

Economic and Social Commission for Western Asia (ESCWA)

**Fact Sheet:
Best Practices and Tools for Large-scale Deployment of
Renewable Energy (RE) and Energy Efficiency (EE) Techniques**

I. THE INTERNATIONAL CONTEXT

- According to the International Energy Agency (IEA), the BLUE scenario for carbon abatement is the most ambitious emission reduction scenario at the 2050 horizon. This scenario explores the possibilities to keep global temperature increases below 2.4°C.
- The BLUE scenario states that energy-related emissions would need to be halved by 2050 compared to the 2005 levels. End-use efficiency accounts for 36 per cent to 44 per cent of all reductions in BLUE, and for 21 per cent in renewables.
- IEA Executive Director, Mr. Nobuo Tanaka, estimated that energy efficiency (EE) and renewable energy (RE) (including biofuels) could account for respectively 54 per cent and 23 per cent of the necessary abatement effort by 2030.
- Renewable energies can contribute to satisfying the demands of electricity and transport, and could be as well used in the heating and cooling sector, while reducing emissions.
- The mainstream of investment flows in the last decade has been mainly oriented to the power sector through investing in wind and solar projects and manufacturing facilities.
- A significant milestone was reached in 2008 when renewables represented more than 50 per cent of total added power generation capacity in both the European Union and the United States.
- Hydropower technologies are well established and have been used for decades, therefore:

This fact sheet only concentrates on large-scale wind and solar energy applications.

II. RENEWABLE ENERGY (RE)

A. LARGE-SCALE APPLICATION TECHNOLOGIES

- Wind Technologies:

- Horizontal Axis Wind Turbines (HAWTs) are the most common type of wind technologies and are the largest rotating machines.
- The turbine size has increased from approximately a rated power of 50 KW and a rotor diameter of 10-15 m up to today's commercially available 5-6 MW machines with a rotor diameter of more than 120 m.
- In addition to becoming larger, wind turbine design concepts have been progressing from fixed speed, stall-controlled and drive trains with gearbox to variable speed, pitch-controlled with or without gearbox.

- The past few years have seen a leveling of turbine size in the 1.5-3 MW range. This has enabled series production of many thousands of turbines of the same design.
- A wind farm composed of several turbines generates power from renewable energy on a large scale.
- Onshore wind farms are built on land, while offshore wind farms are built in the sea. Offshore wind turbines have higher capacity, however they require more civil and maritime work.

- Solar Technologies:

- Solar energy is used in producing heat and electricity.
- Solar water heaters are used in small-scale applications. However, the number of solar water heaters in use would have a large impact on emissions abatement.
- There are two different main approaches to generate electricity from the sun on a larger scale: solar-thermal, mainly Concentrating Solar Power (CSP) technologies, and Photovoltaic (PV) systems.

Concentrating Solar Power (CSP)

- CSP technologies are based on the concept of concentrating solar radiation to be used for electricity generation with conventional power cycles using steam turbines, gas turbines or Stirling engines.
- The main four CSP technologies are: parabolic trough systems, linear Fresnel systems, dish systems and power tower or central receiver system with distributed reflectors (heliostats).
- Large scale CSP projects would use parabolic troughs, linear Fresnel systems and power towers coupled to steam cycles.
- CSP systems achieve average solar-to-electricity efficiencies of about 10-15 per cent.
- CSP plants can work in hybrid operation, i.e. can be operated with fossil fuel as well as solar energy.
- Another mode of operation is storing, thus solar heat collected during the daytime can be stored in such liquid or solid media as molten salts, ceramics, concrete or phase-change media.
- The stored heat can then be extracted at night for running the power block. Their thermal storage capability and hybrid operation with fuels allows CSP plants to provide power on demand.
- The CSP systems availability is about 90 per cent.
- Individual CSP plants are now typically between 50 and 280 MW in size, but could still be larger.

Photovoltaic (PV) Systems

- A photovoltaic panel generates electricity when light energy (photon) hits a semiconductor surface and releases electrons that would generate voltage differences.
- Large numbers of PV panels are needed to generate electricity on a large scale.
- Technologies used in PV systems include heavy layers of pure silicon or thin film coatings of semiconductor materials.
- PV systems efficiency has increased during the last decade and reached a maximum of 20 per cent in some commercial panels.
- PV systems availability could reach 90 per cent, however its capacity factor could be low as its capacity is usually measured in midday full sun conditions.
- About 90 per cent of the current production uses wafer-based crystalline silicon technology.

- The ongoing shortage in silicon feedstock and the market entry of companies offering turn-key production lines for thin film solar cells led to a massive expansion of investments into thin film capacities.
- As for other PV technologies, it is hoped that new products will enter the market enabling further cost reduction.

B. EXISTING LARGE-SCALE RENEWABLE ENERGY APPLICATIONS

- Wind: Global Existing Capacity:

- At the end of 2008, the worldwide capacity of wind-powered generators reached a total of about 121 GW. More than 80 countries around the world had commercial wind power installations by 2008, allowing wind to produce about 1.5 per cent of world-wide electricity use, up from 0.1 per cent in 1997.
- Total worldwide installations in 2008 were more than 27,000 MW, a growth of 28.8 per cent compared to 2007, dominated by the three main markets in Europe, North America and Asia.
- At present, a few grid systems have penetration of wind energy above 5 per cent; Denmark already gets 21 per cent of its gross electricity demand from the wind, Spain almost 12 per cent, Portugal 9 per cent, Ireland 8 per cent and Germany 7.5 per cent.
- There are several projections for the future. The most conservative projection of these scenarios indicated that by 2020, global capacity would stand at 352 GW, with an annual capacity increase of around 30 GW, while in the advanced projection, global capacity would be over 1,000 GW by 2020.

- Solar: Global Existing Capacity:

Concentrating Solar Power (CSP)

- The total CSP capacity whether in operation or under installation was 1,023 MW by mid of 2009.
- The most mature and commercialized technology is the parabolic trough and it is still expected to dominate for the next two decades.
- Most of the projections assume advanced industry development, thus CSP could meet up to 7 per cent of the world's projected power needs by 2030 and a full quarter by 2050.
- Another moderate projection predicts that the world would have a combined solar power capacity of over 830 GW by 2050. This would represent 3.0-3.6 per cent of global demand in 2030 and 8.5-11.8 per cent in 2050.

Photovoltaic (PV) Systems

- In 2008, the Global Photovoltaic (PV) market reached 5.6 GW and the cumulative PV power installed totaled about 15-16 GW. About 94 per cent of the total global PV systems sales in 2008 were grid-connected applications (residential, small, medium and large commercial, large field commercial and utility).
- The year 2004 was a milestone year, when, for the first time, grid-connected PV capacity surpassed the off-grid (stand-alone) systems.
- During the period 2004-2008, demand for large field grid-connected utility-scale solar PV power plants in Europe defined as larger than 200 KW, largely driven by the feed-in tariff model of incentives, led to the largest global market for solar systems.
- The European Union accounts for about one third of the annual worldwide PV-module production and use.

- The PV market dynamism remains fragile because it is still closely linked to national programmes of grid-connected PV systems.
- The strong growth that the PV industry has enjoyed since 2004 was driven by incentives, in particular, the feed-in tariff laws in Europe.
- In 2013, and under the business-as-usual scenario, it is expected that the global annual market reaches 12 GW, while under favorable policy frameworks, the global PV market could reach 22 GW.

C. INVESTMENTS IN RENEWABLE ENERGY PROJECTS

- The United Nations Environment Programme (UNEP) estimates the overall global investments in sustainable energy at US \$155 billion in 2008 (financing of EE projects hardly features in the estimates).
- Compared to the US\$33 billion in 2004, the annual average growth in the last four years was 45 per cent.
- Asset finance reached about US\$110 billion (including small-scale projects).
- This is equivalent to about 9 per cent of global energy infrastructure investment.
- Wind was the leading sector in 2008, accounting for 48 per cent, followed by solar (22 per cent), biofuels (15 per cent), and biomass and waste (7 per cent).
- The share of Europe and the industrialized countries is close to US\$50 billion and US\$82 billion, respectively. This share was due to a supportive policy in many European countries, as well as an investor base that is comfortable with financing RE projects, and more intense competition for deals.
- The share of developing countries continued to increase, reaching 31 per cent in 2008, with US\$36.6 billion, almost 20 times the 2004 level of US\$1.8 billion.
- China attracted almost 50 per cent of that share.

D. COMMERCIAL VIABILITY OF RENEWABLE ENERGY PROJECTS

- It is frequently assumed that, if any renewable technology reaches a cost of US\$0.10 per KWh of electricity generated (assuming price of oil around US\$70/barrel), it can be considered as being economically competitive or close to competitiveness.
- Provided that resources and market conditions are favorable, the economically or near economically renewable energy technologies are small and large hydropower, onshore wind power, geothermal power and biomass power.
- Solar PV and CSP technologies are expected to be economically competitive on the long term when cost reductions stemming from the continued R&D seeking higher productivity and efficiency as well as large-scale applications (economy of scale) are achieved.
- For the ESCWA region, wind and solar technologies are considered the most promising as there are considerable potentials that would allow for large scale grid-connected electricity generation.
- In general, EE measures are self financing with expected benefits to be forecasted in detailed energy audits.

E. RENEWABLE ENERGY POTENTIALS IN THE ESCWA REGION

- The ESCWA countries are sunbelt countries that enjoy an annual mean of more than 4 KWh/m²/day, with considerably high sunshine duration, ranging between 9-11 hours per day from North to South, and with very few cloudy days. Furthermore, there are abundant arid sunny desert areas, which can be used for both PV and CSP systems.
- The wind resources are more or less locally concentrated. However, wind-generated electricity can be distributed through the electricity grid. Many locations have very good wind regimes for electricity

production. These include such countries as Egypt and Oman, which have high average annual wind speed (9-11 m/s in some locations). Other several locations have moderate wind speed (6-8 m/s) that is also sufficient for generating electricity.

- The renewables potentials in the ESCWA region can not only satisfy the development requirements within the region, but also part of the needs of neighbouring regions.
- The electrical interconnections availability is a major limitation to transfer solar-based large-scale electricity from the desert regions to the load centres.

F. LARGE-SCALE RENEWABLE ENERGY PROJECTS IN THE ESCWA REGION

- Egypt is the leader with a total capacity of 430 MW in wind energy in 2009.
- Several countries have adopted ambitious goals to increase reliance on wind energy:
 - In Egypt, it is expected that 12 per cent of the total electric energy generated by the year 2020 will be from large-scale renewable energy projects.
 - Jordan's plans include the establishment of wind farms with a capacity of 600 MW until 2020. Additionally, it is expected that the envisaged Shams Ma'an PV project in Jordan would have an initial capacity of 100 MW, which can be expanded to 200 MW.
 - The United Arab Emirates is investing heavily and extensively in wind power in many Arab and foreign countries.
 - Saudi Arabia began the preparation of feasibility studies for the establishment of two wind farms, the first with capacity ranging from 20 to 40 MW, and the other with a capacity of 10 MW.
 - Yemen has a 60 MW wind farm in the development phase.
 - In addition to this, many countries, such as the Sudan and Syria, carry out resource assessment studies for wind energy as a prelude to setting goals commensurate with their potential. It is worth noting that preliminary assessments indicate that many ESCWA member countries possess potentials that would allow utilizing wind energy on a commercial scale.
- Several ESCWA member countries engaged in solar energy projects:
 - Egypt started the construction of its first grid-connected large-scale CSP project Integrated Solar Combined Cycle (ISCC) of 140 MW with 20 MW solar share, which is expected to be operative by late 2010.
 - Egypt intends to build two new CSP projects with 50 MW each, as well as a 20 MW large-scale grid-connected PV plant in south Egypt by the year 2017.
 - Kuwait has completed a technical feasibility study for the construction of a solar thermal power plant with a capacity of 280 MW, including 60 MW solar component.
 - In the United Arab Emirates, the Abu Dhabi Company for Future Energy, known as Masdar, has already connected a 10 MW PV plant to the grid, and expects the 100 MW Shams 1 CSP plant to be online by late 2011, and the Shams 2 plant by mid-2013.
 - Masdar is also studying the feasibility of the establishment of some plants to produce solar electricity and desalinated water from 500 MW solar plants in Arab countries or abroad.
 - Jordan is intending to build a 100 MW PV plant.
 - Yemen has launched rural electrification projects based on PV systems in cooperation with Germany. ESCWA is also finalizing the Ka'awa Village PV Electrification Project in Yemen.

- In November 2007, the Gulf countries of the Organization of Petroleum Exporting Countries (OPEC) pledged a total of US\$750 million to a new fund to tackle global warming through research for a clean environment.
 - Kuwait, Qatar, and the United Arab Emirates pledged US\$150 million each for the fund.
 - Saudi Arabia, the world’s biggest oil exporter, will invest US\$300 million in the fund.

III. ENERGY EFFICIENCY (EE)

- EE measures could be:
 - Passive measures: focused on reducing the need for energy consumption.
 - Active measures: focused on improving the efficiency of the functions using energy.
- EE projects try to retrofit existing tools and equipment, change some processes, and adopt monitoring and management measures to reduce the overall energy consumption in a facility, while keeping the same level of productivity.
- Complete energy audits are usually needed, resulting in classifying and prioritizing EE measures that can be adopted, with detailed financial analysis for each measure.
- **ESCWA has already issued a promotional material on Energy for Sustainable Development in the Arab Region: the Efficient Energy Management in Selected Economic Sectors” in 2009, and is in the process of issuing a promotional material on Efficient Energy Management in the Tourism Sector. Therefore, the focus in this fact sheet is mainly on renewable energy issues.**

IV. AVAILABLE FINANCING MECHANISMS

- As the financing of large-scale RE and EE projects forms the major barrier towards deployment of large-scale renewable energy applications, several financing mechanisms have been established worldwide:
- There are 22 international RE & EE financing mechanism/funds:

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| <ul style="list-style-type: none"> ◦ European RE Fund LP (Platina Partners) ◦ EnerCap Power Fund LP ◦ GEEREF ◦ FIDEME ◦ CAREC ◦ 1st Energy Conservation Programme ◦ UkrESCO ◦ Bulgarian ESCO Fund ◦ PROSOL ◦ EmPower New YorkSM ◦ TPPPA for Solar PV |
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| <ul style="list-style-type: none"> ◦ CHUEE ◦ Berkeley FIRST ◦ Grameen Shakti ◦ USAID Development Credit Authority ◦ 2nd Energy Conservation Programme ◦ BEEF IREDA ◦ Carbon Trust ◦ EE Revolving Fund ◦ EBRD SEFF AFD Climate credit line |
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- 16 of these mechanisms target developing countries or countries in transition.
- 5 of these mechanisms are global or regional in scope.
- 5 of these mechanisms provide equity/quasi-equity, 13 debt, 3 guarantees and 1 pure grant.
- 4 of these mechanisms involve Energy Service Companies (ESCOs) and 4 energy utilities.
- 5 of these mechanisms schemes target households.
- 16 of these mechanisms involve private financial intermediaries, 6 public or non-profit.
- Carbon finance is also available:
 - The Kyoto Protocol has set emission reduction targets for Annex I (industrialized) countries, to be on average 5.2 per cent below the 1990 levels during the first commitment period of January 2008 to December 2012.

- The ESCWA region is comprised of non-Annex I parties and therefore stands to benefit from the Clean Development Mechanism (CDM), which also allows industrialized countries to achieve part of their emission reduction commitments by implementing emission reduction projects in developing countries without emission reduction targets.
- Currently, there are some CDM projects in such countries as Bahrain, Egypt, Jordan and United Arab Emirates.
- In the Gulf, many companies and consulting firms have begun to explore this fast-developing field.
- The New and Renewable Energy Authority of Egypt was the first entity to pursue a CDM project in the field of renewable energy (wind) in the region.

V. HOW TO PROMOTE THE DEPLOYMENT OF LARGE-SCALE RENEWABLE ENERGY (RE) AND ENERGY EFFICIENCY (EE) TECHNIQUES

The key stakeholders involved in the large-scale renewable business are Governments, renewable manufacturing industries, renewables service industries, lenders, financiers, traditional energy utilities and companies, trade and export organizations, energy and environmental non-governmental organizations, and consumers and energy offtakers. The responsibilities should be shared by all stakeholders in all development phases.

However, Governments are the main stakeholder and have a key role in promoting and encouraging the deployment of large-scale renewable energy and energy efficiency techniques and projects.

Policy and Regulatory Issues

- Have consistent rules at national and local levels;
- Have clear rules of ownership and control of alternative energy facilities;
- Have effective market policies;
- Adopt encouraging tariff pricing, including standby charges and feed-in tariffs;
- Acquire renewable energy through competitive bidding process with known renewable portfolio standards;
- Provide governmental incentives that tackle taxes, carbon credits and other incentives;
- Facilitate and expedite the approvals and applications processes;
- Establish renewable energy fund that uses the “anticipated fuel savings” from RE/EE projects in financing such projects.

Technical Issues

- Assess grid connection points;
- Assess grid stability and protection requirements;
- Assess equipment and capacity requirements;
- Adopt clear metering procedures tackling telemetering/communication channels, and net metering;
- Cooperate between all concerned parties for upgrading the existing transmission grid by removing bottlenecks and for more dependence on HVDC lines, together with advanced "smart" dispatching control to transfer large-scale solar-based electricity generation from deserts to load centres.

Contractual Issues

- Clarify the dispute resolution processes;
- Develop adequate Power Purchase Agreements (PPA);

- Assess the potentials to benefit from the different financing mechanisms;
- Facilitate the processes to reach financing mechanism(s).

Capacity-building

- Encourage the establishment of specialized training and consultancy houses to prepare qualified human resources for large-scale renewable projects;
- Encourage the establishment of service companies to serve Independent Power Producers (IPP) projects on both the national and regional levels;
- Perform perception correction campaigns, as well as risk management approaches to overcome the lack of knowledge and cautious attitude toward renewables.