS BROKEN DOWN BY MARKETS OF DESTINATION (DEVELOPING REGIONS)



Source: UN Comtrade data, using WITS.

Derived from Annex 6; Trade in RE products is based on selected HS subheadings detailed in Annex 1 and includes some non-related goods and excludes some related goods.

3 South-South trade flows in renewable energy goods

This chapter analyses trends in developing countries' trade in RE products during the period 2004-2011, based on COMTRADE (including HS 854140 as a proxy for trade in solar PV cells and modules). While HS 854140 trade flows greatly outweigh the flows of other RE goods, thereby dominating the trends, the data on the four RE sectors analysed here – solar PV, wind, hydro and biomass – nevertheless clearly show the growth of developing countries' global trade in RE goods, in particular exports of solar PV cells and modules to developed country markets. In general, developing country exports (Table 3) grew faster than their imports (Table 2). Whereas growth in developing country exports exceeded growth in global exports, growth in their imports lagged global growth.

However, using HS 854140 as a proxy to measure South-South trade in solar PV cells and modules is more challenging than in the case of global developing country solar PV exports (see Box 8). This chapter provides some additional insights into the size and direction of key South-South solar PV trade flows based on solar PV-specific trade information for four key Asian developing country exporters, covering the period 2009-2012.

3.1 Developing countries' global trade in renewable energy goods

Trends in developing country trade in RE products in the period 2004-2011, including South-South trade, are shown in Tables 2 (imports) and 3 (exports).[26] Because trade in HS 854140 accounted for around 85 per cent of total trade in RE products selected in this paper, this subheading weighs heavily in this analysis. Globally, the data show three clear trends for trade in RE products.

First, the share of developing countries in global exports (excluding intra-EU trade) of RE goods more than doubled, from 32 per cent in 2004 to 75 per cent in 2011, in all RE sectors considered (solar, wind, hydro and biomass). As shown in Figure 6, the share of China alone increased strongly from only 6 per cent in 2004 to 46 per cent (38 per cent in 2012); the share of developing countries other than China also increased, but only moderately, from 26 per cent in 2004 to 29 per cent in 2011 (32 per cent in 2012).

Second, focusing on solar PV cells and modules (including unrelated products) as the driving force of the group, there was a shift in trade directionality. There was a rapid increase of developing country exports (especially from Asia) to developed economies. This trend was largely driven by developed country incentives for solar power and lower manufacturing costs in developing countries (see Vossenaar, 2010; USITC, 2013). As a result, the South-North directionality of trade in solar PV cells and modules increased as a share of global trade, whereas the shares of North-South and North-North trade declined significantly (Figure 7).[27]

Third, as shown in Figure 8, developing countries as a group turned what was a trade deficit in selected RE goods into a large and growing trade surplus after 2007. This trend was driven entirely by trade in solar PV cells and panels. In the case of other RE products, the value of their imports continued to be larger than the value of exports (see Figure 9).

3.2 South-South trade flows in renewable energy goods

COMTRADE data show that South-South trade in RE products, including photosensitive semiconductor devices

TABLE 2 IMPORTS OF RENEWABLE ENERGY (RE) PRODUCTS BY SUBSECTOR, 2004-2012

SECTOR	2004	2005	2006	2007	2008	2009	2010	2011	2012	CAGR 2004/11 (%)
Global imports (including intra-EU trade), in US$ millions										
RE products*	13 242	16 241	21 013	27 330	41 235	39 027	63 686	68 070	54 399	26
Solar *	11 363	13 569	16 665	21 230	33 209	30 874	56 761	60 171	46 477	27
Wind	588	1 064	2 427	3 579	4 751	4 601	3 452	3 879	3 770	31
Hydro	465	597	762	873	1 109	1 336	1 381	1 625	1 329	20
–Small hydro	46	43	166	111	111	163	166	254	217	28
Biomass	826	1 011	1 159	1 648	2 165	2 216	2 091	2 395	2 824	16
Developing country imports, in US$ millions										
RE products*	6 641	7 740	9 398	11 356	14 064	14 277	20 276	23 597	22 593	20
Solar *	5 762	6 485	7 611	8 989	11 080	10 784	17 157	19 977	19 202	19
Wind	168	324	627	761	948	1 418	1 127	1 412	1 273	36
Hydro	323	397	565	625	806	935	961	1 168	856	20
–Small hydro	31	26	145	91	77	119	119	192	143	30
Biomass	388	533	595	982	1 230	1 140	1 030	1 039	1 262	15
South-South trade, in US$ millions										
RE products*	2 492	3 137	4 106	5 269	7 163	7 687	12 457	14 357	13 880	28
Solar *	2 341	2 904	3 775	4 737	6 082	6 256	11 163	13 095	12 519	28
Wind	2	4	14	47	238	388	228	213	278	101
Hydro	54	107	157	205	347	495	479	500	429	38
–Small hydro	5	10	26	34	29	44	30	73	51	73
Biomass	95	122	160	280	496	548	586	543	654	28
Developing country imports as a share of global imports (%)										
RE products*	50.2	47.7	44.7	41.6	34.1	36.5	31.8	34.6	40.8	
Solar*	50.7	47.8	45.7	42.4	33.4	34.9	30.2	33.2	42.1	
Wind	28.6	30.5	25.8	21.3	20.0	30.6	32.7	36.1	33.7	
Hydro	69.5	66.5	74.1	71.6	72.7	70.0	69.6	70.7	60.2	
Biomass	47.0	52.7	51.3	59.6	56.9	51.4	49.2	43.3	39.1	
South-South trade as a share of global trade (%)										
RE products*	18.8	19.3	19.5	19.3	17.4	19.7	19.6	21.2	25.0	
Solar*	20.6	21.4	22.7	22.3	18.3	20.3	19.7	21.8	26.6	
Wind	0.3	0.4	0.6	1.3	5.0	8.4	6.6	5.7	7.3	
Hydro	11.6	17.9	20.6	23.5	31.3	37.1	34.8	33.0	29.5	
Biomass	11.5	12.1	13.8	17.0	22.9	24.7	28.0	23.0	19.1	
Share of developing country imports originating in other developing countries (%)										
RE products*	37.5	40.5	43.7	46.4	50.9	53.8	61.4	60.8	61.4	
Solar*	40.6	44.8	49.6	52.7	54.9	58.0	65.1	65.5	65.2	
Wind	1.0	1.2	2.2	6.2	25.1	27.4	20.2	15.0	21.8	
Hydro	16.7	27.0	27.8	32.8	43.1	52.9	50.0	45.9	48.9	
Biomass	24.6	22.9	27.0	28.5	40.3	48.1	56.9	52.3	51.8	

Source: UN Comtrade data, using WITS (6 February 2014).

* Including other photosensitive semiconductor devices and light-emitting diodes.

and LEDs, has been largely growing. South-South imports as a share of global developing country imports increased significantly from 37.5 per cent in 2004 to 60.8 per cent in 2011. With regard to exports, in the case of wind-powered generating sets, hydroelectric turbines and products used in the generation of energy and heat from biomass, developing countries were exporting a growing portion of their total exports to other developing countries. In recent years, the share of South-South trade in developing countries' trade in HS 854140 is increasing (see Tables 2 and 3).

So far, however, South-South trade in RE products has been largely confined to East and South-East Asian developing countries. As previously shown in Table 1, developing countries in East and South-East Asia accounted for 97 per cent of total South-South exports in the period 2008-2012, whereas all Asian developing countries accounted for 84 per cent of total South-South imports. In solar PV cells, including other photosensitive semiconductor devices and LEDs, these numbers are even more dramatic: 99 per cent of exports and 97 per cent of imports, respectively (based on PV-specific export data for key Asian developing countries, it is estimated that 93 per cent of these exports had developing Asia as market of destination; see Table 6). Intra-regional trade in RE goods in other developing regions is still in its infancy as export values and import demand have in most cases been small. As mentioned previously, the clear outlier is Latin America's high import demand for wind-powered generating sets in recent years. A key question deriving from this analysis is how to unlock the potential for greater South-South trade in other regions.

While South-South trade in wind-powered generating sets makes up only around six per cent of global trade in that category in the period 2009-2012, South-South trade in the HS subheadings selected as proxies for trade in products associated with biomass-based energy generation and hydropower make up 45 per cent of such global trade (see Figure 10). Overall South-South trade (measured at the level of HS subheadings) in RE products made up more than a quarter of all global trade in RE in 2012 (around one fifth in the period 2009-2012).

3.3 South-South trade in solar PV cells and modules

This section provides some insights into the size and direction of key South-South solar PV trade flows, based on PV-specific trade information for four key Asian developing country exporters, covering the period 2009-2012, e.g., China, Chinese Taipei, India and Thailand (see Table 5). Since only two of these countries (Chinese Taipei and India) cover the period 2004-2011, it is not possible to use this information to analyse this longer period.

Using HS 854140 does not put into question the extraordinary growth of developing countries' global exports of solar goods. In fact, it may underestimate growth rates, as in the case of US imports.[28] This is because solar PV cells and modules, account for a large and growing share of all imports under HS 854140 into developed country markets.[29] For example, whereas solar PV cells and modules accounted for a large share of global HS 854140 exports of China and Chinese Taipei, they represented a much smaller portion of China's exports to other developing countries, as shown in Table 4. Thus, whereas HS 854140 may be considered as a reasonably reliable for developing countries global trade in solar PV, it is a weaker proxy for South-South trade.[30]

Table 5 shows the values of solar PV imports and exports of selected developing countries that have designated tariff lines in their tariff schedules for the period 2009-2012 (covering both South-South and global trade). These figures indicate relatively high portions of South-South solar PV trade in developing country solar PV imports, which would indicate that further growth in developing country imports may be largely met by South-South trade.

Table 6 analyses the breakdown of these countries' PV-specific exports to different developing regions, providing more precision to the information presented in Table 1 for solar PV energy (based on HS 854140).

As shown in Table 6, which is based on Annex 26, Chinese Taipei was the largest exporter to developing country markets in the period 2009-2012. As much

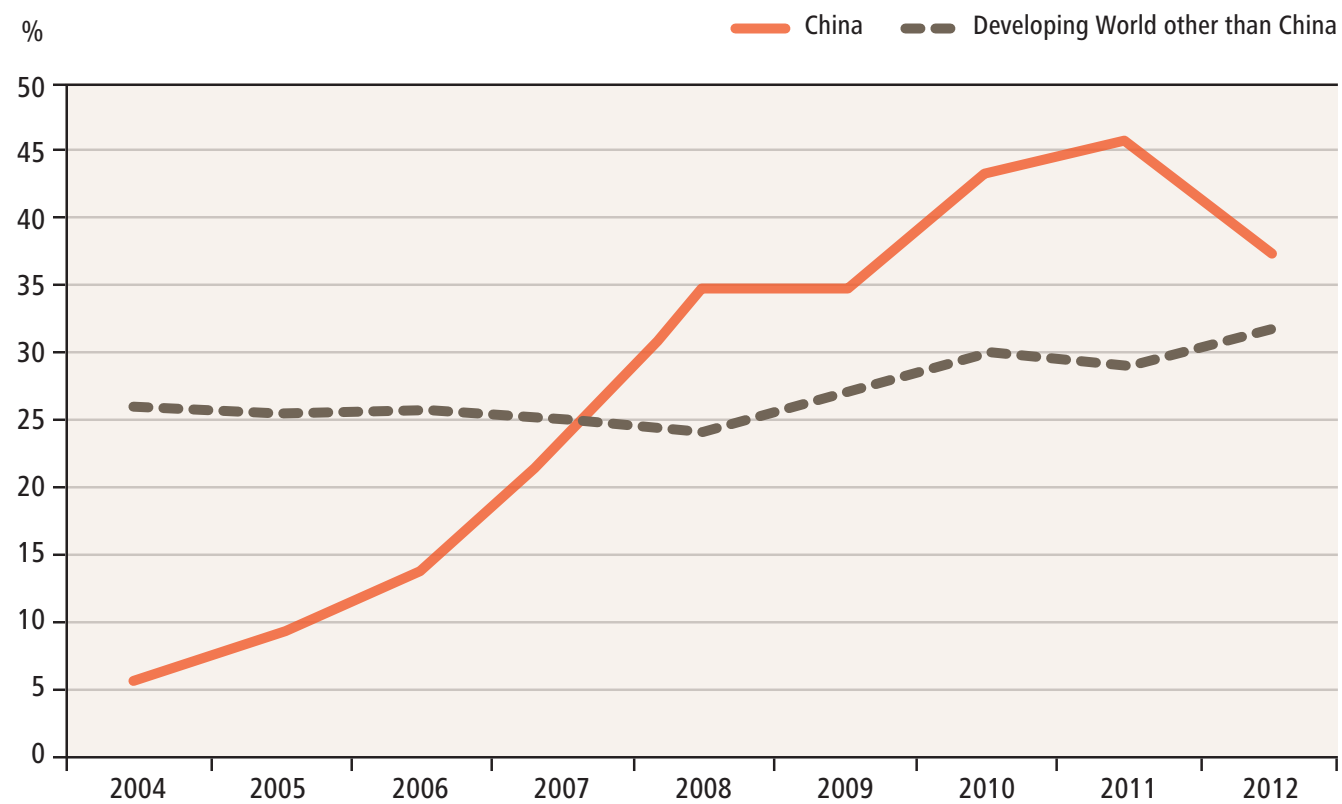
TABLE 3 EXPORTS OF RENEWABLE ENERGY (RE) PRODUCTS BY SUBSECTOR, 2004-2012

SECTOR	2004	2005	2006	2007	2008	2009	2010	2011	2012	CAGR 2004/11 (%)
Global exports (including intra-EU trade), in US$ millions										
RE products*	12 106	14 402	18 992	24 402	36 726	33 992	60 106	64 789	50 345	27
Solar*	10 333	11 751	14 696	19 411	30 486	27 898	54 005	57 793	42 729	28
Wind	561	1 104	2 532	2 803	3 338	2 503	2 488	2 981	3 366	27
Hydro	429	678	780	905	1 150	1 497	1 574	1 526	1 531	20
–Small hydro	44	53	59	60	108	199	133	162	184	20
Biomass	783	869	984	1 282	1 752	2 093	1 990	2 489	2 719	18
Developing country exports, in US$ millions										
RE products*	3 867	5 016	7 512	11 908	21 692	21 040	44 203	48 611	35 226	44
Solar *	3 615	4 629	6 790	10 683	19 455	18 864	42 418	46 156	3 2717	44
Wind	20	66	285	525	1 010	625	295	541	567	60
Hydro	56	130	176	240	441	561	691	694	698	43
–Small hydro	6	7	15	16	35	46	42	71	50	42
Biomass	175	190	260	462	785	990	799	1 219	1 244	32
South-South trade, in US$ millions										
RE products*	2 200	2 623	3 560	4 586	6 503	7 214	11 725	14 108	13 846	30
Solar*	2 040	2 394	3 241	4 051	5 399	5 953	10 431	12 326	11 995	29
Wind	7	4	10	60	239	99	74	179	261	59
Hydro	33	77	137	189	348	462	570	538	573	50
–Small hydro	5	5	12	14	26	34	35	57	36	42
Biomass	121	148	172	287	517	701	649	1 065	1 017	36
Developing country exports as a share of global exports (%)										
RE products*	31.9	34.8	39.7	48.8	59.1	61.9	73.6	75.1	69.9	
Solar*	35.0	39.4	46.2	55.0	63.8	67.6	78.5	79.9	76.5	
Wind	3.6	6.0	11.6	18.7	30.3	25.0	11.9	18.2	16.9	
Hydro	13.1	19.2	22.6	26.5	38.3	37.5	43.9	45.8	45.6	
Biomass	22.3	21.9	26.4	36.1	44.8	47.3	40.1	49.3	45.2	
South-South trade as a share of global trade (%)										
RE products*	18.2	18.2	18.8	18.8	17.7	21.2	19.5	21.8	27.3	
Solar*	19.7	20.4	22.0	20.8	17.7	21.3	19.3	21.3	27.9	
Wind	1.2	0.4	0.4	2.1	7.2	4.0	3.0	6.0	8.0	
Hydro	7.5	11.4	17.6	20.8	30.3	30.8	36.2	35.3	37.4	
Biomass	15.5	17.1	17.5	22.4	29.5	33.5	32.6	42.7	37.0	
Share of developing country exports destined to other developing countries (%)										
RE products*	56.9	52.3	47.4	38.5	30.0	34.3	26.5	29.0	39.3	
Solar*	56.4	51.7	47.7	37.9	27.7	31.6	24.6	26.7	36.7	
Wind	33.1	6.1	3.3	11.4	23.6	15.8	25.2	33.0	46.0	
Hydro	57.7	59.1	78.3	78.8	78.8	82.3	82.5	77.6	82.1	
Biomass	69.0	77.0	66.0	62.2	65.9	70.8	81.4	87.3	81.8	

Source: UN Comtrade, using WITS (6 February 2014).

* Including other photosensitive semiconductor devices and light-emitting diodes

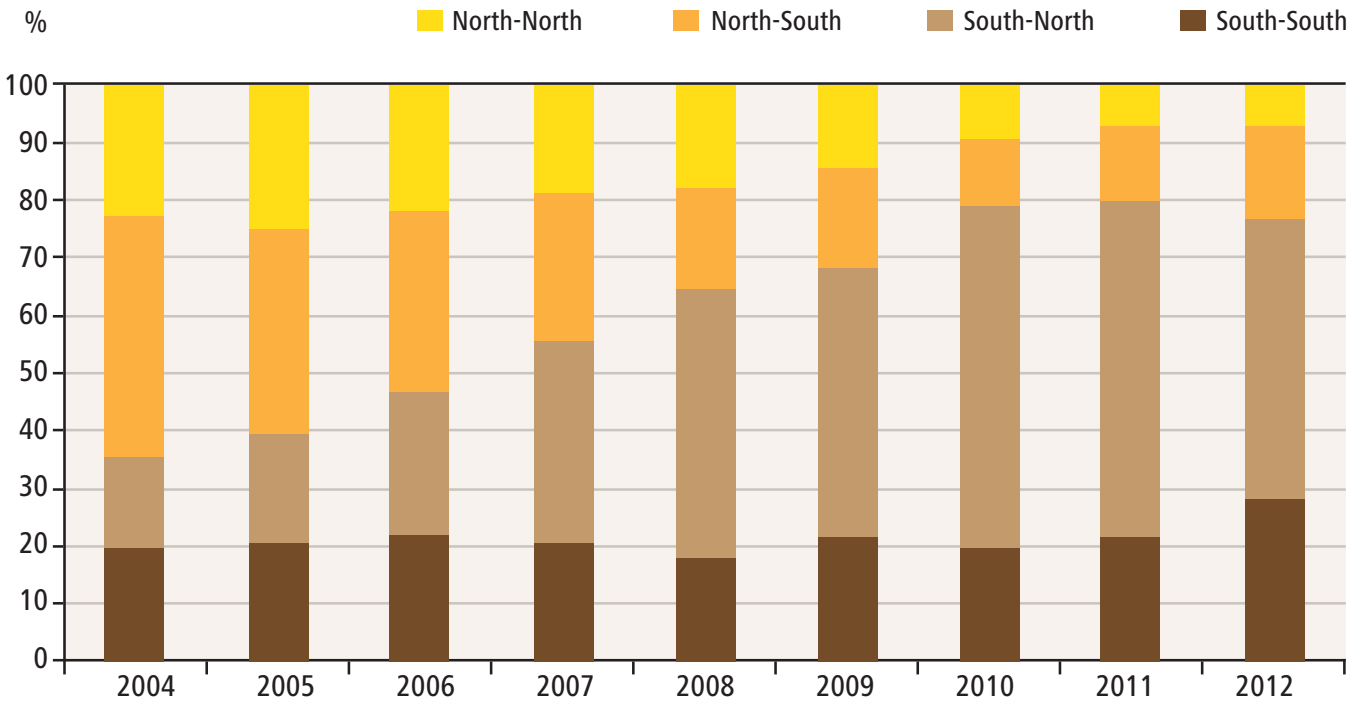
FIGURE 6 PARTICIPATION OF CHINA AND OTHER DEVELOPING COUNTRIES IN GLOBAL EXPORTS OF RE PRODUCTS 2004-2012 (%)



Source: UN Comtrade data (or UN Comtrade Statistics), using WITS

Note: Excludes Derived from Tables 2 and 3. intra-EU trade. Trade in selected HS subheadings detailed in Annex 1, including trade in some non-related goods.

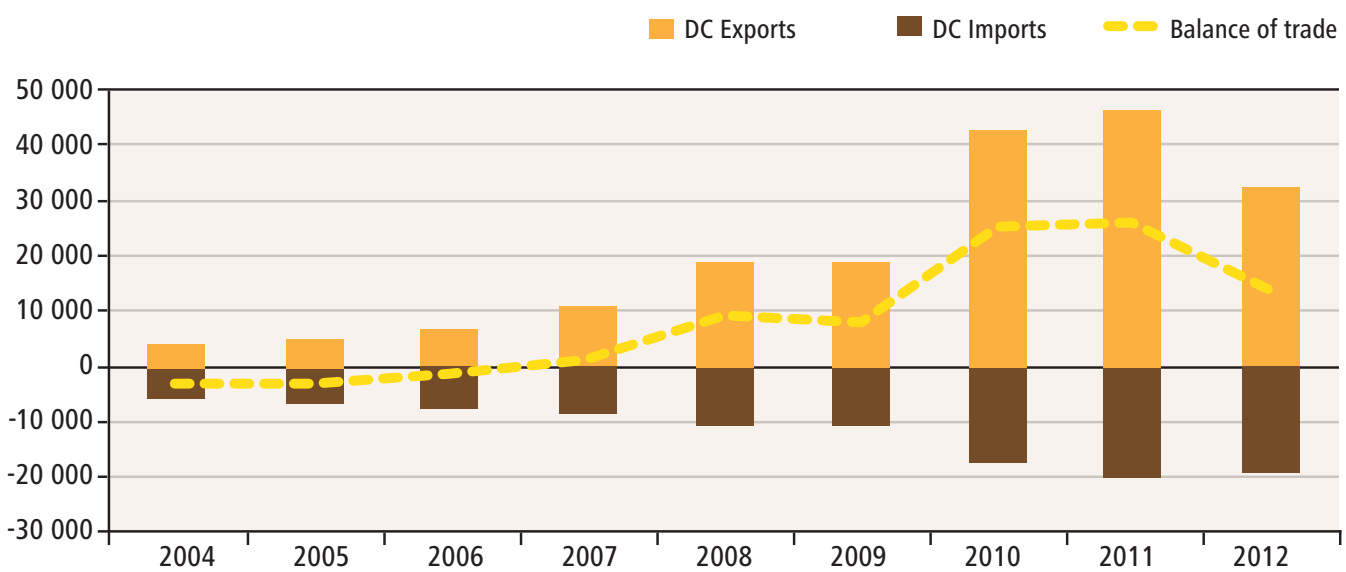
FIGURE 7 DEVELOPED AND DEVELOPING COUNTRIES' SHARES OF TOTAL TRADE IN HS 854140 (INCLUDING SOLAR PV), 2004-2012* (%)



Source: UN Comtrade data, using WITS.

*Excluding rest of the world.

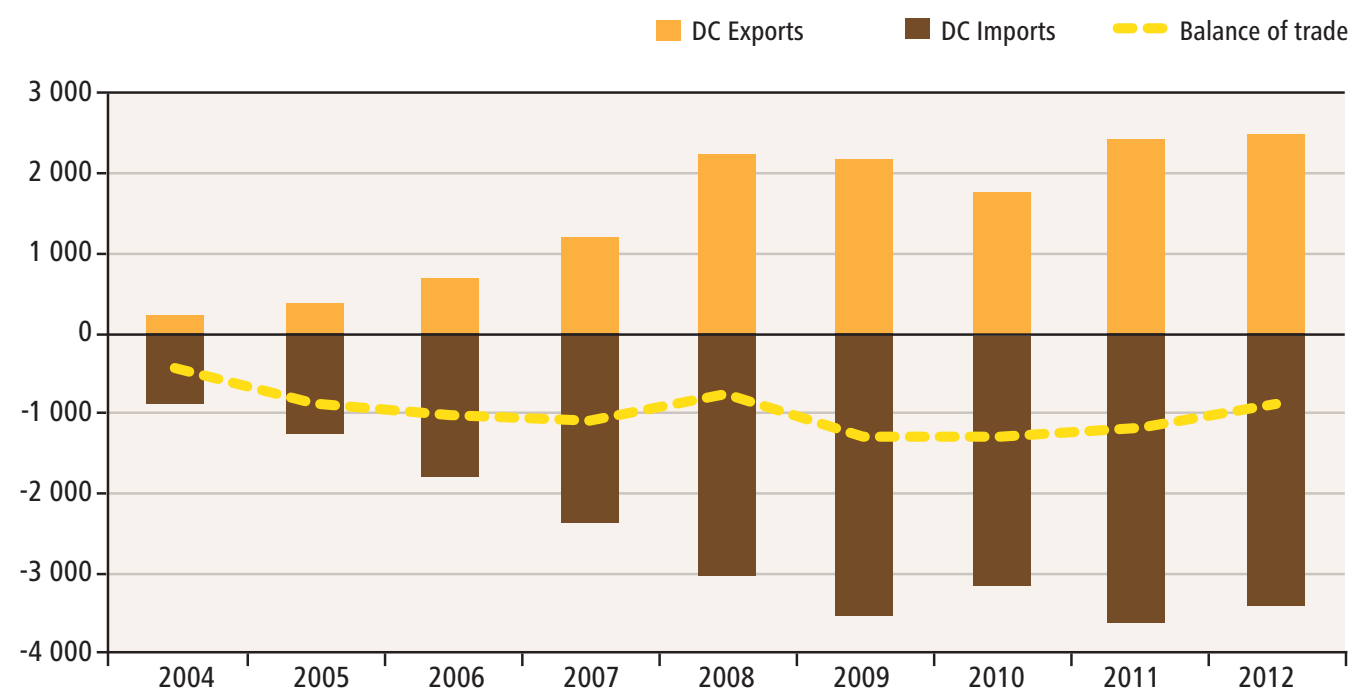
FIGURE 8 DEVELOPING COUNTRIES' BALANCE OF TRADE IN HS 854140 (INCLUDING SOLAR PV)



Source: UN Comtrade data, using WITS.

Note: Derived from Tables 2 and 3. These include some non-related goods and exclude some related goods.

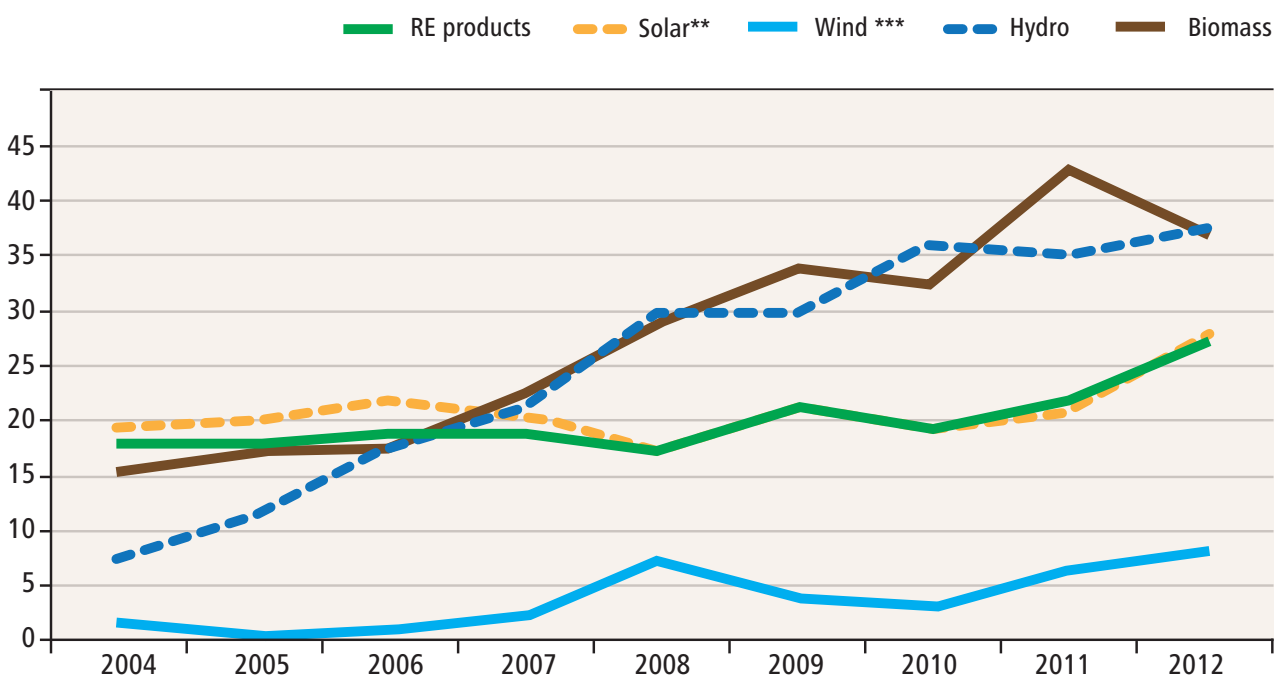
FIGURE 9 DEVELOPING COUNTRIES' BALANCE OF TRADE IN RENEWABLE ENERGY (RE) PRODUCTS, EXCLUDING HS 854140 – WIND, HYDRO AND BIOMASS



Source: UN Comtrade data, using WITS.

Note: Derived from Tables 2 and 3. These include some non-related goods and exclude some related goods.

FIGURE 10 SOUTH-SOUTH TRADE AS A SHARE OF GLOBAL TRADE (%), 2004-2012*



Source: UN Comtrade data, using WITS.

* Excludes intra-EU trade. Derived from Tables 2-3, based on HS subheading selections detailed in Annex 1. See also Section 1.5, Methodology.
**Including other photosensitive semiconductor devices and LEDs.
*** HS 850231, i.e. excluding some wind-related components.

as 86.9 per cent were exports to developing countries in East and South-East Asia, in particular solar cells exported to China (worth US$ 3 billion, part of which may have been incorporated as inputs into Chinese solar PV exports to developed countries) and Korea. Another 11.2 per cent was exported to other Asian developing countries, in particular to India. Interregional solar PV exports to other developing regions (principally to South Africa) accounted for less than two per cent.

China's South-South exports also consisted primarily of intra-regional trade with countries in East and South-East Asia (mostly Hong Kong, China; Korea; Chinese Taipei and Thailand). China's exports to other Asian developing countries accumulated in the period 2009-2012 exceeded US$ one billion (of which US$ 782 million was exported to India). China is the largest exporter to many emerging solar PV markets in other developing countries, including Asia and Africa (China's role in South-South trade in solar PV products is further discussed in section 4.3.4, based on the period 2009-2013).

India is another significant solar PV exporter (although much smaller than China and Chinese Taipei), including to emerging solar PV markets in Asia and Africa. India exported solar PV cells and modules to several African countries, such as Kenya, Nigeria, South Africa, Sierra Leone and Uganda.[31]

With regard to intra-regional trade outside East and South-East Asia, the ITC Trade Map data reveal some PV-product trade among developing countries within a regional context. India, for example, exported small volumes of solar PV cells and modules to Afghanistan and Bangladesh (India also reported exports to the United Arab Emirates). Some very small volumes of regional exports were also reported by South Africa (to Mozambique) and Morocco (to Mauritania and Mali).

3.4 South-South trade flows in wind turbines

South-South trade in wind turbines accounted for US$ 1.3 billion in the period 2008-2012 (US$ 270 million

BOX 8 CLASSIFYING KEY SOLAR PV AND WIND POWER EQUIPMENT IN TRADE STATISTICS

Solar PV equipment

For a global trade analysis it is unavoidable to use HS subheading 854140 as a proxy of trade in solar PV cells and modules. The subheading, however, also provides for trade in unrelated products, e.g., other photosensitive semiconductor devices and LEDs. This has important implications for the trade flow analysis.

Some countries have PV-specific tariff lines (TLs) in their national tariff schedules. These include Argentina, Brazil, China (as from 2009), Chinese Taipei, Colombia, Ghana, India, Japan (imports), Morocco, Peru, Thailand (as from 2007) and the United States. Indonesia and South Africa introduced national tariff lines in their 2012 schedules. The Combined Nomenclature (CN) of the European Communities, the world's largest PV importer, has separate tariff lines for LEDs and other products imported under the provisions of HS 854140. The latter provides for a narrower coverage of solar PV cells and modules, but still includes unrelated photosensitive semiconductor devices. Hong Kong, China also has a separate tariff line for LEDs (which account for a large portion of its total imports of HS 854140).

The analysis of trade under the provisions of PV-specific national tariff lines, using the International Trade Centre's Trade Map, although incomplete, complements the global analysis based on COMTRADE. It confirms one major trend identified on the basis of HS subheading 854140, namely the very fast growth in developed-country imports from developing countries, in particular from China. Indeed, it reveals even faster growth, as PV trade is clearly the most dynamic component of South-North trade under the provisions of HS 854140.

In 2011, solar cells and modules accounted for 77 per cent of US imports from developing countries in subheading HS 854140 in value terms (68 per cent in the case of global US imports in the subheading). At the same time, solar PV cells and modules accounted for 81 per cent of China's global exports under the provisions of HS 854140; in the case of Chinese Taipei, this portion was 56 per cent.

Using the subheading as a proxy for analysing South-South PV trade is more challenging. In 2011, PV cells and modules accounted for "only" 36 per cent, in value terms, of both China's and Chinese Taipei's total exports to other developing countries in HS 854140 (in both cases, LEDs accounted for most exports). On the import side, PV cells and modules accounted for 27 per cent of China's imports in HS 854140 and less than six per cent of Chinese Taipei's imports. On the contrary, PV cells and modules (mostly from China) represented more than 90 per cent of India's imports from other developing countries under the provisions of HS 854140.

In 2012, the above-mentioned portions of trade in PV cells and modules in overall trade in HS 854140 fell considerably, due to a combination of factors such as declines in prices, slower growth in new capacity installations in several countries and, in some cases, the chilling effects of AD (AD) and countervailing duty (CVD) actions. The study's analysis therefore focuses on the period until 2011.

Wind-powered generator sets

HS 850231 (wind-powered generating sets) is one of very few HS subheadings that are specific for RE technologies. Wind-powered generating sets include nacelles and any items imported with the nacelle, such as the blades or hub. If these components are imported or exported separately from the nacelle, they are classified under different HS subheadings (usually together with other, unrelated products). The nacelle is a fibreglass structure that houses the main components of the wind turbine (e.g., the gearbox and the generator). The term wind turbine refers to the tower, blades, rotor hub, nacelle and the components housed in the nacelle. It covers a broader range of products than HS 850231 as it would include components imported under other HS subheadings.

TABLE 4 CHINA: EXPORTS OF SOLAR CELLS AS A PORTION OF TOTAL EXPORTS IN HS 854140, 2009-2012

	EXPORTS TO DEVELOPING COUNTRIES					EXPORTS TO THE WORLD				
	2009	2010	2011	2012	2009-2012	2009	2010	2011	2012	2009-2012
Value of trade, in US$ millions										
HS 854140	2 053	2 713	3 738	3 767	12 270	10 721	25 179	27 946	17 483	81 350
Solar cells	573	766	1 354	952	3 644	6 174	20 198	22 565	12 788	61 725
Other photosensitive semi-conductor devices	496	558	610	634	2 298	3 387	3 404	3 306	2 206	12 303
Light emitting diodes	983	1387	1 771	2 177	6 318	1 161	1 581	2 073	2 508	7 322
Composition of trade (%)										
HS 854140	100	100	100	100	100	100	100	100	100	100
Solar cells	28	28	36	25	30	58	80	81	73	76
Other photosensitive semi-conductor devices	24	21	16	17	19	32	14	12	13	15
Light emitting diodes	48	51	47	58	52	11	6	7	14	9

Source: ITC Data Map.

TABLE 5 SELECTED REPORTERS: TRADE IN PV CELLS AND MODULES, BASED ON NATIONAL TARIFF LINES, 2009-2012

REPORTER	NATIONAL TARIFF LINES FOR SOLAR PV	TRADE WITH DEVELOPING COUNTRIES (SOUTH-SOUTH) (US$ MILLIONS)				TRADE WITH THE WORLD (US$ MILLIONS)			
		2009	2010	2011	2012	2009	2010	2011	2012
Imports									
China	85414020	555.5	1 677.0	1 393.3	874.9	968.0	2 198.9	1 980.1	1 231.8
India	85414011	121.9	173.2	1 034.8	484.8	210.7	240.5	1 410.5	713.9
Thailand	85414090001854140220008 5414021000	5.5	19.8	149.3	172.5	11.3	64.2	352.7	336.6
Taipei, Chinese	854140300048541403006	12.7	38.3	36.0	35.2	42.3	63.5	69.2	64.2
Indonesia	85414021008541402200	n/a	n/a	n/a	3.7	n/a	n/a	n/a	4.2
Ghana	8541400010	0.1	3.2	0.0	26.8	4.5	5.9	0.0	28.3
South Africa	85414010	n/a	n/a	n/a	17.9	n/a	n/a	n/a	23.8
Morocco	8541401000	1.0	0.8	1.0	2.7	3.1	3.0	2.3	10.2
Peru	8541401000	1.5	3.1	6.0	77.2	3.2	3.7	7.0	145.0
Colombia	8541401000	0.9	2.3	3.4	4.8	3.3	4.1	5.6	6.6
Brazil	85414032	1.0	0.9	3.3	4.4	3.3	4.8	7.5	5.5
Argentina	85414032	0.1	0.5	3.4	0.4	0.2	0.5	4.0	0.4
Total		**700.2**	**1 919.1**	**2 630.5**	**1 705.3**	**1 249.9**	**2 589.1**	**3 838.9**	**2 570.5**
Exports									
China	85414020	572.9	765.8	1353.8	951.5	6173.7	20 198.0	22 565.3	12 787.6
Taipei, Chinese	854140300048541403006	827.1	1 591.9	1 566.3	1 017.4	2 223.3	4 725.2	4 090.2	2 530.9
India	85414011	25.7	54.7	24.3	32.6	285.9	505.3	165.3	100.2
Thailand	85414090001854140220008 5414021000	5.9	2.6	4.6	2.9	16.0	11.9	8.1	5.5
Total		**1 431.6**	**2 415.0**	**2 949.0**	**2 004.4**	**8 698.9**	**25 440.4**	**26 828.9**	**15 424.2**

Source: ITC Data Map.

TABLE 6 SELECTED DEVELOPING COUNTRIES: SOUTH-SOUTH EXPORTS OF PV CELLS AND MODULES BY REGION OF DESTINATION, 2009-2012

EXPORTER(S)	DESTINATION OF EXPORTS					
	East and South-East Asia	Other developing Asia	Developing Asia total	Africa	Latin America and the Caribbean	Total developing countries
Value (US$ millions)						
China	2 154.4	1 048.4	3 202.8	339.9	97.8	3 644.0
Chinese Taipei	4 336.8	560.8	4 897.6	79.2	16.2	4 993.1
Thailand	7.6	7.8	15.4	0.9	0.0	16.3
Subtotal East and South-East Asia	6 498.8	1 617.0	8 115.8	420.0	114.0	8 713.0
India	63.9	42.3	106.3	30.3	0.7	137.2
Developing Asia	6 562.7	1 659.4	8 222.1	450.3	114.7	8 850.2
Regional distribution of exports (%)						
China	59.1	28.8	87.9	9.3	2.7	100
Chinese Taipei	86.9	11.2	98.1	1.6	0.3	100
Thailand	46.3	48.2	94.5	5.8	0.0	100
Subtotal East and South-East Asia	74.6	18.6	93.1	4.4	1.3	100
India	46.6	30.9	77.5	22.1	0.5	100
Developing Asia	74.2	18.7	92.9	5.1	1.3	100

Source: based on ITC Trade Map. For year-by-year trade data please see Annex 10.

TABLE 7 WIND-POWERED GENERATING SETS, KEY SOUTH-SOUTH TRADE FLOWS, 2008-2012, HS 850231* (US$ BILLIONS)**

IMPORTING COUNTRY	SOUTH-SOUTH TRADE (IN US$ MILLION)		IMPORTS FROM THE WORLD
	Total South-South imports	Largest developing country suppliers	
Brazil	579.1	India (495.2); China (83.7)	1 380.2
Turkey	159.3	India (75.7); Brazil (38.4); China (33.3); Vietnam (11.9)	1 838.2
Mexico	135.1	Brazil (76.5); China (36.6)	1 236.0
Thailand	119.2	China (115.3)	149.6
Chile	88.5	China (82.9)	269.6
Korea	62.5	China (57.7); India (4.3)	145.8
Sri Lanka	47.8	India (47.7)	47.9
Pakistan	41.0	China (41.0)	41.0
Total	**1 232.5**		**5 060.2**
All developing countries	**1 344.3**		**6 178.6**

Source: UN COMTRADE data, using WITS (9 February 2014).

* Based on import statistics reported to COMTRADE.
**According to the ITC Trade Map, African countries collectively imported US$ 342 million in wind-powered generating sets from other developing countries in the period 2009-13. The largest importers were South Africa (US$ 238 million in 2013), Ethiopia (US$ 19 million in 2011-2012) and Egypt (US$ 14 million in 2009).

per year on average). Key bilateral trade flows (measured by imports) are shown in Table 7.

South-South trade in wind-powered generating sets was relatively small until 2007. In the period 2004-2007, China was the largest developing country importer, with more than 95 per cent of its imports in value terms originating in the EU-27. South-South trade accounted for only 1 per cent of developing country imports in 2004-2007, but this portion increased gradually to 6 per cent in 2007 and then jumped to 25 per cent in 2008 as some other developing countries started importing wind turbines (Annex 28). African countries collectively imported US$ 44.5 million in wind-powered generating sets from other developing countries from 2008 to 2012. The largest importers were Ethiopia (US$ 19 million in 2011-2012) and Egypt (US$ 14 million in 2009).

The prominent position of Chinese companies has been gained largely through domestic sales (Wiser and Bolinger, 2013). However, in 2011 and 2012, Chinese companies became more active in export markets.[32] Direct exports of wind-powered generating sets increased sharply in 2011 and 2012 from a very small base (see Table 8).

TABLE 8 CHINA – EXPORTS FROM OF WIND-POWERED GENERATING EQUIPMENT (HS 850231) TO OTHER DEVELOPING COUNTRIES, 2011-2013 (US$ MILLIONS)

DESTINATION	PERIOD			
	2011	2012	2013	Accumulated In 2009-13
Developing countries	110.7	194.0	309.5	614.2
South Africa	0.2	0.1	100.3	100.6
Ethiopia	20.8	6.1	53.2	80.1
Thailand	0.1	62.3	0.2	62.5
Peru	0.1	0.0	55.8	55.9
Pakistan	16.5	17.7	17.0	51.2
Mexico	0.1	20.2	27.6	47.8
Turkey	0.3	32.9	13.5	46.6
Argentina	40.6	0.4	0.0	41.1
Chile	0.2	17.1	21.0	38.3
India	29.8	0.3	1.0	31.1
Other developing countries	2.2	36.9	19.9	58.9
China's global exports	351.2	466.9	467.6	1 285.7
Portion of global exports going to developing countries (%)	31.5	41.5	66.2	47.8

Source: ITC Trade Map.

BOX 9 HYDROPOWER

Hydroelectricity is the most widely used form of RE. Hydropower is a more mature technology, whose growth has been modest (in the range of 3-4 per cent per year) compared with other RE technologies. Total installed hydropower capacity at the end of 2012 was 990 gigawatts (GW). An estimated 30 GW of new hydropower capacity was installed in 2012, mostly in China, Turkey, Brazil, Vietnam and Russia (REN 21, 2013).

Small hydropower (SHP) systems have relatively small environmental impacts. Most SHP systems do not make use of a dam or major water diversion, but rather use water wheels to generate energy. Other advantages of SHP technologies include their simplicity, long-term reliability, high performance and easy maintenance (Auzãne, 2012). SHPs are often presented as the cheapest technology for rural electrification over the lifetime of the system (Rolland, 2011).

According to one estimate (Altprofits, 2009), cumulative installed small hydro capacity was 50GW in 2008 and expected to increase to 110 GW in 2015 (large hydro capacity was estimated to increase from 800 GW in 2008 to 946 GW in 2015). Asia accounted for more than two thirds of installed SHP capacity, South America for 2.7 per cent and Africa for only 0.5 per cent (Rolland, 2013). China alone has developed more than half of the world's SHP capacity and represents the bulk of installed capacity in developing countries. India also has significant SHP capacity (Rolland 2013), while Sub-Saharan Africa has less installed capacity, but a large untapped potential.

HS heading 8410 (hydraulic turbines), which provides for trade in hydraulic turbines and parts, is relevant for the hydropower sector. International trade in hydraulic turbines is relatively small (around US$1 billion). This paper presents trends in trade in HS 8410 and also for small hydraulic turbines (of a power not exceeding 10 MW). China and the European Union dominate exports of small hydraulic turbines (Annex 32), while Turkey and Vietnam are leading importers.

Micro hydropower plant in Kyrgysztan. Photo: UNDP Europe and Central Asia

4 Recent developments in renewable energy markets

This chapter discusses recent trends in RE markets and, in particular, the two highest-profile RE supply products: solar PV cells and modules and wind-powered generating sets. It is based on both COMTRADE and PV-specific trade data available for key developing country exporters of solar PV cells and modules. The chapter takes into account not only trade trends but related factors, including global capacity additions, value chains, incentives, and trade barriers. The chapter also analyses more recent developments based on available information at the time of writing.

4.1 General market trends

The trends in trade in RE products presented in the previous chapters reflect events in the past, during the period 2004-2011. However, some positive developments observed in the most recent years may provide favourable conditions for enhanced South-South trade; these include falling prices, growth in investment, increasing importance of developing countries, and high potential for regional trade.

4.1.1 Falling prices

As observed in the UNEP GE-TOP Report (2013), one of the most significant developments in the RE sector in recent years has been the decline in the cost of various RE technologies and associated equipment. For example, a major theme of 2012 was a further significant reduction in the costs of solar PV technology. The levelised cost of generating a MWh of electricity from solar PV was around one third lower in 2012 than the 2011 average. This took small-scale residential solar PV power, in particular, much closer to competitiveness (Frankfurt School-UNEP Centre/BNEF, 2013). Falling prices are an important driver of RE investment in developing countries, in particular in countries that do not provide substantive subsidies for RE generation.

4.1.2 Faster growth in RE investment in developing countries

New RE investment in developing countries is already growing faster than investment in developed countries. According to the 2013 UNEP Global Trends In Renewable Energy Investment report:

> *The highlight of 2012 was a further shift in activity from developed, to developing, economies. Total investment in developed economies in 2012 was down 29 per cent at US$ 132 billion while that in developing economies was up 19 per cent at US$ 112 billion, the highest ever (Frankfurt School-UNEP Centre/BNEF, 2013).*[33]

4.1.3 The growing importance of developing economies as drivers of trade in RE products

This can be observed in market developments for key RE sectors. For example, developing countries in 2012 increased solar PV capacity by more than 60 per cent (Annex 7) while new additions in Europe fell. The European Photovoltaic Industry Association (EPIA) predicted that in 2013 most new solar PV capacity would be installed outside of Europe and that future expansion would be driven by China, India, Japan and the United States (EPIA, 2013a). There may also be strong growth in developing countries other than China and India: new capacity more than doubled in these countries in 2012 over 2011, although from a low base (see Annex 7). This

was due to the falling cost of solar PV installations and these countries' increasing implementation of enabling policies for solar PV. Similarly, in the wind power sector, countries such as Brazil and Mexico have dynamic markets.

4.1.4 Untapped potential for intra-regional trade in other developing regions

So far, intra-regional trade in East and South-East Asia has accounted for the lion's share of South-South trade in RE products. However, in the wake of recent price declines (in particular of solar PV), strong growth is expected in new RE installations in other developing regions. In the long run, this will add dynamism to RE markets that may trigger higher intra-regional trade in other developing regions. A recent US International Trade Commission study observed that substantial growth is taking place across many countries in the Latin American region, driven by factors such as declining solar PV equipment prices, rising electricity demand, rising cost competiveness of solar PV-generated electricity, excellent solar resources and government policies (USITC, 2013).[34] In Chile, solar PV-generated electricity is already fully price competitive in several sectors and parts of the country (Deutsche Bank, 2013). In late 2013, Brazil started to include proposals for solar energy projects in its energy auctions.[35] Such auctions have already played an important role in Brazil's sector (see Section 4.4).

4.2 Global installations and investment in solar PV and wind markets

The global market for solar PV and wind power technologies grew from US$ 15.2 billion in 2004 to US$ 163.1 billion in 2011 (Clean Edge, 2013; see also Annex 4). The size of international trade, in value terms, of RE supply goods in these sectors varies widely.[36] Figures for global markets and international trade flows are shown side by side in Table 9, even though these figures are not directly comparable. The former, which are based on Clean Edge estimates, include demand for both domestically-produced and imported equipment as well as services, whereas the latter include only internationally-traded equipment (based on COMTRADE). To help improve the comparability of market and trade figures, some estimates are presented on the equipment-only portions of the solar PV and wind markets, based on additional sources.

For example, in a recent United States International Trade Commission (USITC) study (USITC, 2013), the value of global solar PV services associated with installations was estimated at US$ 34 billion in 2011, or 37 per cent of the broader market (including equipment and services) for solar PV installations (US$ 91.6 billion). Based on these figures, the global equipment market could be around US$ 58 billion. Subtracting from this the value of the global solar PV BoS equipment market (estimated by

TABLE 9 SELECTED RENEWABLE ENERGY (RE) GOODS SECTORS, MARKET SIZE AND TRADE FLOWS IN 2011 (US$ BILLIONS)

SECTOR	MARKET SIZE[a]	HS SUBHEADING	GLOBAL TRADE[b]		DEVELOPING COUNTRIES
			Including intra-EU trade	Excluding extra-EU trade	
Solar PV (2011) (modules, system components, and installation)	91.6 *	HS 854140 **	72	68 (imports) 58 (exports)	20 (imports) 46 (exports)
Wind (2011) Wind (new installation capital costs)	71.5 ***	HS 850231	7.3 (imports) 5.4 (exports)	3.9 (imports) 3.0 (exports)	1.3 (imports) 0.6 (exports)

Sources: [a]Clean Edge, 2013 (see also Annex 4); [b]COMTRADE, using WITS.

* PV module market likely around US$ 41 billion.
** Including other unrelated products (photosensitive semiconductor devices and LEDs).
*** The equipment market might be less than US$ 50 billion.

IMS Research at US$ 17 billion in 2011),[37] the solar PV modules market would amount to around US$ 41 billion. Similarly, USITC estimated the value of services associated with wind installations at nearly US$ 23 billion. Therefore, the equipment market may have accounted for less than US$ 50 billion of the US$ 71.5 billion wind market estimated by Clean Edge. These figures reveal that the trade intensity of the solar PV market is much higher than that of the wind market.[38]

Similarly, trade figures need to be analysed carefully. First, as already stated earlier, the value of trade in subheading HS 854140 is considerably larger than the value of solar PV cells and modules alone. Furthermore, it includes trade in products associated with a considerable part of manufacturing, i.e. both cells and modules (possibly leading to a certain degree of double-counting). In the case of wind power, HS 850231 covers mainly trade in completed wind-powered generating sets and does not include components unless they are imported or exported jointly with the nacelle (see Box 8).

Figures 11 and 12 add context to developments in solar PV and wind power markets, two key sectors in RE goods trade in recent years. First, using HS 854140 as a proxy, Figure 11 shows that global trade growth in solar PV equipment was slower in value terms than growth in installations. This could be attributed to rapidly falling prices for solar PV cells. In addition, trends estimated on the basis of HS 854140 may significantly underestimate growth in its solar PV component, which may be more dynamic than the other products under the subheading.[39]

Second, Figure 12 shows that trade in wind-powered generating sets increased faster than other variables, such as investment[40] in the wind sector until 2008-2009, but more slowly since then. In fact, global trade in wind-powered generating sets fell considerably from 2008 peak levels for several reasons, in particular declining prices after 2008, increased servicing of foreign markets through foreign direct investment (FDI) rather than direct exports and strengthened domestic manufacturing capacities, for example in the US market.

4.3 Solar PV

Chapter 3 highlighted the rapid increase of developed country solar PV imports from developing countries, in particular from East and South-East Asia. It found that South-South trade has been largely dominated by intra-regional trade in East and South-East Asia. This section further analyses developments in key solar PV markets, including solar PV capacity additions, recent trade flows, and prospects for developing countries. Given the importance of solar PV in RE trade flows, special consideration is given to emerging solar markets and the role of China.

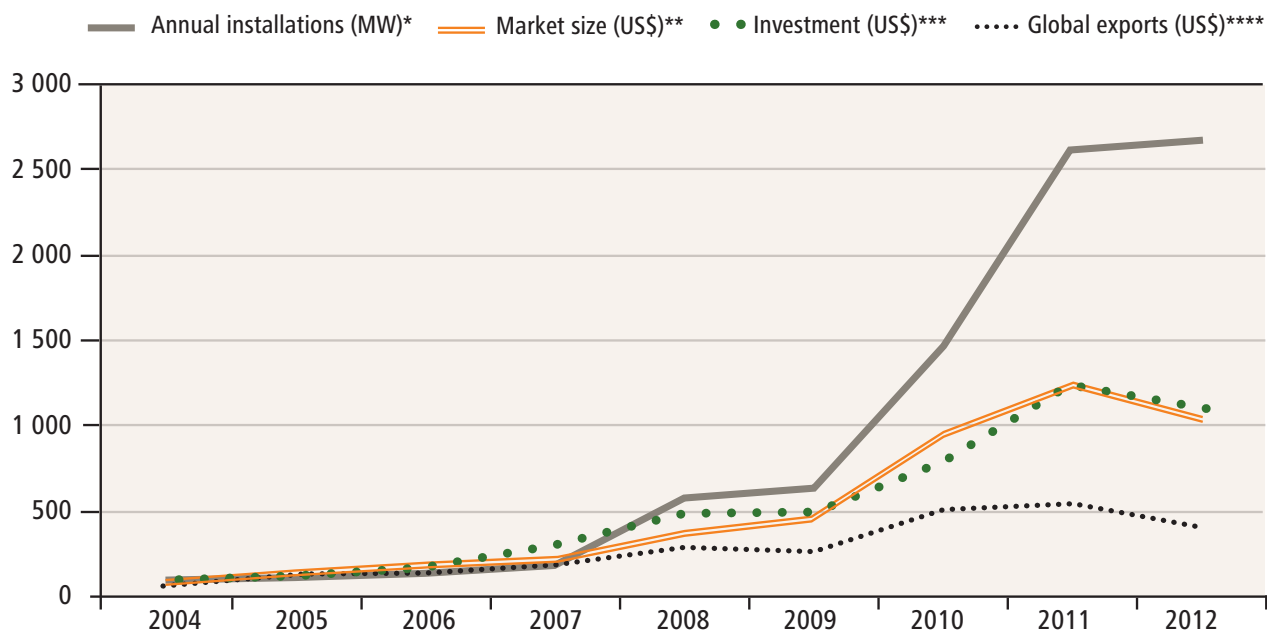
The solar PV value chain can be broken into three segments: upstream (mainly the production of crystalline polysilicon; see Box 10), manufacturing (wafers, cells, modules and other components) and downstream (finished products and related services, including system integration, installation, maintenance and disposal) (Lako, 2008; Wind, 2008). The BoS equipment market mostly includes inverters, solar tracking systems, controllers, solar panel mounting equipment, cables, wiring, storage,and batteries for off-grid systems.

4.3.1 Capacity additions

The relative importance of solar PV markets can be tracked by the volume of new annual capacity additions. Data on annual solar PV capacity additions in key markets (see Annex 7) are based on reports of the IEA Photovoltaic Power Systems Programme (IEA-PVPS)[41] for PVPS reporting countries (IEA-PVPS 2012 and 2013b) and the European Photovoltaic Industry Association (EPIA) for other countries (EPIA 2012a). These reports are mostly based on country-specific data reported by individual countries. In addition, they include some estimates for the 'rest of the world'. IEA-PVPS counts all solar PV installations, both grid-connected and off-grid installations.[42] Data on grid-connected installations are generally more reliable than data on off-grid systems.[43]

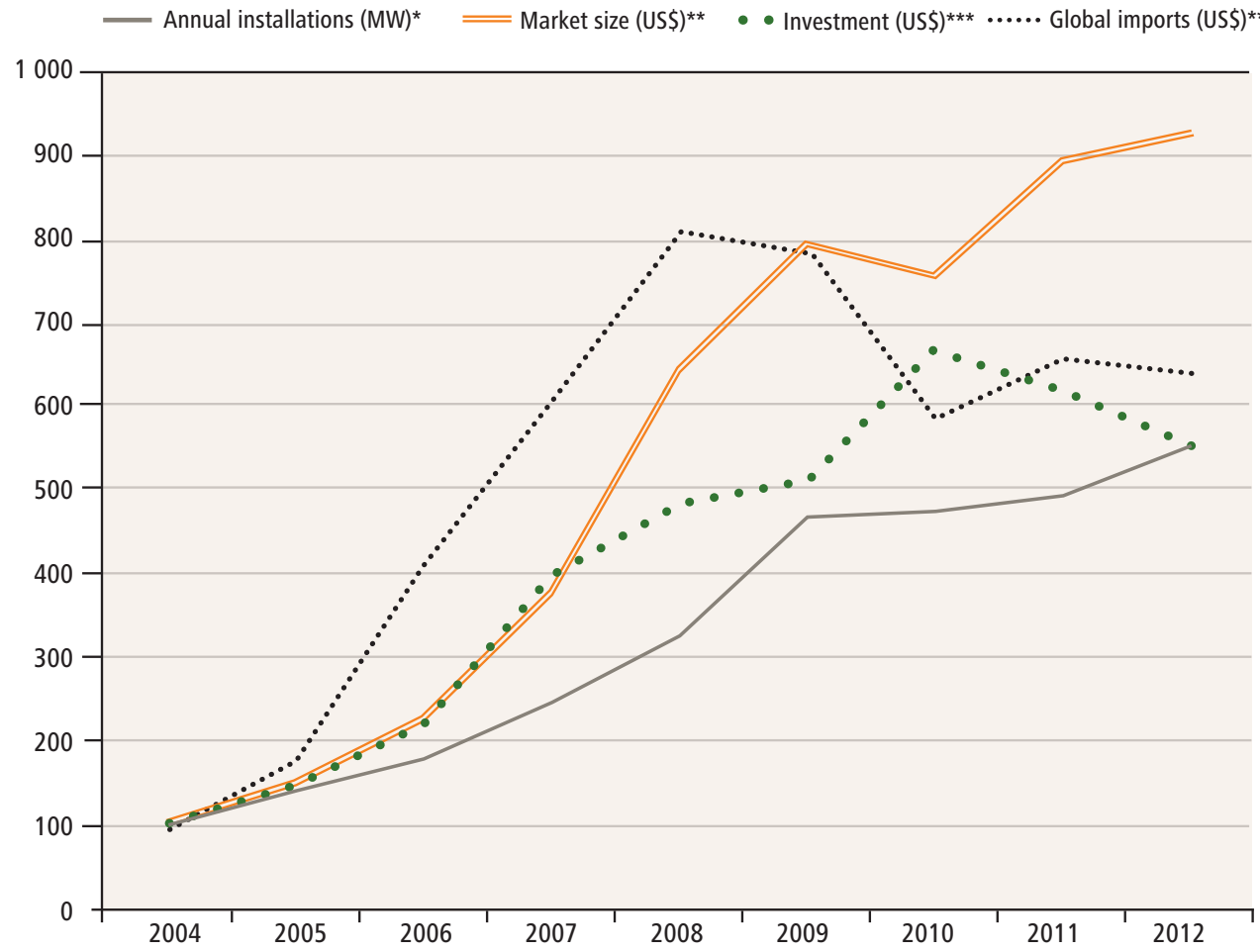
The size of the global solar PV market in 2012 was similar to that of 2011. In 2012, the EU market contracted by 25 per cent (following a large expansion in 2011),[44]

FIGURE 11 TRADE IN PV CELLS AND MODULES, INSTALLATIONS AND INVESTMENT, 2004-2012 (INDEX NUMBERS 2004=100)



Sources: *EPIA (2013); **Clean Edge (2013); ***Frankfurt School-UNEP Centre/BNEF (2013); ****Excluding intra-EU trade (US$) in HS 854140: COMTRADE.

FIGURE 12 TRADE IN WIND-POWERED GENERATING SETS, INSTALLATIONS AND INVESTMENT, 2004-2012 (INDEX NUMBERS 2004=100)



Sources: *Global Wind Energy Council, GWEC (2013); **Clean Edge (2013); ***Frankfurt School-UNEP Centre/BNEF (2013); ****COMTRADE

whereas there was continued strong growth in key non-European markets such as China (40 per cent), India (176 per cent, see Box 11), Japan (33 per cent) and the United States (78 per cent). The markets of other key developing countries (Chinese Taipei, Korea,[47] Malaysia, Mexico and Thailand) collectively increased by 166 per cent. The EU nevertheless still accounted for 55 per cent of the global solar PV market in 2012 (EPIA, 2012a). The share of developing countries in annual capacity additions is still relatively small but increased from less than 5 per cent in 2004 to around 19 per cent in 2012 (see Annex 7). In the period 2010-2012, the developing countries' share in annual capacity additions was 12.3 per cent on average.

Preliminary data indicate that new solar PV capacity installed globally during 2013 was almost a quarter larger than in 2012. Whereas there was a further decline in the Europe, there was strong growth in China, Japan, the United States and several developing country markets other than China (e.g., India, Korea and Thailand). Developing countries collectively accounted for well above one third of new capacity additions in 2013. Many developing countries now have policies in place to encourage solar PV projects. Promising opportunities are reported in developing countries not covered by the IEA-PVPS and EPIA data shown in Annex 7, such as Morocco, Saudi Arabia and the United Arab Emirates (IEA-PVPS, various reports). Such opportunities also include off-grid projects, including countries with large populations that are without regular access to electricity. Thus, solar PV capacity additions could be expected to increase in several developing countries in coming years.

4.3.2 Trade flows in solar PV

4.3.2.1 Global trade in HS 854140 based on COMTRADE

The top 10 importing and exporting economies in HS 854140 are listed in Table 11. At the same time, the majority of these countries belong to the top 10 importers and the top 10 exporters. This can be largely explained by the broad coverage of HS 854140. For example, China is the top exporter of solar PV cells and modules (US$ 22.6 billion in 2011, based on tariff line-level trade data), and is also the third largest importer in HS 854140, largely on account of LEDs (US$ 4.5 billion, based again on tariff line-level data). Even within the solar PV sector, a significant portion of trade may be associated with differences in product specialization as well as different positions in the solar PV value chain. For example, whereas China plays a leading role in the production of silicon cells and modules, thin-film solar PV modules are mainly produced in Germany, Japan, Malaysia and the United States (IEA-PVPS, 2013b).[47]

World trade under HS 854140 increased rapidly in the period 2004-2011. World imports (excluding intra-EU trade) increased 27 per cent per year on average in value terms (Annex 8). As prices have been falling in recent years, the per cent increase in volume is sure to be even larger.[48] Half the increase in world trade from 2004 to 2011, in value terms, was the result of growing EU imports, triggered mostly by large increases in annual solar PV capacity additions in the EU.[49]

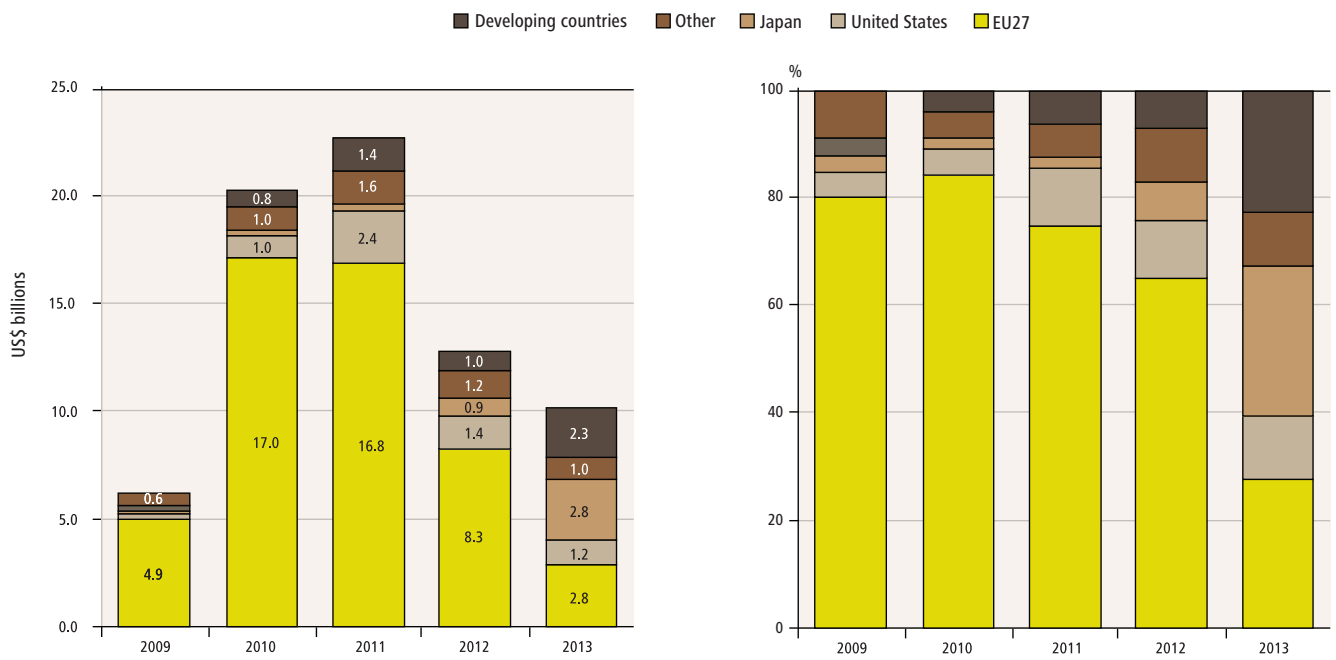
Between 2004 and 2011, world exports (excluding intra-EU trade) in HS 854140 increased by 28 per cent per year on average in value terms, while Chinese exports increased by 71 per cent per year. In 2011, China alone accounted for almost half the value of world exports that increased from only 6 per cent in 2004. Collectively, developing countries accounted for 80 per cent of export value in 2011, increasing from 35 per cent in 2004 with an average 44 per cent annual increase. Developing countries other than China increased their exports in HS 854140 by 30 per cent per year, lifting their share in world exports from 29 per cent in 2004 to 32 per cent in 2011.

In 2012, world exports in HS 854140 (excluding intra-EU trade) fell by 27 per cent in value terms compared with 2011 (Annex 9), largely as a result of falling prices. Exports may nevertheless have fallen less, or even increased in volume terms. For example, according to the 2012 PVPS National Survey Report of solar PV Power Applications in China, Chinese exports of solar PV cells and modules in 2012 fell by 43 per cent in value terms

FIGURE 13 CHINESE EXPORTS OF PV CELLS (NATIONAL TARIFF LINE 85414020) BY MARKET OF DESTINATION

A VALUES (US$ BILLION), 2009-2013

B PORTION OF TOTAL CHINESE EXPORTS BY MARKETS OF DESTINATION (%), 2009-2013



Source: ITC Trade Map.

(see Figure 13), but increased by 12.5 per cent in terms of GW installed to 18 GW, compared with 2011 (IEA-PVPS, 2013c).

4.3.2.2 Trade in solar PV cells and modules based on Chinese national tariff lines

TL-level statistics available in the International Trade Centre (ITC) Trade MAP reveal significant new developments in Chinese exports of solar PV cells and modules during 2012 and 2013. Between 2011 and 2013, exports to the EU fell by 83 per cent equivalent to US$ 2.8 billion, with exports to Italy[50] and Germany[51] falling by 98 and 92 per cent, respectively, in value terms (see Table 12). The value of China's exports to the US market fell by more than 50 per cent as a 42 per cent decline in 2012 was followed by a further 15 per cent decline in 2013, even though the United States added 4.75 GW of new solar PV capacity in 2013 (41% more than it did in 2012 according to the US Solar Energy Industries Association (SEIA)).

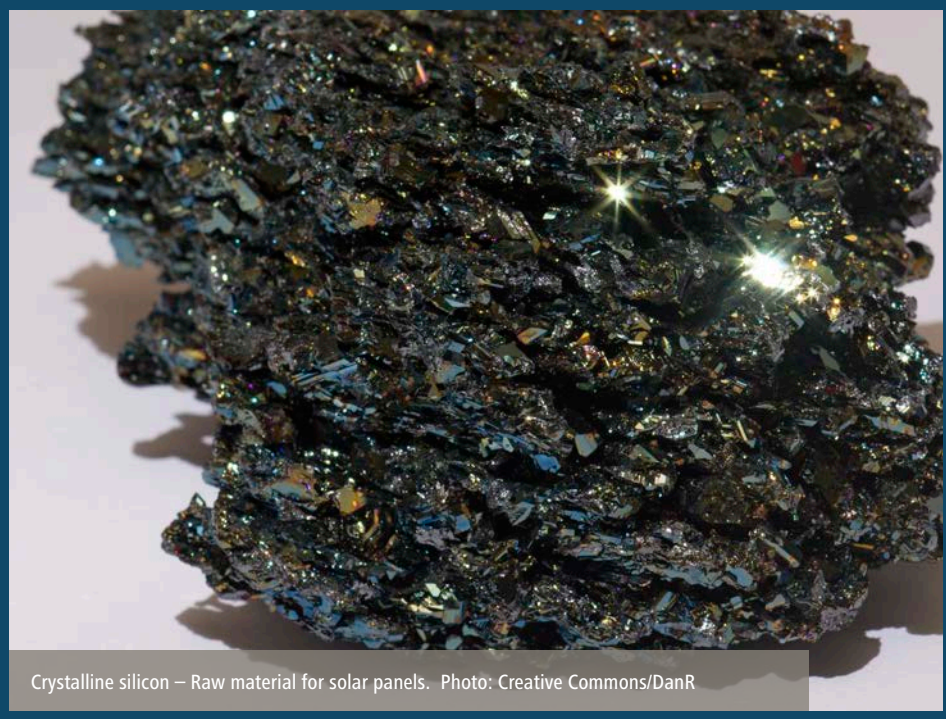
Chinese 2013 exports to these markets combined were worth US$ 15.3 billion less than 2011 exports. China has been trying to cope with this decline by promoting its domestic market and by diverting exports to other markets, in particular Japan and developing countries. In two years' time, exports to Japan increased more than six-fold to US$ 2.8 billion in 2013 (new Japanese capacity solar PV additions increased from 1.7 GW in 2011 to 6.9 GW in 2013, driven largely by the new feed-in tariff (FiT) scheme).

The portion of developing countries as a destination for Chinese global solar PV exports increased from only 6% in 2011 to 23% in 2013 (Figures 13 A-B). In 2013, China's solar PV exports to other developing countries increased by 145% to US$ 2.3 billion over 2012, with particularly strong growth (from a small base) in exports to Africa, Latin America and other Asian countries (i.e. those not in East and South-East Asia).[52] Very dynamic individual developing country markets include Chile, Chinese Taipei, Korea, Mexico, South Africa and Turkey.

BOX 10 CRYSTALLINE SILICON – THE RAW MATERIAL OF SOLAR PV CELLS AND MODULES

Crystalline silicon is an important feedstock for cells and modules, although not all of its trade is related to solar PV cells. There is significant use in the electronics industry as well. Silicon is traded under HS 280461 (silicon, containing by weight not less than 99.99 per cent of silicon).

Top exporters and importers of crystalline silicon are shown in Table 10. The EU and United States are the largest exporters, while China is the largest importer. The value of world trade (excluding intra-EU trade) dropped significantly in 2012, largely due to falling prices.



Crystalline silicon – Raw material for solar panels. Photo: Creative Commons/DanR

TABLE 10 TOP IMPORTERS AND EXPORTERS OF SILICON (HS 280461), 2010-2012 (US$ MILLIONS)

IMPORTS	PERIOD			EXPORTS	PERIOD		
	2010	2011	2012		2010	2011	2012
All reporters *	7 549	9 919	5 632	All reporters*	7 175	8 533	5 559
China	2 790	3 915	2 165	United States	2 658	2 564	1 838
Japan	1 521	1 790	1 208	EU*	1 674	2 025	1 693
Chinese Taipei	1 002	1 157	833	Korea	1 380	2 170	890
Korea	436	501	467	Japan	858	856	617
Developing countries	4 633	6 078	3 945	Developing countries	1 850	2 846	1 353
South-South trade	1 319	2 283	1 063	South-South trade	1 343	2 216	1 035

Source: UN Comtrade data, using WITS (6 February 2014).

* Excluding intra-EU27 trade.

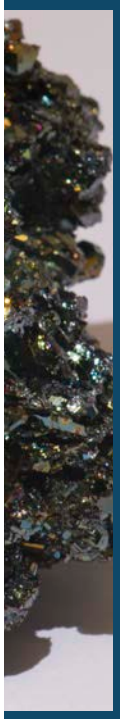


TABLE 11 WORLD TRADE IN SOLAR PV CELLS, OTHER PHOTOSENSITIVE SEMICONDUCTOR DEVICES AND LEDS (HS 854140), 2011

IMPORTS			EXPORTS		
REPORTER	US$ millions	Share (%)	REPORTER	US$ millions	Share (%)
All reporters *	60 171	100.0	All reporters *	57 793	100.0
EU27 *	27 416	45.6	China	27 946	48.4
United States	7 193	12.0	Chinese Taipei	6 951	12.0
China	6 720	11.2	Japan	6 604	11.4
Hong Kong	3 637	6.0	Korea	3 884	6.7
Korea	2 823	4.7	Malaysia	2 726	4.7
Japan	2 306	3.8	United States	2 427	4.2
Chinese Taipei	1 153	1.9	EU27 *	2 100	3.6
Australia	1 510	2.5	Singapore	2 081	3.6
India	1 333	2.2	Mexico	932	1.6
Mexico	1 107	1.8	India	328	0.6
Developing countries	19 977	33.2	Developing countries	46 156	79.9
–excluding China	13 257	22.0	–excluding China	18 210	31.5
South-South trade	13 095	21.8	South-South trade	12 326	21.3

Source: UN Comtrade data, using WITS (6 February 2014).

* Excluding intra-EU27 trade

TABLE 12 CHINA – EXPORTS OF SOLAR PV CELLS AND MODULES (NATIONAL TARIFF LINE 85414020) BY MARKET OF DESTINATION, 2009-2013

DESTINATION	PERIOD (US$ MILLIONS)					CHANGES (%)		
	2009	2010	2011	2012	2013	2012/11	2013/12	2013/11
Global exports	6 174	20 198	22 565	12 788	10 151	-43.3	-20.6	-55.0
EU27	4 940	17 034	16 772	8 282	2 801	-50.6	-66.2	-83.3
–Germany	2 294	6 451	4 792	1 584	339	-66.9	-78.6	-92.9
–Italy	605	4 388	3 568	723	64	-79.7	-91.1	-98.2
United States	278	1 046	2 448	1 417	1 208	-42.1	-14.7	-50.7
Japan	187	318	371	893	2 794	140.9	212.9	653.8
Developing countries	573	766	1 354	952	2 334	-29.7	145.3	72.4
–East and South-East Asia	447	526	641	540	975	-15.9	80.6	51.9
–Other Asia	56	139	577	276	677	-52.1	145.1	17.5
–Latin America	12	25	30	31	150	4.4	382.1	403.3
–Africa	55	75	105	103	531	-1.2	413.5	407.5
Other markets	197	1 034	1 621	1 244	1 013	-23.2	-18.6	-37.5

Source: ITC Trade Map.

4.3.3 Emerging solar PV markets in developing countries

While Table 8 in Chapter 3 shows solar PV imports into some developing countries that use solar PV-specific national tariff lines, it is difficult to obtain data on solar PV imports into other developing countries because of classification issues. In order to get an indication of other emerging (small) solar PV markets, the study therefore estimated their solar PV imports using mirror data from the exports of countries that do report PV-specific trade data. These countries are China, Chinese Taipei, India, Thailand and the United States (Table 13). The advantage of Table 13 is that it shows only PV-specific trade data (i.e. excluding trade in other photosensitive semiconductor devices and LEDs). However, it shows an incomplete picture because other countries also export solar PV cells and modules to developing countries other than the five considered (hidden under HS 854140).[53] The value of total solar PV exports to developing countries accumulated over the period 2009-2012 shown in Table 13 is US$ 9.8 billion, of which 90 per cent is South-South trade.

Furthermore, Table 13 suggests that apart from the largest developing countries for which data on annual solar PV capacity additions have been reported (in particular China and India), a number of other developing countries are emerging as still small, but potentially significant importers of solar PV cells and modules (see Figure 14). These include Bangladesh,[54] Indonesia, Nigeria, South Africa, United Arab Emirates and Viet Nam. Dynamic markets in this period include, in descending order of accumulated imports, Myanmar, Philippines, Kenya, Tanzania and Ghana. These countries increased imports year after year in value terms despite falling prices.

4.3.4 The role of China in South-South solar PV trade

China's imports and exports have played a key role in South-South trade in solar PV cells and modules. First, China's rapidly-growing exports to developed-country markets have provided opportunities to some other Asian countries to export intermediate products to be incorporated into China's exports. Although China is the world's largest producer of solar PV modules, growing end-market demand in China itself has also provided trade opportunities for certain developing countries. In fact, China has been a net importer of solar PV cells and modules from other developing countries in East and South-East Asia, largely on account of imports from Chinese Taipei and Malaysia. Second, China has played a key role in South-South trade as an exporter (see Box 12). National tariff line-level information (available in the ITC Trade Map) shows that China's solar PV exports to other developing countries increased from US$ 570 million in 2009 to US$ 1.4 billion in 2011, before falling to just under US$ 1 billion in 2012. During 2013, however, China's exports of solar PV cells and modules to other developing countries increased 145 per cent to a record of US$ 2.3 billion (72 per cent above the value of 2011 exports) (Table 14).

Asia is clearly dominant as a destination market for Chinese solar PV exports. In the period 2009-2013, Asia absorbed 81 per cent of Chinese solar PV exports to other developing countries, in value terms (East and South-East Asia accounted for 52 per cent and other Asia for 29 per cent). Chinese exports have provided low-cost solar PV modules to emerging solar PV markets, both in Asia and other developing regions. Exports to Africa accounted for 15 per cent. This may appear surprisingly high when compared with data presented in Table 1 (Chapter 2).[55] China exported solar PV cells and modules to a large number of African countries for a value of US$ 869 million accumulated in the period 2009-2013, of which US$ 531 million was in 2013 alone with exports to South Africa worth US$ 456 million. Other African destinations include Ethiopia, Kenya and Nigeria. On the contrary, the value of Chinese exports of solar PV cells and modules to Latin America and the Caribbean was much smaller than Table 1 might suggest, accounting for only four per cent of China's total South-South solar PV exports.

Although China is regularly at or among the top suppliers in overseas markets, the period 2009-2012 saw

TABLE 13 SOLAR PV CELLS AND MODULES EXPORTED TO DEVELOPING COUNTRY MARKETS, 2009-2012* (US$ MILLIONS)

DESTINATION MARKET	ANNUAL TRADE				CUMULATIVE TRADE 2009-2012
	2009	2010	2011	2012	
Developing countries	**1 577.6**	**2 617.5**	**3 304.2**	**2 276.9**	**9 776.3**
China	514.7	1093.4	972.2	681.4	3 261.7
India	146.9	255.0	819.0	343.6	1 564.5
Hong Kong, China	337.1	412.9	387.6	200.2	1 337.8
Korea, Republic of	314.0	444.2	300.5	198.4	1 257.1
Thailand	4.6	17.9	261.4	230.7	514.6
Malaysia	11.3	11.0	93.7	153.3	269.4
South Africa	27.8	74.1	62.6	40.9	205.4
Mexico	9.7	43.6	72.9	75.2	201.4
Singapore	13.9	36.7	16.1	37.9	104.7
Bangladesh	6.8	25.6	36.8	28.8	98.0
United Arab Emirates	29.1	20.7	15.8	24.9	90.4
Taipei, Chinese	17.5	17.6	27.7	16.7	79.4
Nigeria	12.1	13.7	24.2	8.9	59.0
Indonesia	11.4	9.3	17.4	17.9	55.9
Viet Nam	8.3	11.7	11.7	3.1	34.8
Ethiopia	32.1	0.9	0.2	0.7	33.9
Myanmar	0.4	2.0	8.5	22.3	33.3
Kenya	5.0	7.6	8.9	8.7	30.2
Philippines	1.5	3.4	6.2	17.4	28.4
Iran (Islamic Republic of)	1.2	6.0	10.9	9.8	28.0
Pakistan	1.8	4.6	10.9	9.1	26.4
Turkey	3.5	4.4	7.8	9.9	25.6
Chile	1.6	3.3	10.0	8.0	23.0
Saudi Arabia	2.0	2.4	11.9	3.9	20.1
United Republic of Tanzania	1.7	3.7	6.5	8.0	20.0
Afghanistan	3.2	5.3	6.4	3.2	18.1
Jordan	1.0	2.3	10.4	3.6	17.3
Brazil	3.9	4.3	2.3	3.8	14.3
Morocco	2.4	5.3	4.1	1.6	13.4
Nepal	1.4	6.0	2.9	3.0	13.3
Senegal	1.1	1.1	5.6	5.1	12.9
Peru	2.6	2.5	5.3	1.5	11.9
Uganda	1.5	4.2	2.3	4.2	12.2
Dominican Republic	4.3	0.9	1.5	4.5	11.3
Ghana	0.7	0.8	2.1	6.9	10.4

Source: ITC Trade Map.

*This Table has been elaborated on the basis of exports from PV-specific national tariff lines in China, Chinese Taipei, India, Thailand and the United States.

BOX 11 INDIA'S CHALLENGES IN DEVELOPING PV MANUFACTURING

In November 2009, the Government of India launched the Jawaharlal Nehru National Solar Mission (NSM). Two of its eight missions are: (a) to create an enabling policy framework for the deployment of 20,000 MW of solar power by 2022 and (b) to create favourable conditions for solar manufacturing. Along with state solar policies (in particular the state of Gujarat), the NSM led to a rapid increase of PV energy-generating capacity in India within three years: the total grid-connected solar PV capacity base reached 2,079 megawatt (MW) by the end of September 2013 (ESMAP, 2013).

Demand-side measures, such as the NSM's feed-in tariff and various state-level incentive schemes have increased the size and stability of the solar PV market (Johnson, 2013). But this has not resulted in progress towards another objective of the NSM: to develop India into a major force in low-cost, high-quality solar manufacturing. With a view to boosting local manufacturing, local content requirements (LCRs) were attached to the NSM's feed-in tariff, but their impact has been limited. LCRs were applied to crystalline silicon, but waived for thin film cells and modules (for which there was only a small manufacturing base in India). The Energy Sector Management Assistance Program of the World Bank (ESMAP) report argues that LCRs were therefore leading to a skewed technology choice and resulting in only minimal benefits for Indian manufacturers. Favourable financing conditions offered by the US EximBank also contributed to increased imports of TF cells and modules.

India's solar manufacturing segment consists largely of solar cell and module manufacturers, as the country currently has only limited manufacturing capacity in the high-end technology upstream segments of the industry, such as polysilicon, wafers and ingots. The Indian solar PV manufacturing industry has a total installed capacity of 1,100 MW of cells and 1,800 MW of modules, but operates at an average capacity utilization of less than 50 per cent. PV manufacturers in India face issues related to lack of raw materials, an inverted import duty structure, non availability of low-cost financing, and an underdeveloped supply chain leading to high inventory costs.

The ESMAP report argues that, in light of recent international experience (in particular the decline in polysilicon and solar PV module prices due to substantial over-capacities across the manufacturing value chain), upstream capital intensive investments in polysilicon and solar cell manufacturing needs careful analysis before being replicated. Downstream investments in modules and certain BoS equipment may be a more promising option for business viability and job creation. The report argues that India has done well in localizing manufacturing in this segment, with several global solar inverter manufacturers setting up facilities in India in recent times.

The report further argues that LCRs address only one narrow segment of demand-side actions, which in itself may not be sufficient to make local manufacturing self-sustainable and to address its competitiveness in the long term. Industrial policy actions, combining appropriate demand- and supply-side measures, may be needed. Specific actions on the supply side include financial and fiscal incentives for manufacturers; addressing backward linkages and input costs; and financial assistance and guarantees for export.

Source: ESMAP (2013), The Energy Sector Management Assistance Program (ESMAP)

BOX 12 CHINA'S CONSOLIDATION OF THE PV MANUFACTURING SECTOR

In 2012, solar PV market growth slowed down significantly and may even have stagnated (at around 29.3 GW of newly-installed capacity (IEA-PVPS, 2013b)). Since global solar PV manufacturing capacity has increased significantly in recent years, the solar PV industry has been affected by overcapacity, resulting in continuous reductions of prices of PV cells and modules and negative or very low profit margins. IEA-PVPS estimates that the global PV manufacturing capacity reached close to 60 GW in 2012, with a utilization rate of about 58 per cent. Overcapacity also exists in polysilicon: global production capacity of in 2012 was over 380,000 tons, almost double the actual global demand for crystalline silicon PV cells (IEA-PVPS, 2013b). The solar PV industry is clearly in a consolidation phase.

China, which exports a large share of its PV equipment, has been affected by a slowdown in demand in external markets as a result of the recession, a reduction in incentives, and AD and CVD actions in the EU and the United States. The Government of China is seeking to consolidate the solar PV sector (including polysilicon production) to address oversupply and increase efficiency. China has many large-scale, integrated and low-cost producers, but also many "backward companies." According to the IEA-PVPS National Survey Report 2012 on China, the strategy is to concentrate resources to support only a limited number of utility-scale enterprises that are internationally competitive and eliminate outdated capacity in backward companies through the market (IEA-PVPS, 2013c). The Government is also seeking to increase domestic demand and reduce its dependence on export markets.

In January 2011, China's Ministry of Industry and Information Technology (MIIT) decided that new polysilicon factories must be able to produce more than 3,000 metric tonnes of polysilicon a year and meet certain efficiency, environmental and financing standards. It is believed that these conditions, in addition to enormous price pressure, were the reason why a significant number of Chinese manufacturers closed down their production in the first half of 2012. On 24 February 2012, MIIT published its Industrial Restructuring and Upgrading Plan (2011-2015) for the PV industry, in which the ministry states that by 2015 it expects to be supporting only 'backbone' enterprises, which should produce a minimum of 50,000 tonnes polysilicon, or 5 GW of solar cell or module production (Jäger-Waldau, 2013). In 2014, MIIT published a list of slightly over 100 producers of silicon materials, solar panels and other components of PV that meet certain conditions (in terms of production, capacity utilization and technical standards) and will continue to receive government support and other incentives. Other companies will not be eligible for participation in government-sanctioned RE project auctions or to receive power, refund of export tariffs or low-cost financing.

The Chinese Government is also actively supporting growth in the domestic market. The key schemes that were in place in 2012 are (a) a feed-in tariff scheme for utility-scale PV, financed by a RE surcharge (which is also used to support electricity-generation based on wind-power and biomass) on electricity consumers and (b) a special Renewable Energy Fund (controlled by the Ministry of Finance), used to support the PV Building Project and the Golden-Sun Program through capital subsidies (IEA-PVPS, 2013b).

Targets for solar-power capacity installations in China are also important and were increased several times during 2012. In the "Twelfth Five-year Plan of Renewable Energy Development", published by the National Energy Administration (NEA) in August, the target for cumulative solar power installations (PV and CSP, concentrated solar power) in 2015 was increased from 15 GW to 21 GW. In December 2012, the target for 2015 was increased again to 35 GW (IEA-PVPS, 2013c). The target for 2020 is 100 GW. In January 2014, the NEA announced a target for annual capacity additions during 2014 (14 GW). According to some reports 11.3 GW was added during 2013 (Bloomberg News, 2014), the highest annual capacity ever in any country.

developing countries absorbing only around six per cent of Chinese global solar PV exports, in value terms. Developing countries may absorb a growing portion of Chinese exports of solar PV modules as they increasingly invest in solar PV power, driven by lower prices, and as Chinese manufacturers look for new markets in developing countries. Indeed, the portion of developing countries as a destination for Chinese global solar PV exports, in value terms, increased to 23 per cent during 2013.

4.3.5 Prospects for developing countries

South-South trade in solar PV has so far been largely confined to trade among developing countries in Eastern and South Eastern Asia. In the next few years there may be opportunities for enhanced South-South trade involving other developing countries and regions. Import demand could expand on account of increasing new solar PV installations in developing countries, as costs have fallen and enabling policies have been increasingly implemented. Developing country solar PV exporters may seek trade opportunities in Southern markets as growth in the European market slows. In 2012, for example, new capacity additions in developing countries increased by more than 60 per cent (Annex 7).

Developing countries may find it difficult to enter the highly-competitive manufacturing segment of the solar PV value chain, in particular upstream production of polysilicon and solar PV cells. Therefore, developing countries interested in building up a degree of local manufacturing capacity will do well to focus on specific parts of the solar PV value chain where their companies can be competitive. These include module assembly, production of certain components and certain parts of the BoS segment. Some countries may also engage in South-South trade in emerging regional markets. Beyond manufacturing, new employment opportunities may be created in downstream services, including installation, operation and maintenance of solar PV.

Data limitations in global trade flow analysis obscure additional South-South trade opportunities in RE. Off-grid systems are still the major solar PV applications in Africa, but market statistics on these products are imprecise or non-existent (Jager-Waldau, 2013). Off-grid markets for solar-home-systems, mini-grids, solar pumps, solar cooking stoves and solar lighting appliances are all difficult to trace. Although they currently make up a small part of the global solar PV market, they can play a key role in the transition to a green economy by providing off-grid access to clean energy to people living in remote areas in many developing countries.

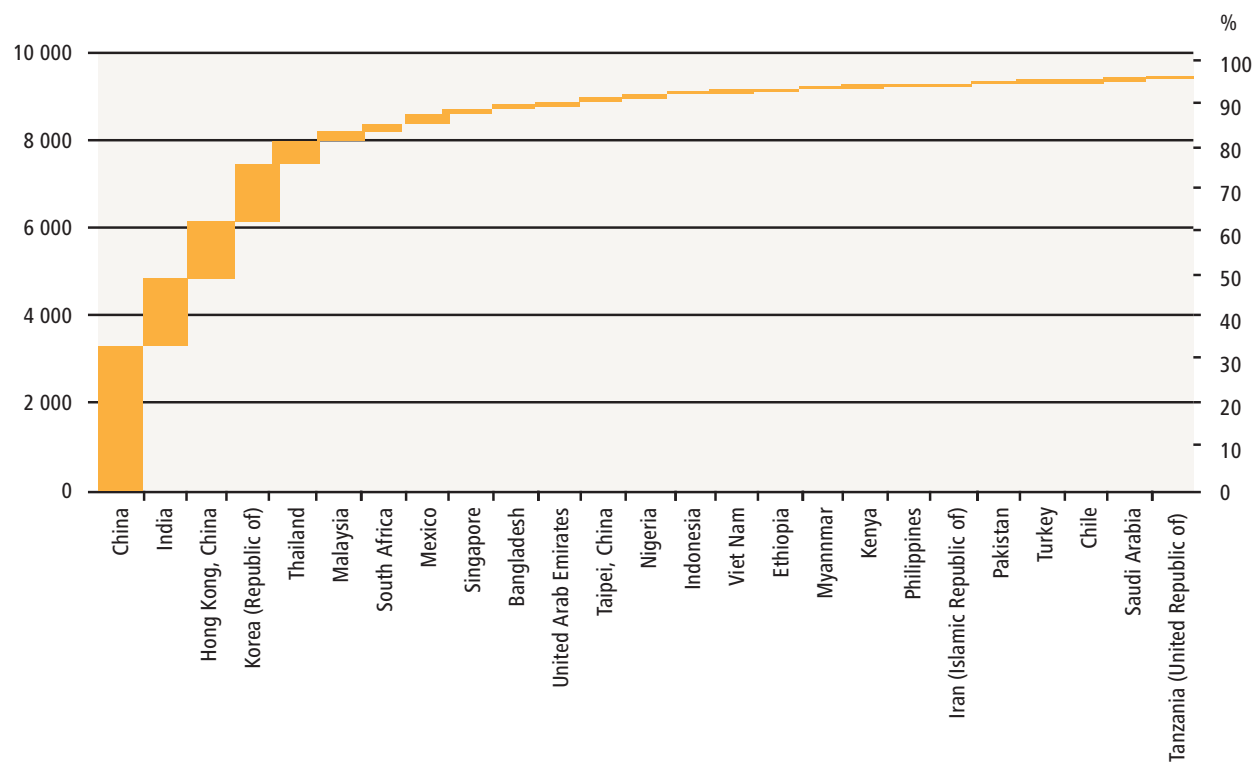
4.4 Wind energy

The previous chapter found that, between 2004 and 2011, the fastest South-South trade growth in RE products occurred in wind-powered generating sets (retreating from a peak level reached in 2009), together with hydraulic turbines (used in hydropower projects). A growing portion of developing country exports of wind-powered generating sets were destined for other developing countries, especially Asian exports destined for Latin America, while intra-regional trade remained low. This section further analyses key trends in trade in wind energy equipment, including capacity additions, recent trade flows, and prospects for developing countries.

The wind value chain can be broken down into three segments: (i) upstream (the production of key materials, such as cast iron, forgings and reinforcement fibres); (ii) manufacturing, including manufacturing of components (such as towers, blades, gearboxes and generators) and turbine manufacturing (i.e. final turbine assembly); and (iii) downstream wind power production (consisting mainly of services).

Similarly, the capital costs of a wind power project can be broken down into four major categories: (i) turbine costs (production, transportation and installation of the wind turbines, including towers, blades and other components; (ii) civil works costs (including construction costs for site preparation and the foundations for the towers); (iii) grid connection costs (cabling) and (iv) other capital costs (e.g., development and engineering costs and consultancy costs). Overall, the turbine accounts for between 64 per cent and 84 per cent of the total installed costs, with the grid connection, civil works

FIGURE 14 SOLAR PV CELLS AND MODULES EXPORTED TO DEVELOPING COUNTRY MARKETS, 2009-2012 (US$ MILLIONS, % OF TOTAL)



Source: ITC Trade Map data.

Derived from Table 13 and elaborated on the basis of exports from PV-specific national tariff lines in China, Chinese Taipei, India, Thailand and the United States.

and other costs accounting for the rest. With regard to turbine costs, the largest costs components are the rotor blades, the tower and the gearbox (together, these three items account for around 50 per cent to 60 per cent of the turbine costs) (IRENA, 2012b).[56]

4.4.1 Capacity additions

Wind power capacity additions create demand for wind power equipment whether domestically produced or imported. Data published annually by the Global Wind Energy Council (GWEC) show that global annual wind capacity additions increased from 15.2 GW in 2006 to 41.2 GW in 2011, i.e. at an average annual rate of growth of 22 per cent (Annex 27). Growth slowed to less than 9 per cent in 2012, with 44.8 GW of new capacity added (GWEC, 2013) and contracted by more than 20 per cent in 2013, when 35.5 GW was added (global cumulative capacity reached 318.1 GW by the end of 2013 (GWEC, 2014).

During the period 2006-2011, newly installed capacity in developing countries grew at more than 40 per cent per year on average (from a small base), lifting developing countries' participation in global capacity additions from 26 per cent in 2006 to 55 per cent in 2011 (see Annex 11). Growth in China was very high (70 per cent per year on average), in particularly until 2010. Capacity additions in India, the second largest developing country wind market, increased at an average annual rate of 10 per cent. Capacity added in developing countries other than China and India increased by 42 per cent per year. Growth was also particularly strong in Mexico and Brazil. In 2012, developed countries again added more new capacity than developing countries, but this was temporary. There was very strong growth in the United States related to fiscal incentives[57] on the one hand and a strong reduction in China on the other (related, among other things, to grid-connection problems and tighter access to finance). New capacity added in India was 23 per cent lower than in 2011, which was a record year,

mainly due to changes in India's incentive structure in April 2012. New capacity added in developing countries other than China and India was 52 per cent larger than the previous year, with particularly high growth in Mexico and Brazil and 8 per cent growth in Turkey.

According to statistics published in early 2014, worldwide new capacity installations added during 2013 were 21 per cent lower than in the previous year. This was largely due to a more than 90 per cent drop in new installations (to only 1084 MW in 2013) in the United States. As in previous years, ups and downs in new installations can largely be attributed to developments in incentives, in particular uncertainty concerning the Production Tax Credit which was due to expire on 31 December 2013 and extended only in January 2014. A strong recovery in capacity additions is expected in 2014.[58]

In 2013, developing countries collectively added 20.7 GW of new installations. This is 14.6 per cent more than in 2012 (as reported in GWEC 2013), largely due to a strong recovery in China. Apart from the developing countries listed in Annex 10, other developing countries collectively added more than 600 MW of new capacity.[59] In all, developing countries accounted for 58 per cent of new capacity added during 2013. Several countries in Africa and West Asia, including Ethiopia, Kenya, Morocco, Saudi Arabia and South Africa, have announced long-term plans for installing large quantities of commercial-scale wind power.

4.4.2 Trade flows in wind-powered generating sets

Data on imports and exports accumulated in HS 850231 in the period 2008-2012 are presented in Table 15.[60] The United States accounted for 42 per cent of world imports (excluding intra-EU trade) of wind-powered generating sets in value terms, whereas the EU accounted for almost two thirds of world exports (excluding intra-EU trade). China, India and Vietnam[61] were key developing country exporters. Developing countries' wind turbine exports peaked in 2008 at US$ 1 billion, but have fallen in recent years largely due to a decline in Indian exports (Annex 13). World trade in wind-powered generating sets may have peaked in 2008 at US$ 4.8 billion (imports, excluding intra-EU trade). However, rising domestic manufacturing capacities in key wind installation markets are clearly having an effect on international trade in completed wind-powered generating sets.[62] US imports started declining in 2009 (see Box 13). Imports into large developing countries adding wind capacity, such as Brazil, could also decline or grow less quickly in coming years as domestic manufacturing capacities increase. Smaller developing countries that seek to expand wind capacity, but do not have a large-enough domestic market to justify the promotion of local manufacturing capacities, will continue to rely on imports. This may provide opportunities for South-South trade. This is clearly seen in Figure 15.

4.4.3 Prospects for developing countries

The value of world trade in wind-powered generating sets increased rapidly until 2008, but subsequently declined. This can be attributed to several factors including declining prices after 2008, increased servicing of foreign markets through foreign direct investment and on-site construction as well as the shift to domestic manufacturing, especially in the United States and China. In most countries the promotion of wind power as a source of energy initially depends on imported wind-powered generating sets and components. But with growing investment in wind power, local manufacturing capacities may be established in countries with a large-enough domestic market. Some countries implement policy measures, such as LCRs, to boost domestic manufacturing, create employment and attract foreign investment (see Box 14).

Globally, the value of trade in wind-powered generating sets in the period 2008-2012 showed a peak in 2008 at US$ 4.8 billion (imports, excluding intra-EU trade). Opportunities for increased South-South trade may nevertheless arise for a number of reasons:

- Emergence of new developing country markets. New markets are evolving in developing countries. Although their numbers will not have a major impact on the global wind market over the next few years,

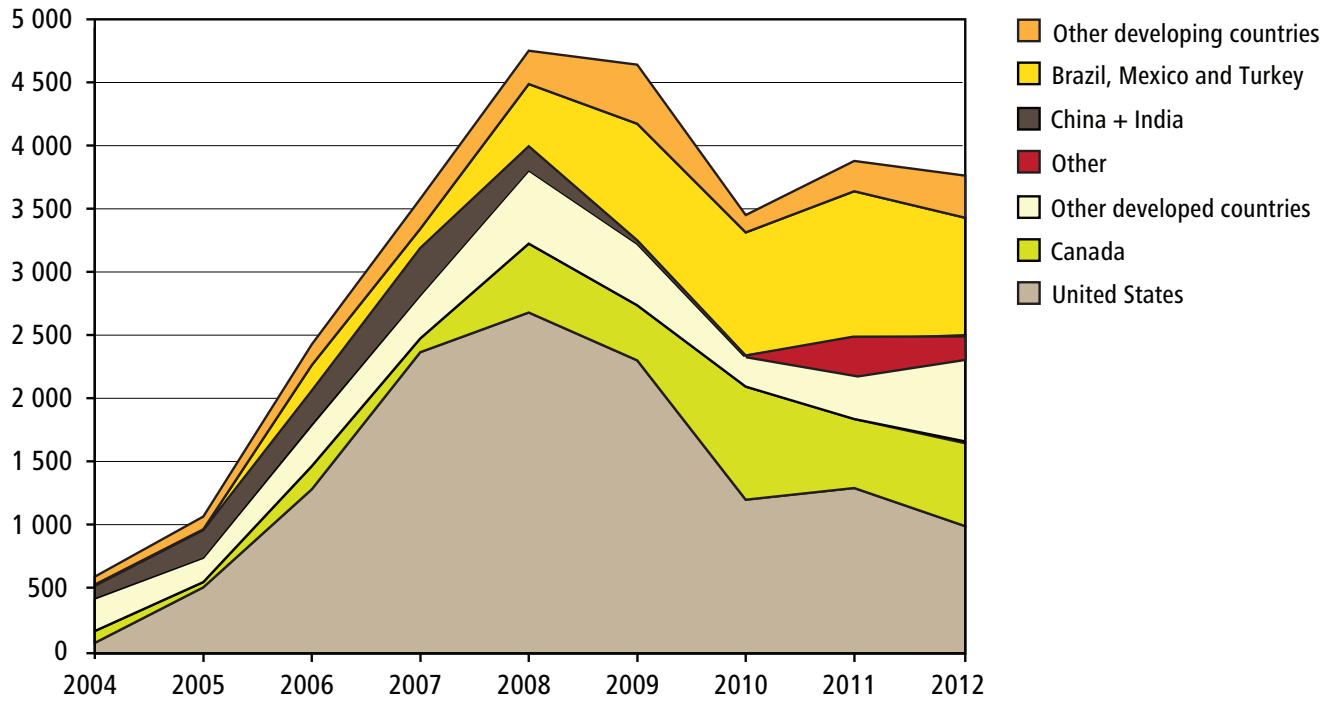
BOX 13 TRADE IN WIND COMPONENTS: LESSONS FROM US IMPORTS, 2012

The trade analysis presented in this paper largely focuses on wind-powered generation sets. New wind energy installations, however, may also generate significant international trade in wind components (the value of trade in wind components can be larger than the value of trade in wind-powered generating sets). As explained in Box 8, components that are imported separately from the nacelle are part of different HS subheadings that also include components used for non-wind-related purposes. An ICTSD study classifies wind components under 35 different HS subheadings, but none is wind-specific (Wind, 2008). Components have therefore been excluded from the trends analysis

Some analysis of trade in wind-specific components, based on available national tariff lines, is nevertheless relevant for this paper. The Harmonized Tariff Schedule (HTS) of the United States recently introduced certain national tariff lines that allow for a rather accurate estimate of the value of imports corresponding to a significant portion of the US wind-power supply chain (see Table 16).

These statistics reveal that the estimated value of US imports of wind power equipment, including components was US$ 3.1 billion in 2012, more than three times that of wind-powered generating sets alone. Of course, the US case cannot be assumed to be representative for other countries, but it illustrates that trade in wind components may have a much larger South-South dimension than trade in completed wind-powered generating sets alone (during 2013, US imports of wind equipment declined by 81 per cent to less than US$ 600 million, in line with an over 90 per cent reduction in new US capacity installations).

FIGURE 15 WORLD IMPORTS OF WIND-POWERED GENERATING SETS (HS 850231) BY GROUPS OF REPORTERS, 2004-2012 (US$ MILLIONS)



Source: UN Comtrade data.

BOX 14 REPOWERING AND USED WIND TURBINES: OPPORTUNITIES FOR SOUTH-SOUTH TRADE?

Many developing countries with good wind resources have interest in investing in wind-powered electricity generation. Up-front capital requirements, however, may be an issue. Buying second-hand wind turbines instead of new ones may offer benefits for developing countries interested in starting wind energy projects at lower costs. Benefits include lower capital expenditure and shorter project duration (which reduces the investor's financial risk). Small generators in the 150 to 600 kW class, suitable for simple grid connections, can be transported and erected without major problems. Maintenance work on used turbines can also be conducted easily (Hulshorst, 2008). Many manufacturers are no longer fabricating turbines of this size, stimulating demand for used turbines.

Many countries that started early with wind energy are now replacing older turbines, also known as repowering. As a result, the number of used wind turbines on the market is growing. Repowering first emerged in the early 1990s in California and Denmark and was followed by the Netherlands and Germany. In countries such as Germany and the Netherlands, repowering is driven by the limited availability of good locations for wind farms. This scarcity makes it more efficient for investors to replace smaller and mid-sized turbines on highly productive sites with newer and larger turbines, rather than build new turbines on less productive sites. Repowering of wind turbines after 5 to 15 years of operation releases a large number of turbines with several years of remaining service life into the market. More than 5,000 second-hand turbines were expected to go on sale in Europe in 2013 (Welstead et al., 2013).

Repowering has many benefits. For example, more wind power can be generated from the same land area with fewer wind turbines. Also, modern turbines allow for higher efficiency and lower costs and offer better power-grid integration. Repowering also permits the re-use of part of the infrastructures already developed on site such as roads and grid connection (Hulshorst, 2008).

The Governments of Denmark and Germany have been providing some incentives for repowering through their Feed-in Tariff schemes. In the United Kingdom, however, new Feed-in Tariffs excluded refurbished or remanufactured turbines. According to the German Wind Energy Association the onshore repowering potential of the country up to 2020 is 15,000 MW, out of a total installed capacity of 25,800 MW. The rate of repowering should increase rapidly; by 2015, 9500 turbines, with 6000 MW capacity, will be older than 15 years (Wind Energy Update, 2012). In 2012, Germany added 432 MW of new wind energy capacity through repowering, dismantling 179 MW (German Wind Energy Association, 2013).

Interest in repowering is also emerging in India, where wind-powered energy projects started in 1986, picking up in the 1990s (Singh, 2013). In 2000, total installed capacity was 1220 MW, mostly in the state of Tamil Nadu (GWEC, 2006). Many of the country's best wind sites are occupied by low-capacity wind turbines that were installed more than a decade ago. These turbines need to be replaced with more efficient, larger capacity machines (GWEC, 2012). The World Institute of Sustainable Energy (WISE), in its report for the Ministry of New and Renewable Energy (MNRE), estimated that old wind turbines with a capacity of 1380 MW could be repowered to achieve 2760 MW capacity. India could consider exporting used turbines in the 250 kilowatts (KW) to 500 KW range to countries in South Asia, Africa and Latin America (Singh, 2013).

Buying used turbines also has disadvantages. For example, more efforts may be required to select suitable turbines for specific projects. Also, the life expectancy of overhauled used wind turbines cannot be satisfactorily predicted and the procurement of spare parts may become an obstacle, as most manufacturers' technical support expires after 20 years (Hulshorst, 2008). Regional cooperation among developing countries interested is using second-hand turbines could help address such issues.

TABLE 14 CHINESE EXPORTS TO OTHER DEVELOPING REGION, 2009-2013

MARKET OF DESTINATION	US$ MILLIONS						SHARES CUMULATIVE TRADE (%)
	2009	2010	2011	2012	2013	CUMULATIVE 2009-2013	
All developing countries	572.9	765.8	1 353.8	951.5	2 334.4	5 978.5	100.0
East-South-East Asia	447.3	525.9	641.5	539.7	974.5	3 129.0	52.3
Other Asia	56.1	139.3	576.6	276.3	677.3	1 725.7	28.9
Latin America and the Caribbean	12.1	24.8	29.8	31.1	150.1	247.9	4.1
Africa	55.5	75.3	104.7	103.4	531.2	870.0	14.6

Source: ITC Trade Map, based on national tariff line 85414020.

TABLE 15 WORLD TRADE IN WIND-POWERED GENERATING SETS (HS 850231) ACCUMULATED IN 2008-2012

IMPORTS			EXPORTS		
REPORTERS	US$ millions	Share (%)	REPORTERS	US$ millions	Share (%)
All reporters *	20 332	100.0	All reporters *	14 675	100.0
United States	8 458	41.6	European Union *	9 704	66.1
Canada	3 080	15.1	China	1 237	8.4
Turkey	1 838	9.0	India	1 195	8.1
Brazil	1 380	6.8	United States	795	5.4
Mexico	1 236	6.1	Viet Nam	439	3.0
Developing countries	6 108	30.0	Developing countries	3 043	20.7
South-South trade	1 344	6.6	South-South trade	860	5.9

Source: UN Comtrade data, using WITS. Derived from Annexes 12 (imports) and 13 (exports).

* Excluding intra-EU27 trade.

TABLE 16 US IMPORTS OF SPECIFIC WIND ENERGY PRODUCTS FROM DEVELOPING COUNTRIES, 2012 (US$ THOUSANDS)

SUPPLIERS	WIND TURBINES	WIND TOWERS	WIND TURBINE BLADES AND HUBS	AC GENERATORS	PARTS OF AC GENERATORS	WIND ENERGY PRODUCTS
HTS	8502310000	7308200020	8412909081	8501640021	8503009546	Sum
China	118 008	405 351	144 918	2 214	7 158	677 649
Brazil	6 244	3 767	431 670	1 450	104	443 234
India	115 698	0	44 765	3 990	1 163	165 616
Vietnam	0	62 953	0	97 598	1	160 551
Korea	1 481	148 981	3	1 419	14	151 898
Mexico	46	13 114	5	106	86 178	99 449
Indonesia	0	52 141	0	0	0	52 141
Taiwan	1 015	84	0	1 418	2 875	5 391
Sub-total	242 491	686 390	621 360	108 195	97 493	1 755 929
Other	585	1 860	88	0	1 112	3 645
All developing country suppliers	243 076	688 250	621 448	108 195	98 605	1 759 574
Other	732 492	136 375	270 607	221 349	27 597	1 388 422
World	975 568	824 625	892 055	329 544	126 202	3 147 996
Developing country suppliers as a portion of all %	25	83	70	33	78	56

Source: Data compiled from tariff and trade data from the U.S. Department of Commerce and the U.S. International Trade Commission, using the USITC Trade DataWeb.

* The table indicates that developing countries accounted for more than half of the value of US imports of wind equipment in 2012. Furthermore, the participation of developing countries in the supply of imported wind components (70 per cent) was much higher than their share in imports of wind-powered generating sets (25 per cent).

these markets may provide opportunities for South-South trade, in particular smaller markets that continue to rely on imports.

- Developing country export competitiveness in wind-powered generating sets and components. A significant number of Indian- and Chinese-owned companies are manufacturing wind-powered generating sets and components and are increasingly gaining export experience, often supported by trade-promotion measures such as low-interest loans granted to foreign clients. Evidence suggests that several developing countries are particularly competitive in wind components (for example, developing countries account for a high proportion of US imports of wind-specific components).

There are nevertheless certain risks to further growth in South-South trade, such as a decline of imports into some major markets, as domestic manufacturing capacity increases (including through trade-policy measures such as LCRs). An additional risk is the dependency of wind markets on policy incentives. Further, part of recent developing country exports may be driven by current oversupply in their domestic markets. As demand and supply become more balanced, these export volumes could fall.

4.5 Trade measures affecting South-South trade in environmental goods

Tariff and non-tariff barriers may affect South-South trade in RE, as well as trade in environmental and manufactured goods general. This section introduces some relevant trade policy considerations for improving South-South trade in RE and environmental goods.

4.5.1 Tariff barriers

Import duties may have implications for South-South trade in RE products. Figure 16 presents simple average applied Most Favoured Nation (MFN) tariffs[63] in 90 developing countries for all 20 six-digit HS subheadings identified in the RE supply category.[64] Simple average tariffs are presented for illustrative purposes only because, in practice, tariffs are applied to national tariff lines and national (or regional) tariff schedules may have a range of tariffs in a particular subheading. In such cases, it is necessary to find out the tariff rate set for the tariff line that provides for imports of the environmental good in question.

The highest simple average MFN-applied tariff across 90 developing countries is for HS 841919 (non-electric water heaters). Solar PV products (which are part of HS 854140) enter most developing countries duty-free. In the wind power sector, some emerging economies have used tariff protection to support the development of domestic manufacturing capacities.

4.5.2 Non-tariff barriers

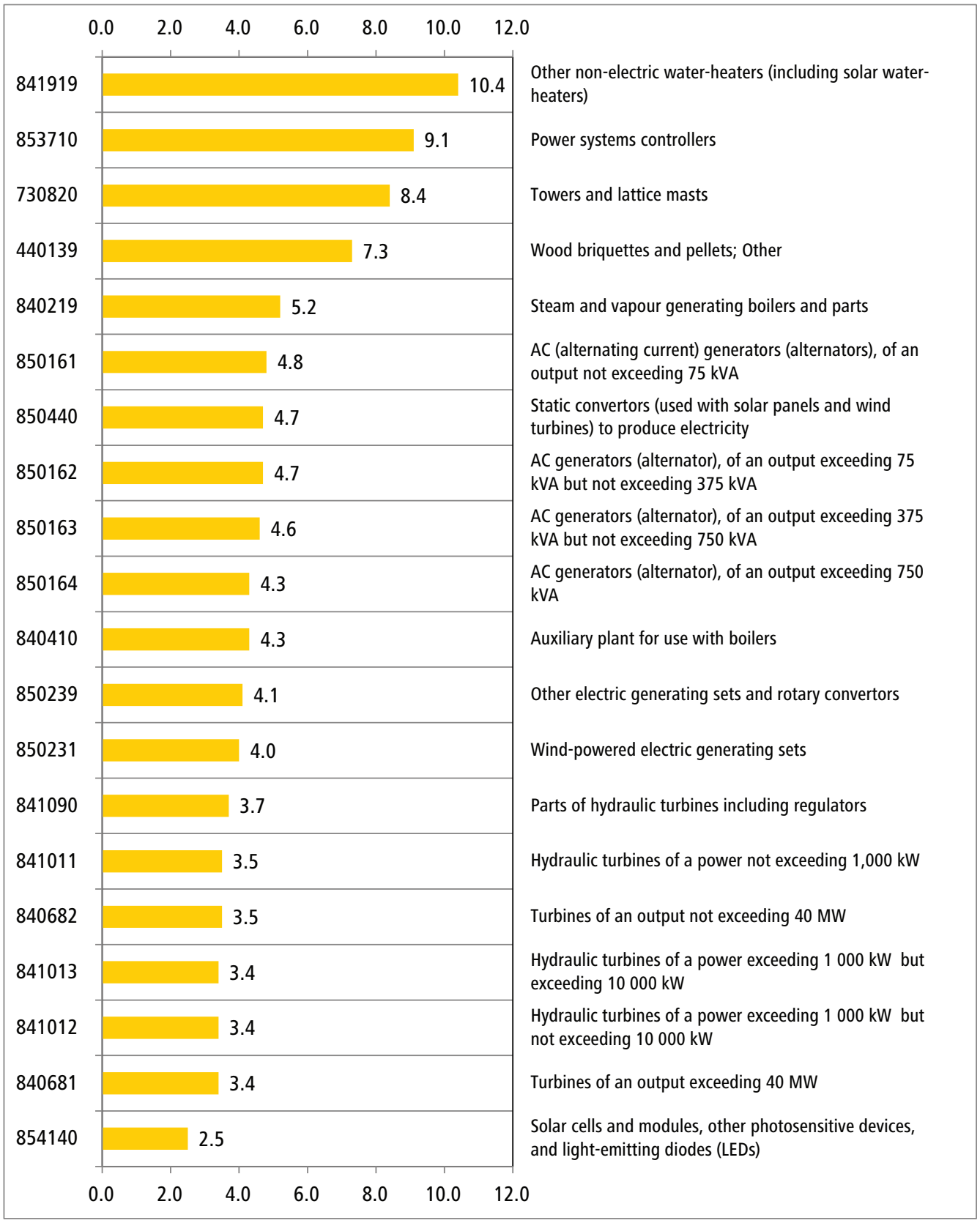
Trade in environmental goods (including RE goods) may face a series of non-tariff barriers, such as:

- LCRs. LCRs oblige investors to source a certain percentage of goods and services from local producers, for example as a condition for accessing incentive programmes, thereby seeking to ensure that RE investments benefit the local economy (e.g., in terms of employment and domestic industry development). LCRs have been applied in both developed and developing countries;[65]

- Standards and certification. New technical standards required for certification and sale may have implications for trade, in particular when they are not based on international standards. In recent years, standards compliance has also been linked to access to government support programs;

- AD and CVD actions.[66] Such actions may have chilling effects on trade even before definitive antidumping duties are imposed because definitive AD and CVD duties may, under certain conditions, be applied retroactively. AD and CVD duties may also result in diversion of trade to other countries; and

FIGURE 16 AVERAGE MFN-APPLIED TARIFFS ON RENEWABLE ENERGY (RE) PRODUCTS IN 90 DEVELOPING COUNTRIES



Source: UN COMTRADE data.

- Subsidies and other incentives. Incentive measures may have implications for international trade. On the one hand, they have contributed to creating demand for environmental goods, including goods imported from developing countries. On the other hand, many countries have combined domestic policies aimed at creating demand for RE technologies with other policies (such as LCRs) intended to ensure that a large share of demand for associated equipment is met by domestic suppliers. Such measures can reduce imports.

In addition to these non-tariff barriers, domestic complications such as difficulties in establishing grid connections or limited grid capacity for the absorption of renewable electricity production could also restrict imports, including from developing countries (see Box 15).

4.5.3 Trade and domestic support measures in the solar PV and wind power sectors

This section discusses trade measures and domestic support measures that may affect trade in solar PV and windpower equipment. With regard to solar PV equipment, MFN-applied tariffs for solar PV cells and modules are, in general, very low. Most countries (60 of the 90 developing countries analysed in Figure 16) allow duty-free access to their markets on an MFN basis. Another 25 developing countries have MFN-applied tariffs of five per cent or less. Only four of the developing countries listed in Table 13, as emerging, but often still small, importers of solar PV cells and modules, have above-zero MFN-applied tariff rates (Brazil, Chile, Morocco and Pakistan).

In 2011 the United States initiated antidumping and CVD actions against crystalline silicon cells manufactured in China. In October 2012, the US Department of Commerce issued a ruling imposing average AD duties of 31 per cent.[67] In the European Union, provisional AD duties were imposed in 2013, starting with 11.8 per cent on 6 June and 47.6 per cent on average on 6 August. The Commission subsequently adopted a price undertaking submitted by China's solar panel exporters. The agreement, which was agreed to by 90 out of 140 of the Chinese companies covered in the initial complaint, sets a minimum price for modules, cells, and wafers as well as a maximum volume that can be imported into the EU without invoking the antidumping duties.[68] The volume cap is widely reported to be 7 GW (James and Mehta, 2103). In turn, China launched an antidumping investigation on polysilicon imported from the United States, Korea, and the European Union.[69] India started an investigation of dumping of solar PV modules made in the United States, China, Chinese Taipei and Malaysia in January 2012.

LCRs can also play a role in the solar PV market. In India, LCRs were attached to the National Solar Mission feed-in tariff for solar PV with a view to promoting local manufacturing.[70] The National Solar Mission's feed-in tariff has increased the size and stability of the solar PV market by catalysing demand, as have various state-level incentive schemes (Johnson, 2013). This is illustrated by the increase of new annual capacity additions from 66MW in 2010 to 980 MW in 2012 (Annex 7). In 2012, Indian imports nevertheless fell by one third in value terms, but it is difficult to know whether LCRs contributed to this development.[71] LCRs are also used in South Africa under the Renewable Energy Independent Producers Procurement Programme (De Vos, 2013).[72]

In the case of wind power equipment, import tariffs are relatively high in a number of developing countries with significant wind markets. Wind-powered generating sets (HS 850231) face a 14 per cent MFN-applied tariff in Brazil,[73] whereas China and Korea both have an 8 per cent tariff. Most developing countries investing in wind energy may not have sufficiently large domestic markets to justify local manufacturing capacity for finished wind-powered generating sets. These countries may apply low or zero tariffs. Imports face a 5 per cent tariff in both Egypt and Pakistan. Wind-powered generating sets can be imported duty-free into Costa Rica, Ecuador, Peru, Sri Lanka, and Vietnam, among others.

The United States initiated antidumping (AD) and countervailing duty (CVD) actions concerning wind

BOX 15 CROSS-BORDER TRADE IN RENEWABLE ELECTRICITY

Technology improvements and reduction in costs of renewable electricity generation make cross-border trade in renewable electricity an attractive export opportunity for developing countries particularly in a regional South-South context, given the still high costs of transmission.

In Bhutan, for example as of 2012, the total installed capacity of hydropower at present is around 1,500 MW. The domestic consumption is approximately 250 MW, and the rest (75 per cent) is exported to India through a bilateral contract. In 2010 alone electricity exports helped the country earn about $223 million, according to Asian Development Bank (ADB) data. The intention is to expand exports to 10, 000 MW by 2020. A hydropower project supported by the Asian Development Bank (ADB) and the governments of Austria and Japan to enable Bhutan to export clean energy to India has been registered as the first cross-border initiative under the Clean Development Mechanism (CDM). Hydropower exports also amounted to 30 per cent of Laos' exports in 2008.

There are a number of challenges to developing large cross-border projects as the case of Desertec project aimed at exporting solar electricity from the Middle-East and North Africa to Europe reveals. These include deciding upon the import price of electricity, the establishment of a new inter-regional feed-in-tariff for green electricity from the Middle East and North Africa (MENA) region, and the share of electricity generated in MENA assigned for exports to Europe. In addition, the harmonisation of policy regimes for renewable sources of energy across the region, along with robust national strategies for RE development, is critical for enabling such an unprecedented cross-regional project.

Further reduction in costs of transmission and investments in associated infrastructure will also facilitate such ambitious long-distance projects. Launching projects on a smaller scale focusing on South-South exports could provide useful lessons that could be applied in larger scaled-up projects like Desertec. Eventually long-distance South-South electricity trade could also become a reality.

Sources:
The Times of India, 2013; Asian Development Bank (ADB), 2010; UNEP, 2013.

towers imported from China and Viet Nam in December 2011. AD and CVD duties were imposed on imports from both countries in January 2013.

China (until 2009) and Brazil have used LCRs in the area of wind power installations, seeking to boost domestic manufacturing. In China, a mix of financial incentives, a local content requirement, and the benefits of the Clean Development Mechanism of the Kyoto Protocol have played a key role in transforming a small domestic wind industry into the world's largest wind market in terms of manufacturing and installed capacity (GWEC, 2013). In Brazil, meeting a local content requirement (known as "nationalisation index") of 60 per cent has been a condition for access to low-cost funding from the Brazilian Development Bank. These requirements have recently been further tightened.[74]

In Brazil and South Africa, regular RE auctions may play a key role in promoting a degree of long-term demand stability for wind power in the domestic market. In South Africa, the government used LCRs as a condition for obtaining "preferred bidder" status in the Renewable Energy Independent Power Producer Programme.[75] In Turkey, renewable electricity producers can, since the start of 2011, receive additional feed-in-tariff payments if LCRs are met.

4.5.4 Trade liberalisation efforts

While trade-liberalisation initiatives are often driven by bilateral, regional or multilateral negotiations, they can also be carried out autonomously. While WTO members launched multilateral trade negotiations on liberalising

environmental goods under the Doha Ministerial declaration in 2001, they have repeatedly stalled over issues of definition as well as due to lack of progress in other areas of WTO negotiations.

Liberalisation initiatives have therefore been launched by smaller country groupings involving major traders of environmental goods including RE products. On 9 September 2012, in Vladivostok, Russia, leaders of the 21 economies that form the Asia-Pacific Economic Cooperation (APEC) group concluded an agreement to reduce applied tariffs on environmental goods classified under a list of 54 HS subheadings to no more than five per cent.[76] At least 15 of the 54 HS subheadings include products that may have RE applications.

In a joint statement on 24 January 2014, a group of 14 WTO members that include the US, EU, China, Australia, Canada, Costa Rica, Hong Kong, Japan, Korea, New Zealand, Norway, Singapore, Switzerland, and Chinese Taipei announced plans to negotiate a plurilateral deal aimed at eliminating tariffs on environmental goods trade. They announced that they will build on APEC's List of Environmental Goods as a 'starting point'. Negotiations would be launched initially outside the WTO framework, but eventually brought back into the WTO with MFN benefits to all WTO Members. This would happen when enough WTO members constituting a 'critical mass' signed onto the pact. This number is often set at 90 per cent of world trade in the products under consideration, as happened with the WTO's Information Technology Agreement (ITA), which also began as a plurilateral initiative (ICTSD Bridges Trade BioRes, 28 January 2014). Both of these initiatives could have implications for South-South trade. Further, as possible tariff reductions will be extended to all WTO members on an MFN-basis, developing countries that do not participate in these negotiations may yet benefit from improved market access.

Our analysis shows an intensification of South-South trade in key products, in particular wind-powered generating sets and products associated with hydropower and biomass-based energy generation. In all these cases, during the period 2004-11 South-South trade grew faster than global trade (excluding intra-EU trade) in the same sectors, with South-South trade accounting for increasing portions of both imports and exports of developing countries.

The most remarkable trend in trade in RE during the period 2004-11, was the very fast increase of exports of developing countries (in particular China) to developed-country markets. This increase was primarily driven by incentives for solar PV energy generation in developed countries and lower manufacturing costs in developing countries.[77] South-South trade in solar PV cells and modules has also grown and is expected to expand further as recently-emerging demand in developing countries is met primarily by exports from other developing countries, principally China.

Much of South-South trade in RE products, in particular solar PV cells and modules, still consists largely of intra-regional trade among Asian developing countries, in particular in East and South-East Asia. Other developing regions have not yet significantly engaged in South-South trade (either intra-regional or inter-regional), as solar PV power installations and capacities to manufacture associated products are still at their infancy. Yet, falling prices of RE technologies and investment, among other factors, are providing new opportunities for electricity-generation from renewable sources of energy in developing countries, creating demand for RE equipment. This new demand, in turn, provides opportunities for enhanced South-South trade.

The challenge for policymakers is now to unlock the potential for South-South trade, in particular intra-regional trade, in RE and environmental goods in other developing regions. South-South trade is also growing in other EGS sectors, in particular in water filtering and purification. This chapter outlines the policy implications of this study, reviews important conclusions based on the data gathered and provides suggestions for future research. These are intended for policymakers and other stakeholders in developing countries as they seek to benefit from the trade opportunities of the green economy transition.

Solar panels in Tunisia.

5 Conclusions and policy implications

5.1 Conclusions on South-South trade in renewable energy goods

5.1.1 COMTRADE-based data conclusions

- With the growing economic importance of developing countries, South-South trade relations rapidly increased between 2004 and 2011. South-South trade in manufactured products increased faster (15.9 per cent per year on average) than global trade (excluding intra-EU trade) in manufactured products (9.7 per cent).

- Developing countries in East and South-East Asia have played a dominant role in South-South trade across sectors, whether looking at manufactured products, environmental goods in general or RE goods, both as exporters and export destinations (except in the case of wind turbine imports, where Latin America dominated). These countries accounted for 81 per cent of South-South manufactures trade in the period 2008-2012; China alone accounted for 37 per cent.

- The share of developing countries in global exports (excluding intra-EU trade) of RE goods more than doubled, from 32 per cent in 2004 to 75 per cent in 2011, in all RE sectors considered (solar, wind, hydro and biomass). The share of China alone increased strongly from only 6 per cent in 2004 to 46 per cent (38 per cent in 2012); the share of developing countries other than China also increased, but only moderately, from 26 per cent in 2004 to 29 per cent in 2011 (32 per cent in 2012).

- Trade in subheading HS 854140 (solar PV cells and modules, other photosensitive semiconductor devices and LEDs) weighed heavily in the trade flow analysis based on COMTRADE. HS 854140 was a reasonable proxy of solar PV trade for the purposes of the global analysis, but more challenging for South-South solar PV trade.

- The period 2004-2011 has showed a shift to South-North directionality. As relative shares of global trade, South-North exports rapidly grew from around 15 per cent in 2004 to around 60 per cent in 2011, while North-North and North-South exports steadily shrunk. Recent trade data seem to indicate a new shift with a shrinking role of European markets and a larger role of Japan and developing country markets. The growing role of South-South trade is clearly shown in China's export data for 2012 and 2013: the portion of developing countries as a destination for Chinese global PV exports increased from only 6 per cent in 2011 to 23 per cent in 2013. In the case of wind-powered generating sets this portion increased from 32 per cent to 66 per cent.

- New (small and dynamic) RE markets are evolving in developing countries. Although these may not have a major impact on global RE markets, they may provide new opportunities for South-South trade. The study's trade flow analysis has focused on the solar PV and wind equipment markets. However, good opportunities for South-South trade may also exist in other product areas, such as intermediate goods (i.e. wind energy components), specific segments of

RE markets which cannot be adequately captured in an analysis of global trade flows (such as small-scale off-grid PV and wind projects) or products that were excluded altogether from the global trade-flow analysis because of HS classification issues (such as solar water heaters).

- South-South trade in wind turbines accounted for US$ 1.3 billion in the period 2008-2012 (US$ 270 million per year on average). The prominent position of Chinese companies has been gained largely through domestic sales (Wiser and Bolinger, 2013). China's exports to developing countries have shown strong growth in recent years. As a result, South-South trade (over US$ 300 million in 2013) accounted for two thirds of China's global exports in 2013.

5.1.2 Conclusions based on solar PV-specific trade data, using ITC Trade Map

- Available PV-specific trade data show that, in the period 2009-2013, Chinese Taipei was the largest exporter of solar PV cells to other developing country markets. Most of these exports (87 per cent in value terms) were shipped to other markets in East and South-Eastern Asia (principally China and Korea). China was the second largest exporter (of which 58 per cent was shipped to East and South-Eastern Asia), but the largest exporter to other developing regions in particular in "other Asia" (28 per cent) and Africa (11 per cent). China's intra-regional exports to Africa and Latin America showed very strong growth in recent years, although from a small base.

- Mirror data based on the exports of key traders reporting PV-specific trade data in 2009-2012, namely China, Chinese Taipei, India, Thailand and the United States, revealed that a number of other developing countries are emerging as still small but potentially significant importers of solar PV cells and modules. These include Bangladesh, Indonesia, Nigeria, South Africa, Viet Nam and United Arab Emirates. Kenya, Ghana, Myanmar, Philippines and Tanzania emerged as dynamic markets in this period.

5.1.3 Conclusions based on recent market developments and other factors

- Large portions of solar PV imports into many developing countries may be related to off-grid applications, but global solar PV trade is largely dominated by developments in grid-connected installations. Thus, this area of trade is hidden or unmeasured. In the developing country context, it may not only represent an important area of RE trade growth in the future, but may already be important.

- Capacity additions and investment in RE goods, including solar PV cells and wind turbines in particular, are on the increase in numerous developing countries, indicating that South-South trade growth could continue to grow in coming years. In three of the last four years, developing countries added more new wind power installations than developed countries (accounting for 53 per cent of cumulative global capacity additions in the period 2009-2013). Their share in new solar PV installations rose steadily from only 4 per cent in 2010 to 19 per cent in 2012. Developing countries collectively accounted for well above one third of new capacity solar PV capacity additions in 2013.

- Trade policy, including tariffs, non-tariff barriers and domestic support measures such as LCRs and fiscal support, significantly impact trade in RE goods. Tariff barriers are low in some RE goods categories, but in others they remain a significant problem together with non-tariff barriers.

5.2 Policy implications for trade and a green economy transition

Based on the preceding information, South-South trade opportunities in RE and other environmental goods are clearly rising quickly, and are likely to accelerate in coming years. In order to benefit from this increasing trade, countries may consider taking the following concrete steps.

5.2.1 Trade policy initiatives

- Actively identify South-South trade opportunities for RE installation, innovation and diffusion. RE products are increasingly being supplied to developing countries by developing countries, due to increasing global cost competitiveness and shared needs. Frugal innovation can lead to the design of low-cost environmental goods that bolster South-South trade. Some examples include small off-grid solar PV systems, solar lighting, community wind turbines, small-hydro and water filtering. Countries may seek to improve South-South trade cooperation for the installation, innovation and dissemination of RE technologies.

- Design appropriate incentives for RE that do not distort South-South trade in environmental goods. Incentives, including government subsidies, may have implications for international trade, including South-South trade. Incentives aimed at encouraging the use of RE-based electricity, by creating demand for associated goods and services, may have a positive impact on trade as part of such demand will be met by imports. For example, incentives in key developed-country markets have stimulated trade in renewable-energy products, such as solar PV cells and wind turbines.

  Governments could also provide incentives, including through subsidies, intended to boost domestic manufacturing capacities to help ensure that the use of RE-based electricity results in benefits to the domestic economy (in terms of employment and industrial development). Such incentives may have direct and indirect impacts on trade. Many incentives such as the provision of infrastructure and financial assistance may indirectly support trade, including South-South trade. Subsidies that are provided across sectors and which do not specifically benefit one sector or industry would not be considered incompatible with WTO subsidy rules. However, certain types of subsidies and other support measures to boost domestic manufacturing may have negative effects on trade, distort global markets, causing trade tensions and potentially undercutting the competitiveness of industries in other developing countries. In certain cases, trade policymakers may wish to consider time-limited exemptions from WTO subsidy rules to enable developing countries to build up a certain degree of domestic manufacturing capacity.

- Bolster support for environmental goods that are particularly suited to South-South trade. For many developing countries, imports of water purification equipment, a sector characterized by growing South-South trade, could be a vital component of their transition towards a green economy. Organic agriculture is another environmental goods sector where developing countries have immediate potential for increasing production and export. Successful development of the organic sector requires sustained government and private sector support and the involvement of various stakeholders in policy and strategy formulation. Standards, mutual recognition and labelling initiatives, both globally and regionally, can facilitate South-South trade in environmental goods.

- Implement a trade policy regime favourable to local RE potential, including relaxed barriers to trade in intermediate goods. The reduction or elimination of import duties and non-tariff barriers on RE goods, including components, may promote the domestic availability of affordable RE products. Inverted duty structures, where components face higher import tariffs than final products, may discourage the development of local manufacturing capacity. Where a certain level of tariff protection for finished products is considered desirable for some time to help boost local manufacturing capacities (where domestic markets are large enough to economically justify local production), tariffs on final products could be reduced gradually to provide an incentive to manufacturers to reduce costs and become internationally competitive. Trade agreements including those at the regional level may facilitate South-South trade if designed accordingly.

- Support revision of the Harmonised System codes for trade in environmental goods to assist policymakers in making better informed decisions. The fact that most environmental goods are classified

under HS subheadings that include unrelated products complicates trade analysis and negotiations. Future HS revisions could pay special attention to creating specific subheadings for key RE goods, in particular solar PV.

5.2.2 Investment initiatives

- Promote new RE installations in order to increase domestic generating capacity, on-grid and off-grid, leading to cheaper, more secure and more abundant electricity supplies. Declining global costs of RE equipment, in particular solar PV cells and modules, are making investments in RE more attractive. In many countries, 'off-grid' RE projects in solar, wind and hydro are already cost-competitive with conventional sources. Appropriate targets, incentives and flanking environmental and social policies are helpful tools to take advantage of current favourable conditions for RE generation.

- Implement appropriate policies to harness green economy benefits from RE installations. Apart from improved electricity supply and greater energy security, RE investment brings a range of additional green economy benefits. These include reductions in fossil fuel production and imports, cleaner production, rural electrification and new employment opportunities in downstream services such as RE installation, operation and maintenance. Policies are recommended that encourage both RE deployment and sustainable trade.

- Take advantage of green economy-related financial assistance initiatives. Incentives will be important in enabling deployment of environmental goods and services. This is particularly true in countries where governmental and financial support may be insufficient. Such incentives include financing mechanisms such as the Clean Development Mechanism (CDM) and the 'Green Fund' at the United Nations Framework Convention on Climate Change (UNFCCC), among others. Export finance initiatives launched by regional development banks could also bolster South-South RE deployment.

- Strategically consider investments for developing domestic manufacturing capacity suited to global RE value chains. Countries seeking to build up a certain degree of export manufacturing or downstream service capacities can focus on parts of the global value chain where local companies may be competitive, such as solar PV components, module assembly, and parts of the BoS segment. In many countries, the introduction of RE technologies will initially depend on imported equipment, but as markets become more significant, local manufacturing and export capacity could become competitive.

- Improve national and regional grid capacity to support increased renewable electricity production and trade. Countries with excellent RE resources (e.g., solar radiation, wind and hydropower potential) may export renewably generated electricity by investing in improved grid capacity. Some regions, including the Economic Community of West African States (ECOWAS), have begun building institutional support through regional mechanisms such as the West African Power Pool (WAPP).

- Invest in domestic downstream skills development for an adequate human talent pool. Many economic benefits from downstream services can accrue in the RE sector, especially in installation, maintenance and removal. Investing in a skilled RE labour force will not only provide more quality jobs, but prepare the wider economy for the RE transition. A skilled domestic RE labour force could be key in attracting further investment in the RE sector, including for the development of domestic manufacturing and export capacity.

5.3 Future research

Important questions remain for future researchers regarding South-South trade in RE goods.

- How can a larger range of environmental goods be identified? The value of global trade in environmental goods is difficult to estimate, in particular its South-South component. Environmental goods are not

defined as a sector in the HS nomenclature, rather are classified on a product-specific basis under a large range of HS subdivisions (which in most cases include large portions of trade in non-environmental goods). This study shows that it is possible to discern trends in trade in a small number of RE goods. Further work should aim at including a larger range of RE products and other environmental goods in order to help policymakers make more informed decisions.

- What conclusions about EGS value chains are hidden by trade volume measurement? This study has demonstrated the large gross trade volumes in EGS, including RE goods, especially in East and South-East Asia. However, since trade volumes are measured in gross volumes, rather than value added, there may be important insights about the structure of EGS value chains that are not illuminated here. For example, in the manufacturing process of a solar cell, the value of the original polycrystalline silicon would be recounted every time it is moved between countries further along the value chain. This measurement system leaves some questions about the true value of trade in EGS unanswered. What proportion of the value-added of solar cells happens in the final manufacturing stage versus earlier steps? How have the tightening profit margins changed the structure of competition and opportunities for importers and exporters?

- What are the opportunities for South-South trade in RE and other environmental products involving other developing countries? East and South-East Asia has dominated the trade in RE goods. However, small but dynamic solar PV and wind equipment markets are emerging in other developing regions, including elsewhere in Africa, Asia and Latin America. How will these markets benefit from South-South trade? Will these regions emerge only as new markets for Asian exports? Will new demand provide incentives for building manufacturing and services capacities or support intra-regional trade?

- To what extent do export-driven EGS represent a critical sector of developing economies? While this study focuses on the absolute trade volumes of South-South trade in RE and other EGS, it has not focused on the relative importance of these sectors to the various countries examined. While China has been the dominant actor in many of the subsectors, it also has the largest economy of any developing country. As a result, export-driven EGS production may play a larger role in other nations that this paper has overlooked. Future research should examine the relative importance of the EGS sector in a number of developing nations in order to give a better sense of its current and potential development impacts.

- What is the relevance of factors affecting trade volatility in RE products? Trade in RE products is highly volatile for number of reasons. First, markets for RE goods depend largely on government incentives such as subsidies. This has resulted in large fluctuations in markets and trade flows as incentives ebbed and flowed. Second, some trade barriers may be rising. For example, antidumping and CVD actions have had an important impact on Chinese exports to the EU and US markets. Third, price fluctuations have had a significant impact on trade flows. Fourth, to address shortfalls in exports and overcapacity, key developing are looking for new market outlets. How do these factors affect a trends analysis? Is South-South trade a way out? Are South-South trade flows more immune to these fluctuations?

- Are RE exports driven mainly by overall industrial capacity? This study highlighted that East and South-East Asia have become the dominant players in RE exports. But the same region has also made the most strides in the formation of industrial capacity overall. To what extent did specific RE development policies impact the rapid growth of the sector? Was East and South-East Asia an inevitable choice of EGS manufacturers given its wider industrial development? What are the lessons that other regions can learn from East and South-East Asia's growth path?

- How can the classification of internationally-traded products be improved to allow more precise analysis of trade flows in environmental goods? The World Customs Organization (WCO) seeks to keep the HS

headings and subheadings up to date in terms of changes in technology or patterns of international trade, through amendments that are introduced every five years (and most recently in 2012).[78] Some classification issues in the area of RE goods should be considered in future revisions. Meanwhile, countries continue to add greater detail to their national tariff schedules, providing some additional progress in achieving transparency in this important category of international trade.[79] The increasing incorporation of specific tariff lines for RE products into national tariff schedules, including of developing countries, are an indication of the perceived need for more specific classifications. What are the priorities for the incorporation of specific descriptions for RE products at international (HS) and national levels?

Wind turbine farm in Tunisia. Photo: World Bank/Dana Smillie

Annexes

ANNEX 1 TABLE OF SELECTED RENEWABLE ENERGY (RE) GOODS SECTORS, MARKET SIZE AND TRADE FLOWS IN 2011 (US$ MILLIONS)

		GLOBAL TRADE EXCLUDING INTRA-EU		DEVELOPING COUNTRIES TRADE		SOUTH-SOUTH TRADE	
		Imports	Exports	Imports	Exports	Imports	Exports
Solar		6 0171	57 793	19 977	46 156	13 095	12 326
854140	Photosensitive semi-conductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes	6 0171	57 793	19 977	46 156	13 095	12 326
Solar water heaters		1 120	989	267	539	162	131
841919	Other non-electric water heaters*	1 120	989	267	539	162	131
Wind power		6 049	4 976	2 471	1 861	1 023	1 081
850231	Wind-powered electric generating sets	3 879	2 981	1 412	541	213	179
730820	Towers and lattice masts *	2 170	1 995	1 058	1319	811	902
Hydro Hydraulic turbines and water wheels		1 625	1 526	1 068	694	506	538
841011	Of a power not exceeding 1 000 kW	93	55	54	10	20	6
841012	Of a power exceeding 1 000 kW but not exceeding 10 000 kW	161	107	135	61	54	51
841013	Of a power exceeding 10 000 kWkW	274	194	252	98	151	84
841090	Parts	1 097	1 170	724	525	282	396
Biomass		2 395	2 489	1 039	1 219	543	1 065
440130	Wood waste and scrap	1 005	810	44	75	30	40
840219	Other vapour generating boilers, including hybrid boilers	652	574	504	277	194	235
840410	Auxiliary plant for use with boilers of heading 84.02 or 84.03	738	1 105	491	867	319	790
All cross-cutting products *		82 912	70 389	41 280	34 238	19 316	16 463
All renewable energy (RE) sectors		154 271	138 157	65 976	84 698	34 618	31 596
Of which included in trends analysis		68 070	64 789	23 597	48 611	14 357	14 108

Source: UN Comtrade data, using WITS (6 February 2014)

* These subheadings have been excluded from the trends analysis.

ANNEX 2 TABLE OF SELECTED 20 HS SUBDIVISIONS IN ENVIRONMENTAL PROTECTION PRODUCTS, 2011
(US$ MILLIONS)

HS SUB-HEADING	PRODUCT	GLOBAL TRADE EXCLUDING INTRA-EU		DEVELOPING COUNTRIES TRADE		SOUTH-SOUTH TRADE	
		Imports	Exports	Imports	Exports	Imports	Exports
280110	Chlorine	174	159	60	45	36	28
380210	Activated carbon	1 260	1 166	463	641	239	213
391400	Ion exchangers	1 046	625	364	244	104	101
450410	Agglomerated cork (with or without a binding substance) and articles of agglomerated cork: Panels, boards, tiles, blocks and similar articles of agglomerated cork	262	284	46	15	6	4
841780	Other furnaces, ovens, incinerators, non-electric	1 713	964	1 391	386	344	317
842121	Water filtering or purifying machinery apparatus	4 974	5 099	2 320	1 188	841	712
842129	Other machinery for purifying liquids	5 400	5 610	2 697	1 309	499	593
842139	Filtering or purifying machinery and apparatus for gases	12 828	11 455	4 544	5 345	1 275	1 152
851410	Industrial/ lab electric furnaces and ovens (Resistance heated)	1 696	1 525	1 315	247	226	186
851420	Industrial/ lab electric furnaces and ovens (Electric induction or dielectric)	511	371	368	84	89	62
851430	Industrial/lab electric furnaces and ovens, Other.	1 150	715	943	225	232	171
902610	Instruments and apparatus for measuring or checking the flow or level of liquid	3 542	3 328	1 696	561	277	276
902620	Instruments and apparatus for measuring or checking pressure of liquids or gases	4 815	4 628	1 684	1 324	410	398
902710	Gas or smoke analysis apparatus	2 724	2 338	1 061	189	104	93
902720	Chromatographs and electrophoresis instruments	2 300	1 488	1 477	346	285	221
902730	Spectometers	2 726	2 744	1 320	256	173	157
902810	Gas meters	404	388	225	86	78	64
902820	Liquid meters	633	690	300	345	112	152
902830	Electricity meters	1 622	1 771	546	1 246	346	513
903220	Manostats	416	751	173	84	42	27
Total		**50 195**	**46 100**	**22 990**	**14 168**	**5 717**	**5 441**

Source: UN Comtrade data, using WITS (September 2013).

ANNEX 3 TABLE OF STATISTICS ON RENEWABLE ENERGY (RE) INVESTMENT, 2004-2012 (US$ BILLIONS) – NEW INVESTMENT BY SECTOR

SECTOR	PERIOD									CAGR 2004/11 (%)	CHANGE 2011/12 (%)
	2004	2005	2006	2007	2008	2009	2010	2011	2012		
Wind	14.4	25.5	32.4	57.4	69.9	73.7	96.2	89.3	80.3	30	-10
Solar	12.3	16.4	22.1	39.1	59.3	62.3	99.9	158.1	140.4	44	-11
Biofuels	3.7	8.9	26.1	28.2	19.3	10.6	9.2	8.3	5.0	12	-40
Biomass and waste-to-energy	6.3	8.3	11.8	13.1	14.1	13.2	13.7	12.9	8.6	11	-34
Small hydro	1.5	4.6	5.4	5.9	7.1	5.3	4.5	6.5	7.8	23	20
Geothermal	1.4	0.9	1.4	1.8	1.8	2.7	3.5	3.7	2.1	15	-44
Marine	0.0	0.1	0.9	0.7	0.2	0.3	0.2	0.3	0.3		13
Total	39.6	64.7	100.0	146.2	171.7	168.2	227.2	279	244.4	32	-2012
Developed countries	32	48	73	103	112	104	150	186	132	29	-29
Y-o-y change (%)		50	52	41	9	-7	44	24	-29		
Developing countries	8	17	27	43	59	64	77	94	112	42	19
Y-o-y change (%)		113	59	59	37	8	20	22	19		
Shares (%)											
Developed countries	81	74	73	70	65	62	66	67	54		
Developing countries	20	26	27	29	34	38	34	34	46		

Source: Frankfurt School-UNEP Centre/BNEF, 2013 (see Figures 2 and 3).

ANNEX 4 TABLE OF STATISTICS ON GLOBAL MARKET SIZE OF SELECTED RENEWABLE ENERGY (RE) SECTORS, 2005-2012 (US$ BILLIONS)

TECHNOLOGY	2005	2006	2007	2008	2009	2010	2011	2012	CAGR 2005-2011 (%)	CHANGE 2012/2011 (%)
Solar PV (modules, system components and installation)	11.2	15.6	20.3	29.6	36.1	71.2	91.6	79.7	42	-13.0
Wind (new installation capital costs)	11.8	17.9	30.1	51.4	63.5	60.5	71.5	73.8	35	3.2
Biofuels (global production and wholesale pricing of ethanol and biodiesel)	15.7	20.5	25.4	34.8	44.9	56.4	83.0	95.2	32	14.7
Total	38.7	54.0	75.8	115.8	144.5	188.1	246.1	248.7	36	1.1

Source: Clean Edge, 2013.

ANNEX 5 TABLE OF STATISTICS ON REGIONAL PARTICIPATION IN SOUTH-SOUTH EXPORTS OF RENEWABLE ENERGY PRODUCTS, 2008-2012 (%)

CATEGORY AND SECTOR	SOUTH-SOUTH TRADE	DEVELOPING ASIA			LATIN AMERICA & CARIBBEAN	AFRICA	SOUTH-SOUTH EXPORTS EXCLUDING CHINA
		East and South-East Asia					
		Total	China	Rest of Asia			
Renewable energy (RE) products*							
Total	100	96.6	34.8	1.6	1.6	0.2	65.2
Solar*	100	99.2	30.4	0.6	0.1	0.2	69.6
Wind	100	59.2	47.3	34.3	6.5	0.0	52.7
Hydropower	100	71.5	66.8	5.2	22.1	1.1	33.2
–Small hydro	100	87.2	84.3	7.9	4.5	0.4	15.7
Biomass	100	89.7	62.9	4.4	5.2	0.7	37.1
Environmental protection products							
Narrow list (20 items)	100	78.1	38.3	6.7	8.3	6.9	61.7
–Water filtering	100	74.0	26.8	12.9	8.2	4.9	73.2
Reference sectors							
Total trade	100	64.9	26.7	18.6	11.1	5.4	73.3
Manufactured products	100	80.8	36.9	8.8	7.5	2.9	63.1
OECD+APEC list**	100	84.3	35.9	5.6	7.3	2.8	64.1

Source: UN Comtrade data, using WITS (6 February 2014).

*HS 854140, e.g., including trade in solar cells and modules, other photosensitive semiconductor devices and LEDs.
**See Table 1, note 2.

ANNEX 6 TABLE OF STATISTICS ON SOUTH-SOUTH EXPORTS, BREAKDOWN BY REGIONAL MARKETS OF DESTINATION, 2008-2012 (%)

CATEGORY AND SECTOR	SOUTH-SOUTH TRADE	DEVELOPING ASIA			LATIN AMERICA & CARIBBEAN	AFRICA	REST OF THE WORLD
		Asia	East and South-East Asia	Rest of Asia			
Renewable energy (RE) products *							
Total	100	94.2	84.5	9.8	3.7	2.0	0.1
Solar*	100	97.4	91.4	6.0	1.1	1.5	0.1
Wind	100	46.5	14.3	32.2	49.0	4.5	0.0
Hydropower	100	61.0	41.9	19.1	31.1	7.5	0.4
–Small hydro	100	85.3	32.4	52.9	7.8	6.5	0.3
Biomass	100	88.1	45.8	42.3	7.0	4.7	0.2
Environmental protection products							
Narrow list (20 items)	100	75.1	52.3	22.8	13.7	11.0	0.2
–Water filtering	100	86.9	43.3	32.8	11.0	12.7	0.0
Reference sectors							
Total	100	79.7	63.8	15.9	12.7	7.5	0.2
Manufactured prod.	100	79.2	62.6	16.7	13.2	7.4	0.1
OECD+APEC list	100	80.0	61.8	18.3	12.0	7.7	0.2

Source: UN Comtrade data, using WITS.

*HS 854140, e.g., including trade in solar cells and modules, other photosensitive semiconductor devices and LEDs.
**See Table 1, note 2.

ANNEX 7 TABLE OF STATISTICS ON ANNUAL SOLAR PV CAPACITY ADDITIONS (MW), 2010-2012

REPORTER	CAPACITY ADDED (MW)				SHARE IN GLOBAL CAPACITY ADDED IN 2010-2012	CHANGE IN CAPACITY ADDED IN 2012 COMPARED WITH 2011 (%)
	2010	2011	2012	2010-2012 accumulated		
European Union (27)	13 357	22 138	16 844	52 339	68.7	-24
United States	890	1 867	3 362	6 119	8.0	80
Japan	991	1 296	1 718	4 005	5.3	33
Other developed*	801	1 814	1 777	4 392	5.8	-2
Developed countries*	16 039	27 115	23 701	66 855	87.8	-13
China	500	2 500	3 500	6 500	8.5	40
India	66	225	980	1 401	1.7	336
Korea	127	79	230	436	0.6	191
Taiwan	13	70	105	188	0.2	50
Malaysia	1.5	0.9	27.4	30	0.0	2 944
Mexico	5.6	6.5	14.7	27	0.0	126
Turkey	0	1	2	3	0.0	100
Thailand	n/a	50	173	223	0.3	246
Subtotal	713	2 932	5 032	8 808	11.4	64
Other developing**	n/a	n/a	600	600	0.8	
Developing countries	713	2 932	5 632	9 408	12.2	
Total	16 752	30 047	29 333	76 263	100.0	
Developing countries' share in total (%)	4.3	10.1	19.2	12.3		

Source: Reports of the IEA Photovoltaic Power Systems Programme (IEA PVPS) and the European Photovoltaic Industry Association (EPIAa). Figures from these sources have been used by the authors to estimate the shares of developing countries in total capacity additions.

*Includes Ukraine.
**Includes Africa, Latin America and other Asia.

ANNEX 8 TABLE OF STATISTICS ON IMPORTS OF SOLAR PV CELLS, OTHER PHOTOSENSITIVE SEMI-CONDUCTOR DEVICES AND LEDS (HS 854140), 2004-2012 (US$ MILLIONS)

IN DESCENDING ORDER OF ACCUMULATED 2010-2012 VALUES

	2004	2005	2006	2007	2008	2009	2010	2011	2012	CAGR 2004/11 (%)	CHANGE 2011/12 (%)
All reporters *	11 363	13 569	16 665	21 230	33 209	30 874	56 761	60 171	46 477	27	-23
EU27 *	2 953	4 096	5 534	8 411	17 129	15 157	30 640	27 416	13 857	37	-49
China	1 931	2 362	2 681	3 289	3 744	3 607	6 145	6 720	6 433	20	-4
United States	1 251	1 391	1 848	2 156	2 760	2 592	4 412	7 193	7 260	28	1
Hong Kong	1 205	1 335	1 715	1 818	1 984	2 109	3 205	3 637	3 525	17	-3
Korea	858	865	979	1 277	2 144	1 996	2 794	2 823	3 031	19	7
Japan	1 002	1 136	1 207	1 131	1 412	1 212	2 189	2 306	3 100	13	34
Chinese Taipei	473	462	525	544	660	697	1 286	1 153	1 224	14	6
Australia	55	52	59	84	171	400	1 047	1 510	1 010	61	-33
Mexico	283	357	414	443	488	541	876	1 107	1 208	22	9
India	50	54	105	169	420	405	299	1 333	872	60	-35
Singapore	339	328	432	504	559	478	814	905	729	15	-19
Canada	165	216	215	202	267	269	701	987	510	29	-48
Malaysia	251	256	225	306	354	299	498	685	389	15	-43
Thailand	154	180	159	163	169	115	229	644	673	23	5
Developing countries	5 762	6 485	7 611	8 989	11 080	10 784	17 157	19 977	19 202	19	-4
South-South	2 341	2 904	3 775	4 737	6 082	6 256	11 163	13 095	12 519	28	-4

Source: UN Comtrade data, using WITS (6 February 2014)

* Excluding intra-EU trade.

ANNEX 9 TABLE OF STATISTICS ON EXPORTS OF SOLAR PV CELLS, OTHER PHOTOSENSITIVE SEMICONDUCTOR DEVICES AND LEDS, 2004-2012 (HS 854140) (US$ MILLIONS)

IN DESCENDING ORDER OF ACCUMULATED 2010-2012 VALUES

	2004	2005	2006	2007	2008	2009	2010	2011	2012	CAGR 2004/11 (%)	CHANGE 2011/12 (%)
All reporters *	10 333	11 751	14 696	19 411	30 486	27 898	54 005	57 793	42 729	28	-26
China	644	1 258	2 460	5 252	11 745	10 721	25 179	27 946	17 483	71	-37
Taiwan	1 175	1 403	1 689	2 580	4 002	3 872	7 425	6 951	5 277	29	-24
Japan	4 629	4 796	5 199	5 472	6 190	4 673	6 397	6 604	5 835	5	-12
Rep of Korea	317	315	422	563	805	1 307	3 807	3 884	3 879	43	0
United States	1 193	1 298	1 298	1 582	1 976	2 018	2 706	2 427	1 804	11	-26
Malaysia	793	844	1 004	942	745	836	2 599	2 726	2 491	19	-9
EU27 *	689	764	1 073	1 260	2 025	1 748	1 835	2 203	2 102	18	-5
Singapore	329	317	445	500	737	674	1 253	2 081	1 585	30	-24
Mexico	82	141	219	201	398	560	711	932	751	42	-19
India	87	94	134	213	529	437	586	328	112	21	-66
Developing countries	3 615	4 629	6 790	10 682	19 455	18 864	42 418	46 156	32 717	44	-29
Developing countries excluding China	2 971	3 371	4 330	5 430	7 710	8 143	17 239	18 210	15 234	30	-16
South-South	2 040	2 393	3 241	4 051	5 399	5 953	10 431	12 326	11 995	29	-4

Source: UN Comtrade data, using WITS (6 February 2014)

* Excluding intra-EU trade.

ANNEX 10 TABLE OF STATISTICS ON SOUTH-SOUTH EXPORTS OF SOLAR PV CELLS AND MODULES BY REGION OF DESTINATION, 2009-2012 (US$ THOUSANDS) (BASED ON PV-SPECIFIC NATIONAL TARIFF LINES)

IMPORTER	DESTINATION OF PV EXPORTS	2009	2010	2011	2012	2009-2012
China	East and South-East Asia	447 333	525 941	641 492	539 657	2 154 423
	Rest of developing Asia	56 107	139 303	576 614	276 344	1 048 368
	Developing Asia	503 440	665 244	1 218 106	816 001	3 202 791
	Latin America and the Caribbean (LAC)	12 073	24 811	29 818	31 130	97 832
	Africa	55 464	75 292	104 655	104 449	339 860
	Developing countries	572 879	765 816	1 353 802	951 544	3 644 041
	World	6 173 674	20 197 980	22 565 292	12 787 637	61 724 583
Taipei, Chinese	East and South-East Asia	689 632	1 381 979	1 331 329	933 871	4 336 811
	–Of which China	479 077	993 460	943 746	654 646	3 070 929
	Rest of developing Asia	110 726	157 230	214 726	78 137	560 819
	Developing Asia	800 358	1 539 209	1 546 055	1 012 008	4 897 630
	LAC	4 046	4 046	4 046	4 046	16 184
	Africa	22 728	34 610	18 832	3 077	79 247
	Developing countries	827 132	1 577 865	1 568 933	1 019 131	4 993 061
	World	2 223 336	4 725 171	4 090 226	2 530 862	13 569 595
Thailand	East and South-East Asia	2 759	1 296	1 901	1 596	7 552
	Rest of developing Asia	3 007	1 235	2 599	1 008	7 849
	Developing Asia	5 766	2 531	4 500	2 608	15 405
	Africa	169	77	102	594	942
	Developing countries	5 899	2 568	4 573	2 921	15 961
	World	15 974	11 909	8 053	5 531	41 467
India	East and South-East Asia	14 588	28 261	5 462	15 623	63 934
	Rest of developing Asia	6 679	12 979	12 721	9 951	42 330
	Developing Asia	21 267	41 240	18 183	25 574	106 264
	LAC	189	202	60	259	710
	Africa	4 275	13 195	6 071	6 732	30 273
	Developing countries	25 733	54 653	24 339	32 565	137 290
	World	285 859	505 344	165 337	100 178	1 056 718

Source: ITC Trade Map.

ANNEX 11 TABLE OF STATISTICS ON ANNUAL WIND ENERGY CAPACITY ADDITIONS (MW), 2006-2013*
IN DESCENDING ORDER OF ACCUMULATED ADDITIONS DURING THE FIVE-YEAR PERIOD 2009-2013

REPORTER	ANNUAL CAPACITY ADDITIONS (MW)								CAGR 2006/11 (%)	CHANGE 2011/12 (%)	CHANGE 2012/13 (%)
	2006	2007	2008	2009	2010	2011	2012	2013			
World	15 197	19 865	27 052	38 342	38 266	41 236	44 799	35 468	22	9	- 21
China	1 260	3 304	6 300	13 803	18 928	18 000	12 960	16 100	70	- 28	24
EU27	7 611	8 554	8 484	10 163	9 295	9 616	11 895	11 159	5	24	- 6
USA	2 454	5 244	8 358	9 996	5 115	6 810	13 124	1 084	23	93	- 92
India	1 840	1 575	1 800	1 271	2 139	3 019	2 336	1 729	10	- 23	- 26
Canada	776	386	526	950	690	1 267	935	1 599	10	- 26	71
Brazil	208	10	94	264	326	583	1 077	948	23	85	- 12
Turkey	0	0	286	343	528	470	506	646		8	28
Mexico	85	0	0	117	316	354	801	623	33	26	- 22
Australia	109	7	482	406	167	234	358	655	17	53	83
Japan	333	229	346	178	221	168	88	50	- 13	- 48	- 43
Chinese Taipei	84	0	81	78	83	45	0	43	- 12	- 100	
Capacity additions by country groupings											
Developed countries	11 254	14 581	18 307	21 884	15 592	18 398	26 743	14 733	10	45	- 45
Developing countries	3 943	5 284	8 745	16 458	22 674	22 838	18 056	20 695	42	- 21	15
Developing countries without China	2 683	1 980	2 445	2 655	3 746	4 838	5 096	4 595	13	5	- 10
Portion of total capacity additions (%)											
Developed countries	74	73	68	57	41	45	60	42	-	-	-
Developing countries	26	27	32	43	59	55	40	58	-	-	-

Source: GWEC, Annual Reports 2006 through 2013 and GWEC, 2014.

*This table does not reflect revisions in subsequent reports.

ANNEX 12 TABLE OF STATISTICS ON IMPORTS OF WIND-POWERED GENERATING SETS (HS 850231), 2004-2012 (US$ MILLIONS)

IN DESCENDING ORDER OF ACCUMULATED 2010-2012 VALUES

REPORTER	2004	2005	2006	2007	2008	2009	2010	2011	2012	CAGR 2004-2011 (%)	CHANGE 2012/11 (%)
World*	588.2	1 064.0	2 426.8	3 578.5	4 751.5	4 601.3	3 452.2	3 878.9	3 769.6	31	-3
United States	64.1	503.8	1 280.0	2 365.1	2 679.1	2 300.6	1 197.5	1 289.9	990.5	54	-23
Canada	93.7	41.3	183.3	108.6	545.2	435.7	895.0	546.2	657.6	29	20
Turkey	5.9	0.1	54.3	92.4	285.0	506.2	405.2	353.6	288.1	79	-19
Brazil	3.9	5.6	61.7	42.3	121.7	221.1	273.9	456.3	307.1	97	-33
Mexico	0.1	0.2	85.3	17.1	85.4	195.3	295.3	341.4	318.7	220	-7
EU27*	3.3	12.5	6.8	98.2	106.0	153.3	74.7	66.4	229.6	54	246
Chile	0.1	0.1	0.2	1.0	15.3	122.3	15.4	69.7	46.9	155	-33
Chinese Taipei	2.3	67.9	49.3	123.9	90.9	124.6	36.5	45.7	54.1	53	18
Japan	112.6	43.8	232.9	62.5	173.7	55.5	40.0	30.9	41.8	-17	35
Other developing countries											
Thailand	0.2	0.2	0.3	37.8	5.6	56.7	10.8	1.2	75.2	29	6 167
China	93.3	211.5	257.1	372.0	189.3	26.4	11.5	11.7	3.3	-26	-72
India	2.1	6.0	4.9	0.6	2.3	1.4	3.9	9.5	4.9	24	-48
Rep of Korea	31.5	22.9	59.2	33.6	102.2	37.5	2.1	2.8	1.2	-29	-57
Developing countries	168.3	324.4	627.4	761.2	947.5	1 418.1	1 127.4	1 412.4	1 272.3	35	-10
South-South	1.6	4.0	13.7	47.1	238.2	388.2	227.8	212.6	277.5	101	31

Source: UN Comtrade data, using WITS (6 February 2014).

* Excluding intra-EU trade.

ANNEX 13 TABLE OF STATISTICS ON EXPORTS OF WIND-POWERED GENERATING SETS (HS 850231), 2004-2012 (US$ MILLIONS)

IN DESCENDING ORDER OF ACCUMULATED 2010-2012 VALUES

REPORTERS	US$ MILLIONS									CAGR 2004-2011 (%)	CHANGE 2012/11 (%)
	2004	2005	2006	2007	2008	2009	2010	2011	2012		
All reporters *	561.1	1 104.3	2 467.1	2 802.9	3 337.6	2 503.4	2 487.8	2 976.6	3 369.9	27	13
EU27 *	534.0	993.1	1 886.8	1 870.7	1 812.9	1 260.6	2 035.5	2 277.1	2 315.2	23	2
China	0.2	0.4	3.2	78.0	210.9	151.1	56.6	351.2	466.9	191	33
United States	4.4	3.6	83.3	14.2	22.1	117.0	142.1	126.0	388.0	61	208
India	1.2	23.8	199.0	335.8	651.1	335.6	122.9	41.1	43.8	66	7
Viet Nam	13.5	37.6	78.4	108.6	126.4	116.9	67.4	128.4	4.0	38	-97
Korea	0.0	0.0	0.4	0.2	3.0	1.6	14.3	13.3	16.1		21
Brazil	0.0	0.0	0.0	0.0	14.0	16.5	25.9	0.6	0.5		-17
Developing countries	20.1	66.4	285.4	524.8	1 010.4	624.9	294.7	541.4	567.4	60	5
South-South	6.7	4.1	9.5	59.6	238.9	98.9	74.2	178.9	260.8	60	46

Source: UN Comtrade data, using WITS (6 February 2014).

* Excluding intra-EU trade.

ANNEX 14 TABLE OF STATISTICS ON WATER FILTERING OR PURIFYING MACHINERY AND APPARATUS (HS 842121), TOP TRADERS, 2010-2012 (US$ MILLIONS)

REPORTER	IMPORTS			REPORTER	EXPORTS		
	2010	2011	2012		2010	2011	2012
All reporters	4 549.1	5 108.9	4 904.1	All reporters	4 379.5	5 124.1	5 151.5
United States	814.3	947.3	1 005.1	EU *	1 671.4	2 090.7	1 985.4
EU *	427.1	496.7	500.6	United States	933.6	1 028.6	1 100.4
Russia	222.1	299.2	394.5	China	416.8	361.4	381.5
Canada	233.8	283.0	304.1	Canada	279.1	339.3	358.3
China	200.0	267.9	270.9	Korea	170.0	277.5	257.8
Australia	225.3	179.5	171.4	Japan	192.0	178.5	175.5
Mexico	129.1	169.0	189.4	Chinese Taipei	111.1	120.1	119.3
Japan	139.6	134.5	139.5	Mexico	106.5	111.4	115.6
Saudi Arabia	129.7	129.8	154.3	Israel	45.3	63.8	87.2
Algeria	141.4	160.8	97.3	India	54.2	76.5	55.4
Developing countries (total, selected developing countries not listed above, and regions)							
All developing	2189.4	2405.2	1923.6	All developing	1092.4	1195.3	1256.7
Africa	482.0	416.5	367.7	Singapore	55.4	51.8	53.0
Morocco	42.6	59.6	52.7	Turkey	35.0	53.5	59.6
Egypt, Arab Rep.	64.4	40.1	32.2	Malaysia	35.7	39.2	49.1
South Africa	32.7	37.4	45.5	Brazil	27.2	31.1	38.6
Nigeria	40.6	21.8	31.2	South Africa	16.2	21.5	44.9
South-South trade	698.4	855.9	698.2	South-South trade	607.5	718.3	752.1

Source: UN Comtrade data, using WITS (30 January 2014).

*Excluding intra-EU (30 January 2014).

ANNEX 15 TABLE OF STATISTICS ON TRADE IN WATER FILTERING OR PURIFYING MACHINERY AND APPARATUS, 2004-2012

REPORTER	2004	2005	2006	2007	2008	2009	2010	2011	2012	CAGR 2004/11
Total imports (US$ millions)										
All reporters *	2 204	2 492	2 813	3 442	4 106	3 628	4 550	5 109	4 904	12.7
Developing countries	947	1 076	1 212	1 538	1 765	1 575	2 189	2 405	1 924	14.2
South-South trade	192	238	337	391	465	486	698	856	698	23.8
Participation in global trade (%) *										
Developing countries	43.0	43.2	43.1	44.7	43.0	43.4	48.1	47.1	39.2	
South-South trade	8.7	9.6	12.0	11.4	11.3	13.4	15.4	16.8	14.2	
South-South trade as a share of total developing countries trade (%)										
Developing countries	20.3	22.1	27.8	25.4	26.3	30.8	31.9	35.6	36.3	
Total exports (US$ millions)										
All reporters *	2 552	2 758	2 995	3 657	4 400	3 957	4 380	5 124	5 153	10.5
Developing countries	299	361	435	581	867	787	1 092	1 195	1 257	21.9
South-South trade	176	216	259	333	529	477	607	718	752	22.2
Participation in global trade (%) *										
Developing countries	11.7	13.1	14.5	15.9	19.7	19.9	24.9	23.3	24.4	
South-South trade	6.9	7.8	8.6	9.1	12.0	12.0	13.9	14.0	14.6	
South-South trade as a share of total developing countries trade (%)										
Developing countries	58.9	59.8	59.5	57.3	61.0	60.6	55.6	60.1	59.8	

Source: UN Comtrade data, using WITS (30 January 2014).

*Excluding intra-EU (30 January 2014).

ANNEX 16 TABLE OF STATISTICS ON TRADE IN HYDRAULIC TURBINES AND PARTS, 2010-2012 (US$ MILLIONS)

IMPORTS				EXPORTS			
REPORTER	PERIOD			REPORTER	PERIOD		
	2010	2011	2012		2010	2011	2012
Hydraulic turbines and parts (HS 8410)							
All reporters *	1 381	1 625	1 329	All reporters *	1 574	1 526	1 531
Turkey	191	186	158	EU *	528	583	568
Vietnam	125	153	70	China	445	449	475
EU *	89	91	66	Brazil	136	103	78
Developing countries	961	1168	856	Developing countries	691	694	698
South-South trade	480	506	429	South-South trade	570	538	573
Hydraulic turbines of a power capacity not exceeding 10 mW (HS 841011 and HS 841012)							
All reporters *	166	254	217	All reporters *	133	162	184
				–EU *	73	81	107
Developing countries	119	192	143	Developing countries	42	71	50
				–China	33	61	40
South-South trade	30	73	51	South-South trade	35	57	36

Source: UN Comtrade data, using WITS (5 February 2014).

*Excluding intra-EU (30 January 2014).

ANNEX 17 TABLE OF STATISTICS ON CHINA: EXPORTS OF SOLAR WATER HEATERS (SWH, 84191910), 2010-2012 (US$ THOUSANDS)

	2010	2011	2012	2010-2012	PORTION OF SOUTH-SOUTH TRADE (%)
World	108 091	123 922	115 563	347 576	
Developing countries	66 614	82 379	78 578	227 571	100
Developing Asia	26 449	31 534	24 983	82 966	36.5
India	3 644	5 658	6 572	15 874	7.0
Turkey	7 672	5 979	424	14 075	6.2
Korea, Republic of	2 813	5 909	4 145	12 867	5.7
Viet Nam	2 980	2 961	3 317	9 258	4.1
Lebanon	1 838	3 531	2 998	8 367	3.7
Jordan	1 530	1 761	1 847	5 138	2.3
Latin America & Caribbean	18 411	25 176	33 084	76 671	33.7
Mexico	13 090	16 915	21 807	51 812	22.8
Chile	2 061	2 293	3 302	7 656	3.4
Brazil	869	1 914	3 010	5 793	2.5
Africa	21 538	25 510	20 349	67 397	29.6
South Africa	13 728	18 904	10 190	42 822	18.8
Mauritius	2 095	2 367	4 946	9 408	4.1
Tunisia	2 150	993	425	3 568	1.6
Kenya	508	1 112	1 835	3 455	1.5

Source: ITC Trade Map data.

Notes

[1] Growth rates presented in this paper are compound annual growth rates, CAGRs

[2] Trade among developing countries. In this paper developing countries include all countries and territories listed as developing economies in the UNCTAD Handbook of Statistics (UNCTAD 2012).

[3] The paper does not include environmental services in the scope of its trade flow analysis given the difficulty of tracking trade flows in services. However, the paper makes reference to renewable energy services such as installation, maintenance and disposal wherever appropriate.

[4] An earlier study by Veena Jha (2008), analysing factors influencing the import of environmental goods, it was shown that while lowering tariffs may increase imports of environmental goods, several other factors such as environmental regulation, gross domestic product (GDP) levels, foreign direct investment (FDI) and technical assistance projects may play a more decisive role. In the trade context, supporting policies which improve the general competitiveness of exports are also likely to trigger trade in environmental goods.

[5] See also for instance UNEP (2010) and Akinyi Kaudia, Alice , Chaofei Yang and Bok-hwan Yu (2012).

[6] COMTRADE depends on trade data reported by countries. Trade data for country groupings may be affected by missing information on countries that had not (yet) reported their trade data at the time COMTRADE was accessed for trade analysis. COMTRADE data has been accessed using the World Integrated Trade Solution (WITS) tool, jointly developed by the World Bank and UNCTAD

[7] The ITC Trade Map uses data based on COMTRADE (up to the level of HS subheadings) plus trade data at the national tariff-line level based on additional sources, such as the General Customs Administration of China. Trade Map data can be accessed at http://www.trademap.org/

[8] Although COMTRADE also expresses trade flows in terms of quantity, it is difficult to assess a variety of products with very different unit values. This paper thus relies on value-based trade flows.

[9] A recent USITC study observes that data on global trade in different renewable energy technologies are largely unavailable, because most renewable energy technologies are classified in basket categories that contain other products within HS at the six-digit level (USITC, 2013). An earlier USITC study observed that "[T]here is no sound method for separating trade data for items classified under the same HS number" (USITC, 2005).

[10] A proxy is a measurable variable (in this case trade in a HS subheading) that is used in place of a variable that cannot be measured (in this case trade in a specific product that is hidden under the subheading in question)

[11] Another issue is that many goods may have both environmental applications and other, non-environmental uses (dual use). Including subheadings under which dual use goods are classified in a trade analysis may significantly overestimate environmental trade flows.

[12] This has been an issue in the context of discussions on trade liberalization of environmental goods, as many developing countries have expressed concern that liberalizing trade in broad HS subheadings might have implications for their domestic industries, whereas environmental benefits might be uncertain.

[13] One study carried out for ICTSD has tried to identify climate-related "single-use environmental goods (Vossenaar, 2010).

[14] The WTO's Doha Ministerial Declaration (WTO, 2001) includes a mandate under paragraph 31(iii) for the "reduction or, as appropriate, elimination of tariff and non-tariff barriers to environmental goods and services," but there is no agreed definition.

[15] Referring to "environmental goods sector", one study, quoted by Steenblik (2005), noted that "This business is less a sector than an agglomeration of providers of many types of goods, services and technologies that are usually integrated into production processes and are often hard to tease out as separate items." (US Office of Technology Assessment, 1994, p. 149)

[16] It has been noted that "researchers who rely on HS 8541.40 trade data as a proxy for "solar PV goods trade data" will vastly underestimate the increase in solar PV trade in recent years and possibly reach erroneous conclusions concerning solar PV goods trade" (Kirkegaard et al., 2010). The study in question analyses trade

flows for the period 1996-2008. Margins of error may gradually become smaller over time because, in general, solar PV goods account for a growing portion of total trade under the provisions of HS 854140.

[17] Information on import tariff rates can (and must) always be found as any product can be imported only under the provisions of a particular item in the tariff schedule of the importing country (among other reasons because an import duty may be levied). Many renewable-energy and other environmental goods are imported under the provisions of tariff lines that serve as a basket for both environmental and non-environmental products. Whereas it is difficult to asses the portion of trade corresponding to environmental goods the tariff rate is known.

[18] As explained in Box 5, we found that HS subheading 841919 (Non-electric water heaters) cannot be used as a proxy for global trade in solar water heaters (SWHs). We therefore excluded SWHs from the global trade analysis. However, Box 6 contains an analysis of China's SWH exports to other developing countries, using national tariff line-level statistics (see also Table 33).

[19] Mirror statistics are indicative of trade but usually do not reflect the whole picture. Consequently, one needs to be very careful when comparing mirror data with direct data.

[20] Growth rates shown are compound average growth rates (CAGR).

[21] Manufactured products have been defined as HS Chapters 28-96, e.g., all merchandise trade except agricultural products (traded under the provisions of HS Chapters 1-24), minerals (HS Chapters 25 and 26), fuels (HS Chapter 27) and miscellaneous products (HS Chapters 97 and 98).

[22] Products that are most closely associated with these sectors are classified under nine HS subheadings (see Annex 1).

[23] The 20 sub-headings were derived from both the combined APEC+OECD list as well as from various submissions made at the WTO by members in the context of negotiations to liberalize environmental goods under Para 31 (iii) of WTO's Doha Mandate.

[24] Based on the combined APEC+OECD list. The group provides for imports of environmental protection products and other unrelated products.

[25] The apparent similarity between the growth of trade in environmental protection products and manufactured products in general may be attributed to two factors. First, environmental technologies may simply not be a major driver of trade compared with other products hidden under the same HS subdivisions, which are in general very broad. Second, markets for certain environmental protection products may be relatively mature (compared with renewable energy) and similar to technologies for manufactured products in general.

[26] Trade data are shown in value terms. Since prices of key renewable energy supply products have been falling significantly in recent years, trade volumes have increased even faster.

[27] Developed countries include the EU27 member States and non-EU OECD countries, excluding Chile, Korea, Mexico and Turkey.

[28] For example, between 2004 and 2011, the value of US imports defined in terms of the solar PV-specific national tariff lines increased by 70 per cent per year on average, whereas the value of all US imports under the provisions of HS 854140 increased by "only" 28 per cent per year.

[29] The portion of extra-EU imports under the provisions of HS 854140 other than LEDs (i.e. CN 854140.90) increased from 73 per cent in 2004 to 94 per cent in 2008 and remained around this level until 2012. The portion of US imports of PV cells and modules in the subheading increased from less than 10 per cent in 2004 to over 70 per cent in 2012.

[30] The Table also shows sharp reductions in the value of 2012 imports (compared with 2011 imports) of solar PV cells and modules into China (38 per cent) and India (49 per cent .The value of India's imports from China, by far its largest supplier, fell by almost 50 per cent and imports from Malaysia and Chinese Taipei by more than 50 per cent. However, India's imports from the United States increased slightly (one per cent).

[31] In 2012, India's PV exports to other developing countries increased by one third, in value terms, whereas India's exports to the EU27 fell by more than 50 per cent.

[32] In the period 2007-2012, Chinese wind turbine manufacturers delivered (either through direct exports or through FDI-type operations) 485 MW to overseas market, more than half in 2012. Some 95 MW was delivered to developing country markets as follows: Brazil (34.5 MW), Ecuador (16.5 MW), India (15 MW), Thailand (13 MW), Pakistan (6 MW), Chile (5.3 MW) and Cuba (4.5MW). In comparison, Chinese companies delivered 264 MW to the United States (Bloomberg New Energy Finance, 2013).

[33] The main issue holding back investment in 2012 was instability in the policy regime for renewable energy in important developed-economy markets. China was the dominant country in 2012 for investment in renewable energy, raising its investment by 22 per cent to US$ 67 billion. There were also sharp increases in investment for several other developing countries, including South Africa, Morocco, Mexico, Chile and Kenya (Frankfurt School-UNEP Centre/BNEF, 2013).

[34] Similarly, GTM Research forecasts that countries in Latin America and the Caribbean will install more than 450 MW of grid-connected PV modules in 2013, compared with less than 100 MW in 2012.

Chile, Mexico, and Brazil have the highest potential for near-term growth, but there has also been development in other markets such as Peru, Ecuador, and some Caribbean countries Krulewitz,A. and Litvak,M. (2013).

[35] No PV projects were selected in auctions held in November and December 2013. However, the energy agency of the state of Pernambuco selected six PV projects totalling 122.8 MW through its first solar-only energy auction held in December 2013. The state government will hold a second energy auction for PV projects in the second half of 2014 (Photon News, 2014).

[36] The biofuels market (USD 95.2b in 2012) generated around USD 29.4 billion in imported biodiesel, but only USD 7.8 billion if intra-EU trade is excluded, This value was estimated using HS2012 subheading 271020 (Biodiesel containing by weight 70 per cent or more of petroleum oils or of oils obtained from bituminous minerals) and heading 3826 (Biodiesel and mixtures thereof, not containing or containing less than 70 per cent by weight of petroleum oils or oils obtained from bituminous minerals). The trade intensity of the hydropower market is low, as most of the costs relate to engineering, concrete and locally-available materials. In the case of small hydro, construction typically represents 60 per cent of total costs of an SHP installation (Rolland, 2011).

[37] IMS Research (2012).

[38] Kirkegaard, et al (2010) compared import levels for solar PV goods in four dominant markets with levels of global solar PV investments and total market size, suggesting a trade intensity of between 60 per cent and 90 per cent during the 2006–08 period. This is substantially higher than in the other main renewable source of power, wind energy, where Kirkegaard et al (2009) found global trade (import) intensities of only about 10 per cent.

[39] Idem.

[40] According to figures published in the 2013 UNEP Global Trends in Renewable Energy Investment report.

[41] The participating countries are Australia, Austria, Belgium, Canada, China, Denmark, France, Germany, Israel, Italy, Japan, Korea, Malaysia, Mexico, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States of America. Thailand is in the process of joining the PVPS programme.

[42] Of the total capacity installed in the IEA-PVPS countries during 2011, less than 0.4 per cent was installed in off-grid projects.

[43] Large, centralized power stations provide the most accurate data because capacity and production are published, metered, and reported to national authorities. Yet much solar PV capacity comes in the form of smaller distributed systems, where power production is consumed directly onsite. Off-grid solar PV systems are not monitored by utilities, and national statistics typically only cover installations over a certain threshold size. Solar PV capacity and production data can also be estimated from surveys or industry reports (Kirkegaard et al., 2010).

[44] The 2013 edition of the IEA-PVPS trends report estimates the market at 29.3GW. EPIA estimates that 31.1 GW of PV systems were installed around the world in 2012. The difference can be largely attributed to data on China: EPIA estimates that China added 5 GW, i.e. more than the 3500 MW reported by IEA-PVPS.

[45] The first market decline since at least 2000 was due largely to reduced incentives (including FIT payments) and general policy uncertainty, with the most significant drop in Italy (REN21, 2013).

[46] In 2012, Korea implemented the Renewable Portfolio Standards (RPS), which replaces the previous FIT scheme. The RPS scheme requires power producers with a capacity greater than 500 MW to generate two per cent of their total power from renewable energy sources and to raise this portion to 10 per cent by 2022. With a view to expanding the domestic PV market, the RPS has a specific target for PV-based power generation of 1.2 GW during the four-year period 2012-15 (of which 220 MW in 2002 and 330 MW in 2013). PV is a key sector for the Government's long-term vision in favour of "Low-carbon Green growth" and has also been designated as one of the nation's most important "New Growth Engine Industries." (Park, 2013)

[47] China is also an important producer, but without playing a leading role.

[48] In the long run, economies of scale and improvements in production process are drivers of price declines. PV prices first declined as a result of mass production and R&D efforts; more recently they declined mostly because of supply and demand gaps (as investment in production capacity was larger than the growth in demand (IEA-PVPS, 2012). In 2011 alone PV module prices dropped to around 1 US$/W from 2 USD/W or higher (IEA-PVPS, 2012).

[49] As noted in Chapter II, it is not clear to what extent off-grid and consumer solar PV markets are included in the international trade figures.

[50] New installations in 2012 fell by two-thirds to 3.3 GW from a record 9.3 GW in 2011. Italian authorities reduced feed-in tariffs (FIT) and set a financial cap as a limit for the cost of FIT to be borne by electricity consumers (the cap was reached in July 2013).

[51] Germany installed some 7.6GW of solar capacity in 2012, similar to 2011. Most of it is small-scale. The value of Germany's investment in sub-1MW PV projects fell by 15 per cent to USD 15 billion, reflecting the sharp reductions in module prices that took place during the year (Frankfurt School-UNEP Centre/BNEF, 2013). In 2013, however,

Germany installed only 3.3 GW of new solar capacity (EPIA 2014).

[52] During 2012, Chinese exports to developing countries as a group fell by 30 per cent, largely as a result of sharp declines in exports to Hong Kong and India (see Table 12).

[53] Comparing data on exports to China, Chinese Taipei, India and Thailand (Table 13) with direct import data for the same countries (Table 5) indicates that data on exports from these countries plus the United States may, in general, provide a good indication of PV imports. In fact, the value of exports (used as mirror data) in the period 2009-212 is 80 per cent of the value of direct imports.

[54] For example, "Bangladesh installed an impressive amount of off-grid SHS systems in recent years. Two million systems were operational by the end of 2012 with an average size of 60 W. This represents a total installed capacity of around 120 MW" (IEA-PVPS, 2013b).

[55] PV cells and modules account for a very large part of Chinese exports to Africa in HS 854140, but for only a mall part of Chinese exports in HS 854140 to other developing regions.

[56] In reality the share of different cost components varies by country and project, depending on turbine costs, site requirements, competitiveness of the local wind industry, and the cost structure of the country where the project is being developed (IRENA, 2012b).

[57] Of the 13.1 GW of new wind power capacity connected to the grid in the United States during 2012, 8.4 GW was installed in the fourth quarter alone, due in large part to impending expiration of the federal Production Tax Credit on 31 December 2012. The tax credit was later extended on 1 January 2013.

[58] According to the American Wind Energy Association (AWEA), over 12,000 MW of new generating capacity was under construction by the end of 2013, of which 10,900 MW started construction during the last quarter of 2013 (AWEA 2014). An important recent development was a change in the tax code, altering the required status of a PTC-eligible project from having to be "placed in service" by the deadline to only starting construction by year-end 2013 (Havens, 2013). Previously, a wind farm had to be producing electricity by the deadline to qualify for tax incentives. The 2013 PTC extension meant that wind farm developers had to start construction by 31 December 2013 to qualify for tax incentives.

[59] In particular: Argentina (76 MW); Chile (130 MW); Ethiopia (90 MW); Korea (79 MW); Mongolia (50); Pakistan (50 MW); Thailand (111 MW); and Uruguay (9 MW).

[60] World trade (including intra-EU trade) in 2011 is estimated at US$ 7.1 billion using import statistics, compared with USD 5.4 billion when export statistics are used. This difference can be attributed to several factors. First, the difference between FOB (Free on Board) and CIF (Cost, Insurance and Freight) values may be large because transportation (included in CIF values) of wind turbines may be costly. Another possible explanation is that wind components that are imported together with the wind turbine may also be imported under the provisions of HS 850231.

[61] According to export data for HS 850231 reported to COMTRADE by Viet Nam, including USD 280 million in exports to the United States. The United States reported USD 408 million in imports in wind towers (under HS 730820) from Viet Nam in the period 2008-2012.

[62] For example, it is estimated that the domestic content of the US wind turbines market has increased from 35 per cent in 2005-2006 to 67 per cent in 2011 (Wiser R and Bolinger M. (2012).

[63] MFN-applied tariff rates are applied uniformly to imports from 'most-favoured' trade partners. In most cases, these are WTO members without preferential trade agreements.

[64] Developing countries have been selected that (a) have submitted recent information on MFN-applied tariffs to the WTO and (b) import renewable energy products above a (low) threshold value, based on trade data reported to COMTRADE.

[65] Local content provisions have received much attention in recent analysis of domestic support measures in renewable energy sectors. See, for example: Bahar, Egeland and Steenblik (2013); GWEC (2013); Johnson O (2013); Kuntze and Moerenhout; (2013); UNCTAD (2013); and World Bank (2013).

[66] AD duties may be imposed by an importing country when a product is perceived to be sold in its market at a cost below the 'normal' cost that prevails in the exporter's home market. Countervailing duties are imposed by an importing country to offset the effect of a subsidy provided by the exporting country.

[67] Modules produced in China from cells produced in a third-country were not covered by the investigations, providing a loophole for Chinese manufacturers to export PV modules assembled from cells made in Chinese Taipei. This may have contributed to the 25.6 per cent increase in solar cell production in Chinese Taipei in (to 5.4 GW) in 2012 (IEA PVPS, 2013b).

[68] The price floor and volume cap are dynamic arrangements aimed at enabling Europe to take advantage of market-wide cost reductions and avoid supply shortfall (James and Mehta, 2013).

[69] Final AD and antisubsidy duties were imposed on polysilicon made in the United States in January 2014. AD duties were also imposed on Korea. No duties were imposed on imports from the European Union, following the agreement reached between the EU and China on solar cells and modules.

[70] In the first batch (FY 2010-11), the local content requirement for solar PV only applied to manufacturing of crystalline silicon modules,

thereby promoting module assembly. In the second batch (FY 2011-2012), the local content requirement also included manufacturing of crystalline silicon cells (Johnson 2013).

[71] Assessing the possible impact of LCRs on imports is always difficult. In the case being analysed here, impacts may have been limited for two reasons. First, LCRs were confined to the National Mission and did not extend to incentives applied to incentive schemes offered at the State level (the State of Gurajat, for example, attracted a lot of investment). Second, LCRs covered only silicon PV and did not apply to thin-film PV. Indian power producers imported significant quantities of thin-film PV cells and modules from the United States, benefitting from favourable financing conditions offered by the US EximBank. More recently, India now extended LCRS to cover thin-film. In February 2013, the United States notified the WTO Secretariat of a request for consultations with India regarding local content requirements.

[72] According to Johnson (2013), for LCRs to be effective, they must be (a) limited in duration and incorporate planned evaluation phases, (b) focused on technologies and components for which technical expertise is available and global market entry barriers are manageable, (c) linked to additional mechanisms, such as training and promotion of business linkages and measures to support other stages of the value chain and wider services that are integral to success of renewable energy industries. Mourenhout and Kuntze (2013) also identifies certain basic conditions that determine the feasibility of creating domestic industries and, perhaps, subsequent innovators. In addition to a stable and sizeable market, the financial support (to which LCRs are often linked) for the RE sector needs to be sufficiently large to avoid alienating potential investors. The local content rate must also not be too restrictive and must be associated with learning benefits, as knowledge of the current technology increases effectiveness. Finally, when technologies are still in their infancy, the potential of LCRs to reduce costs through learning-by-doing is higher. Given the prohibition on LCRs imposed under WTO rules, Stephenson (2013) calls for enabling some policy space for countries to use LCRs with an eventual time-bound phase. She also suggests regional content requirements' to allow accumulation of the LCR within a region rather than within a country as an interim measure to reduce negative trade impacts while the LCRs are eventually phased out.

[73] The MERCOSUR Common External Tariff (CET) is zero. Using its right to maintain 100 exceptions to the CET until 31 December 31 2015, in 2009 Brazil increased its rate to 14 per cent.

[74] Brazil has a dynamic wind market. Annual additions to Brazil's wind-power generating capacity more than doubled from 264 MW in 2009 to 583 MW in 2011 and more than 1000 MW was added in 2012 (85 per cent more than in 2011) and 948 MW in 2013. The value of Brazil's imports also more than doubled between 2009 and 2011, but it decreased by one third in 2012 despite the large growth in new capacity installations. Imports recovered in 2013, growing 23 per cent in value terms (COMTRADE).

[75] After a first bidding round in November 2011, South Africa concluded its second round in March 2012 and a third in August 2013. The programme had not yet resulted in new capacity increases by the end of 2012, but construction work had started in several large wind farms. The largest of these projects resulted in increased South-South cooperation and trade as construction of a wind farm with installed capacity of 138.6 MW (consisting of 66 wind turbines with a capacity of 2.1 MW each, delivered by Indian wind company Suzlon) was started in early 2013 (blades and turbines were imported into South Africa in 2013, but are not yet reflected in trade statistics presented in this paper).

[76] For an analysis of the APEC agreement see Sugathan and Brewer (2012) and Vossenaar (2013).

[77] Assessing trends in global South-South in PV cells and modules, the most trade-intensive renewable energy sector, is challenging because a large portion of South-South trade in HS subheading 854140, which is used as a proxy for trade in PV cells and modules, is in unrelated products, in particular LEDs.

[78] The 2012 version of the HS provides separately for certain products that are relevant for renewable energy technologies and products. These include, for example, biodiesel and new subheadings for accumulators (HS 850750 for nickel-metal hydride accumulators and HS 850760 for lithium-ion accumulators). The process is however time-consuming and may not be readily responsive to the needs of trade analysts and negotiators. Furthermore, even when a new HS digit code is created to specifically provide for an environmental good (for example biodiesel in the 2012 version of the HS), global trade statistics for such products may only be available from that year onwards and not for the years before the revision came into effect.

[79] For example, South Africa inserted 11 new eight-digit tariff lines (TL) in its 2012 tariff schedule following a request from its International Trade Administration Commission (ITAC) to create separate tariff lines for the identification and monitoring of certain green goods.

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