RENEWABLE ENERGY

Medium-Term Market Report 2014

EXECUTIVE SUMMARY

Market Analysis and Forecasts to 2020

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The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 29 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency's aims include the following objectives:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
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- In 2013, new renewable power capacity expanded at its fastest pace to date. Globally, renewable generation was estimated on par with that from natural gas.

- Over the medium term, renewables face a transition period. Despite strong anticipated generation growth, new generation, capacity additions and investment in renewable power are all expected to level off through 2020. Biofuels for transport and renewable energy use for heating and cooling face slower growth and persistent policy challenges.

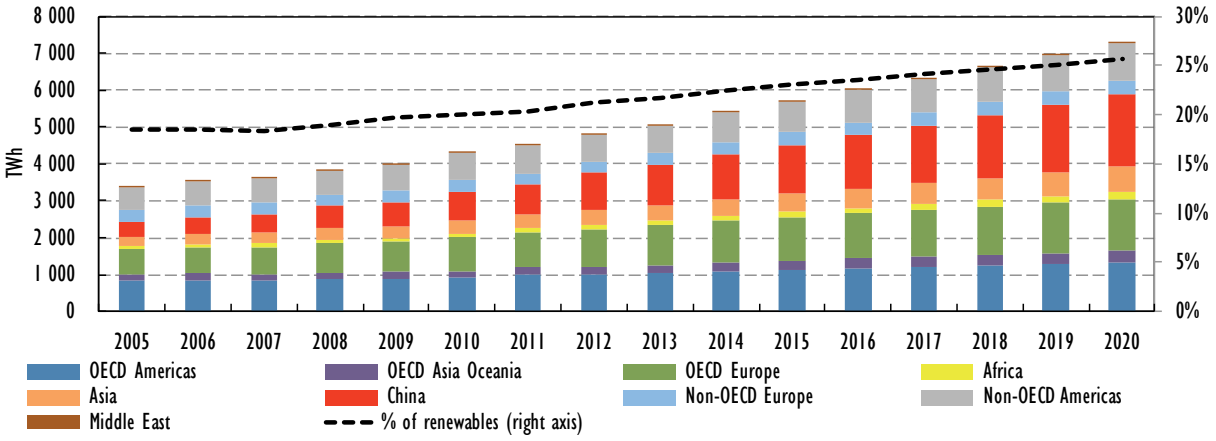
- Even with growing competitiveness, policies remain vital to stimulating investment in capital-intensive renewables. Scaling up deployment to higher levels would require stable, long-term policy frameworks and market design that prices the value of renewables to energy systems and increases power system flexibility to ensure system adequacy with greater variable renewables.

The role of renewables in the energy mix continued to expand in 2013

In 2013, global renewable electricity generation rose by an estimated 240 terawatt hours (TWh) (+5.0% year-on-year) to reach nearly 5 070 TWh and accounted for almost 22% of total power generation. The expansion was somewhat slower than that predicted in the *Medium-Term Renewable Energy Market Report 2013* (*MTRMR 2013*), largely due to lower-than-expected annual hydropower availability and slower-than-expected growth in bioenergy generation. However, the renewable capacity expansion was faster than that foreseen in *MTRMR 2013*, with larger-than-expected deployment of hydropower and solar PV.

Globally, renewable generation was on par with that of natural gas, whose generation declined slightly in 2013, but remained behind coal, which was almost double the size of renewables. This result stems from the strength of the continued renewable expansion as well as difficult economics for gas generation in many member countries of the Organisation for Economic Co-operation and Development (OECD) in 2013 and difficulty to access affordable gas supplies in non-OECD regions (see IEA, 2014a for discussion on recent gas market trends).

Figure 1 Global renewable electricity production by region, historical and projected



Notes: unless otherwise indicated, all material in figures and tables in this chapter derive from International Energy Agency (IEA) data and analysis. Hydropower includes pumped storage; the onshore and offshore wind split is estimated; total generation is gross power generation.

The percentage change in renewable generation was somewhat slower than in 2012, despite record annual renewable deployment of nearly 123 gigawatts (GW). Hydropower deployment reached 41 GW in 2013, partly due to the early commissioning of new capacity in China. But the return of hydro availability to more normal levels in China and the effects of drought in Brazil caused global hydropower generation to expand by less than 2% year-on-year compared to over 4% in 2012. Non-hydropower renewable generation grew rapidly by almost 16% year-on-year, similar to the rate in 2012. New solar photovoltaic (PV) capacity (+39 GW) surged in 2013, led by China and Japan, where deployment is incentivised through attractive feed-in tariffs (FITs). Onshore wind additions (+34 GW) were their lowest since 2008, largely due to a drop in new capacity in the United States stemming from policy uncertainty over the renewal of federal tax incentives at the end of 2012. Though smaller, solar thermal electricity (STE) additions were equivalent to the record level achieved in 2012, and offshore wind was deployed at its highest level to date, with the start of several large projects long under development.

Global biofuels production rose by almost 7% in 2013 to reach over 115 billion litres (L), 3 billion L higher compared with that predicted by *MTRMR 2013*. In Brazil, ethanol output was boosted by a higher-than-expected sugar cane harvest that led to a 2 billion L additional ethanol production compared to the previous forecast. In the United States, ethanol production rose marginally in 2013, as the effect of elevated corn prices resulting from an extensive drought in the previous year was mitigated after the 2013 corn harvest. Biofuels output, adjusted for energy content, accounted for 3.5% of global oil demand for road transport in 2013, versus 3.4% in 2012 and 2.0% in 2007. Meanwhile, the geography of biofuels policy support is shifting; while backing for increased biofuels volumes is waning in several key markets – the United States, the European Union and Brazil – it is expanding in newer non-OECD markets, such as Southeast Asia.

World final energy use for heat (FEH) accounts for more than half of final energy consumption, with three-quarters of this met with fossil fuels. FEH has a significant impact on energy security and is responsible for around one-third of global energy-related carbon dioxide emissions. Global final energy use of renewable sources for heat, excluding traditional biomass, rose by over 2% in 2013 to 14.5 exajoules (EJ), accounting for only 8% of world energy use for heat, only slightly higher than in 2012 and 2007. Final energy use of renewable energy for heating and cooling is rising globally, driven by support policies and increasingly by cost-competitiveness with fossil fuels, but policy frameworks are generally underdeveloped compared with the electricity and transport sectors.

Strong market drivers, but increased risks for renewable power deployment ahead

Over the medium term, global renewable electricity generation is projected to grow by almost 45%, or 2 245 TWh, to over 7 310 TWh in 2020 (+5.4% per year). Hydropower, including output from pumped storage, represents about 37% of total growth, followed by onshore wind at 31% of total growth. Compared with the *MTRMR 2013*, renewable generation is seen 180 TWh lower in 2018, due less optimistic outlooks for hydropower, bioenergy, wind (onshore and offshore) and STE. The hydropower forecast versus *MTRMR 2013* has been revised down largely due to a slower-than-expected expansion in China and in the non-OECD Americas. Bioenergy is seen growing more slowly in China. For wind, onshore and offshore, the forecast has been revised down in China, OECD Europe, the United States and Australia. Growth in STE is likely to be slower-than-expected in the United States, China and the Middle East over the forecast period. By contrast, the outlook for solar PV has been revised up in many areas, notably China and Japan.

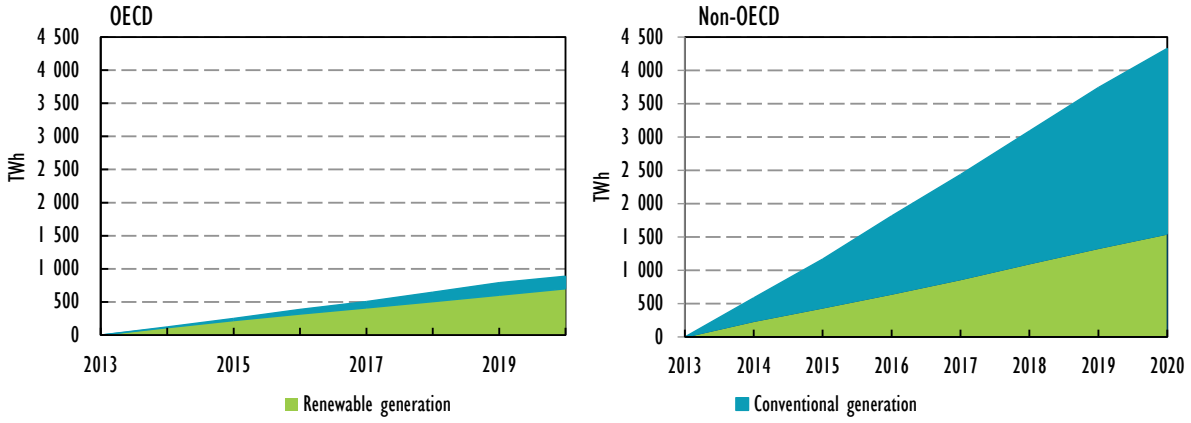
Two global trends should help drive the deployment of renewable power capacity, which is expected to rise from a global total of 1 690 GW in 2013 to 2 555 GW in 2020 (growth of 50%). First,

deployment should spread out geographically as renewable electricity capacity scales up. Second, renewable technologies are becoming increasingly competitive on a cost basis with alternatives in a number of countries and circumstances.

Still, compared to *MTRMR 2013*, increased policy and market risks cloud the development picture, raising concerns over how fast renewables can scale up to meet long-term deployment objectives. In this report's **baseline case** forecast, annual growth in new renewable power capacity is expected to stabilise over 2013-20, a departure from the previous decade's upward trend of rapidly increasing annual growth in some technologies. This trajectory reflects growing risks to deployment in some key OECD markets. At the same time that barriers to development remain in a number of non-OECD areas, including China, and deployment is not expected to proceed as fast as envisaged in *MTRMR 2013*. Nevertheless, this conservative outlook is not inevitable – with certain market and policy enhancements, the most dynamic renewable technologies could grow faster through 2020 than in this report's baseline case (see "Enhanced Case" below).

Under the baseline case forecast, non-OECD markets are expected to account for around 70% of new renewable power generation from 2013-20. Many non-OECD countries have dynamic power systems, with fast-growing demand and diversification needs providing strong drivers for renewables, which are increasingly competitive versus other new generation. To this end, a number of markets have adopted long-term policy frameworks. Combined with good resources and the falling costs of some technologies, such as solar PV, these conditions should support increasing levels of deployment with reduced financial incentives. Renewables are seen as the largest new source of non-OECD generation through 2020. Yet, they meet only 35% of fast-growing electricity needs, illustrating the still-significant role of fossil fuels and large upside for greater renewable growth. Many non-OECD countries, such as those in the Middle East, remain at the inception or early take-off phase of development, with deployment likely to accelerate to high levels only over the long run.

Figure 2 Cumulative change in gross power generation by source and region, 2013-20

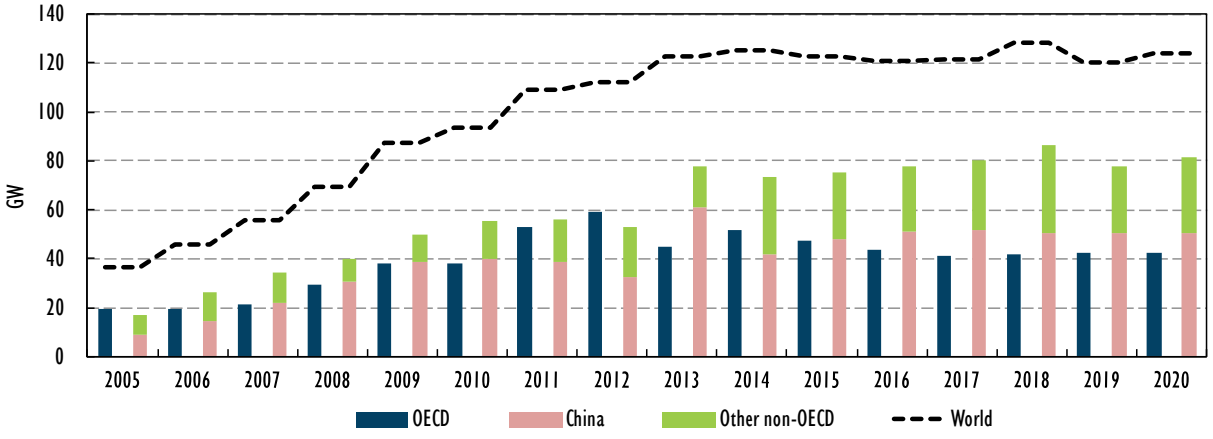


China remains the anchor of renewable capacity deployment, accounting for almost 40% of the global expansion and over 60% of non-OECD growth. Strong generation needs, pollution reduction goals and a favourable policy environment with ambitious targets support China's deployment. There, renewables should account for nearly 45% of incremental power generation over the medium term, ahead of coal. In addition to hydropower and onshore wind, whose significant deployment should continue, solar PV, whose costs have fallen rapidly, has become a strategic pillar of the energy

system. Still, several challenges have emerged. In China, the outlook for power demand has notably slowed versus *MTRMR 2013*. Moreover, the pace of new hydropower approvals has reduced, integration challenges remain for large amounts of new onshore wind, and questions have emerged over whether conditions are favourable for an ambitious planned expansion of distributed solar PV.

Among other non-OECD regions, the Americas and the rest of Asia should make the largest growth contributions. The steady expansion of hydropower, onshore wind and bioenergy capacity in Brazil, supported by the government's long-term auction scheme, underpins the outlook in the Americas. India's diverse set of targets and financial incentives supports the growth of hydropower, onshore wind, solar PV and bioenergy, underpinning the Asia forecast. Other emerging markets, such as Thailand and Indonesia, are also expected to contribute. In Africa, non-OECD Europe and Eurasia, and the Middle East, growth remains more nascent. Some markets should scale up from low bases, such as South Africa, backed by a long-term auction scheme, and Saudi Arabia, which has announced aggressive long-term targets backed by auctions. However, non-economic barriers, needed grid upgrades, and high costs and reduced availability of financing may represent persistent risks and constraints in many non-OECD areas.

Figure 3 Renewable electricity annual net capacity additions, historical and projected



In the OECD, after several years of rapidly increasing growth, renewables are transitioning to a slower but stable annual capacity expansion. Renewable generation is expected to account for near 80% of new power generation from 2013-20. While a significant share, there is limited upside potential to growth given overall sluggish demand and policy risks in key markets. Within the OECD, the growth of renewables has been driven by strong policy support for decarbonisation, a desire for diversification and retirements of conventional power plants. In many cases, the rapid deployment of renewables requires scaling down of part of the existing energy system, which is putting incumbent utilities under severe pressure. In addition, while renewables are now much more competitive with other forms of electricity, all power generators are struggling in OECD markets where there is oversupply and low wholesale prices. These trends are particularly marked in Europe.

OECD power markets increasingly fall into three categories: dynamic systems with rising demand and new generation needs; stable systems with sluggish demand growth and overcapacity; and markets in between, usually with slow demand growth, but a need for capacity replacement due to diversification aims or retirements. Dynamic markets (e.g. Chile, Mexico, Korea and Turkey) have strong drivers for renewable deployment, but face hurdles in scaling up deployment due to non-economic barriers or the

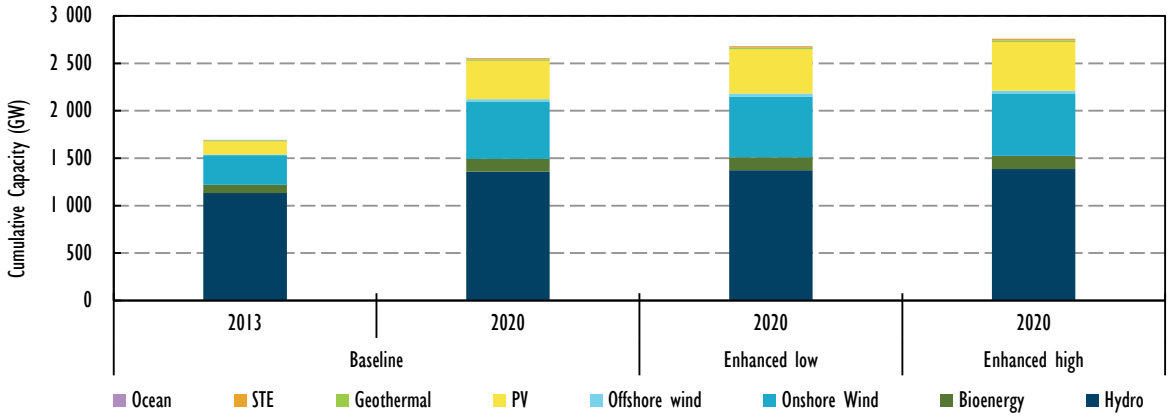
cost/availability of financing. Other systems, such as those with relatively stable demand but diverse supply-side needs (e.g. the United States, Japan, some European markets) face challenges to maintain regulatory frameworks that offer a reasonable degree of remuneration certainty while shifting towards lower levels of economic incentives and integrating higher penetrations of variable renewables.

Policy risks in the latter group of countries represent a significant factor behind an expected stabilising of new renewable growth. In the European Union, uncertainties remain over the precise nature of the post-2020 renewable policy framework and the build-out of a pan-European grid to facilitate the integration of variable renewables. In Japan, there is considerable uncertainty over the future evolution of the FIT scheme and grid integration issues pertaining to solar PV. In the United States, announced federal regulations on existing power plant emissions should help support renewables going forward, but questions persist over the durability of renewable tax incentives, and heated debates are occurring in a number of states over renewable portfolio standards and rules for promoting distributed generation.

Higher renewable electricity deployment possible under enhanced case conditions

This report includes an enhanced case in order to show the potential impacts on deployment from certain market and policy enhancements that help to address challenges to renewable deployment. Under the enhanced case, the most dynamic renewable electricity sources (i.e. solar and wind) could grow faster than the baseline case. A number of country-specific developments, as described within each regional outlook, would need to occur for this result to occur, making it difficult to anticipate and more approximate in nature than the baseline case. The enhanced case is represented by a range and is indicative of the potential upside for cumulative capacity in the year 2020.

Figure 4 World renewable power capacity, baseline and enhanced case projections



Broadly speaking, achieving enhanced renewable deployment would require alleviating some of the challenges enumerated above and repeated through this report. These include, but are not limited to, the rapid clarification of policy uncertainties in some markets; the implementation of stable and sustainable policy frameworks that give greater certainty about the long-term revenue streams of renewable projects; greater measures to ensure the grid and system integration of variable renewables; the implementation of fair rules and appropriate electricity rate design for allocating the costs and benefits from fast-growing distributed solar PV; improved reductions in non-economic barriers; and faster-than-expected decreases in renewable technology and generation costs.

Under the enhanced case, renewable capacity could be 125-205 GW higher in 2020 than the baseline case. Solar PV and onshore wind, with relatively short development times, have the largest upside. In the enhanced case, solar PV could reach a cumulative 465-515 GW in 2020 while onshore wind could climb to 635-655 GW. Further details are in the regional and technology chapters in this report.

Improving competitiveness, but market and policy frameworks keys for investment

Supported by long-term policy frameworks, renewable investment has risen to high levels, from a variety of financing sources. Still, the capital-intensive nature of projects can make the risk/return profile of such assets challenging for investors. In 2013, global new investment in renewable power capacity was estimated over USD 250 billion, down slightly versus that in 2012, and lower than the near USD 280 billion registered in 2011. Despite overall higher global capacity additions (123 GW), declining unit investment costs in solar PV and onshore wind put downward pressure on investment levels. Over the medium term, annual investment in new renewable power capacity is seen averaging a somewhat lower level, at above USD 230 billion annually, in real terms, through 2020. In 2014, investment is seen just under USD 250 billion as total renewable capacity additions remain around 125 GW, but annual investment slows for several years thereafter. The forecast stems from slowing global capacity growth, but also from expectations of reduced unit investment costs going forward for some renewable technologies.

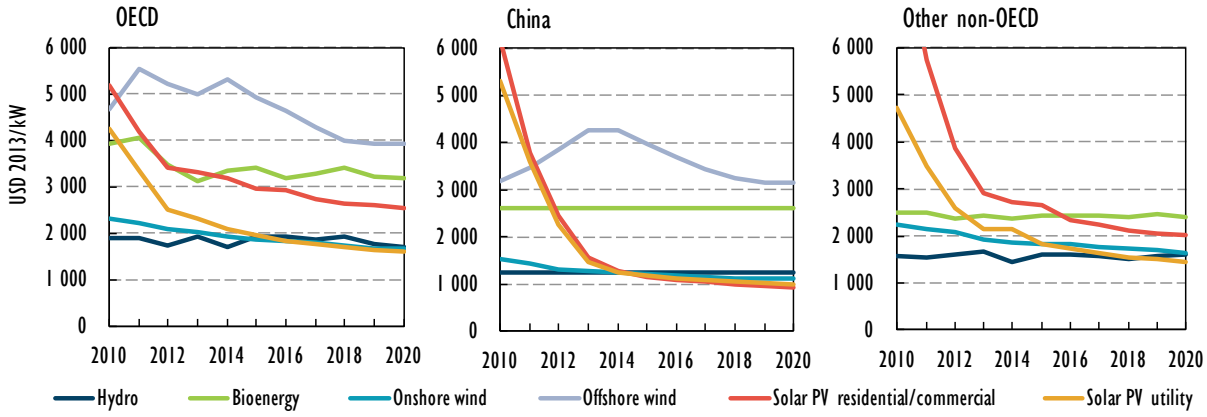
Reductions in investment costs have helped the levelised cost of energy (LCOE), without incentives, for some renewable technologies to further decrease over the past year. Although renewables remain generally more expensive than conventional electricity-generating technologies, this gap is expected to further narrow over the medium term. Still, LCOE provides only a partial indication of competitiveness, and investment decisions are usually based on additional financial information. While comparing the cost of energy for various electricity-generating technologies, LCOE may not take into account the value of electricity, which depends on the time and location of production, the market frameworks under which different technologies compete, or the recovery of fixed network costs. The market conditions in which renewables operate can have a significant impact on their bankability. For example, in markets with good resources, good financing conditions and rising demand, some renewables are able to compete under a market design of wholesale pricing. For other markets, renewables may find it difficult to recoup their costs with wholesale prices, even as their generation costs decline.

With decreasing system costs, competitive opportunities are expanding for some renewable energy technologies under some country-specific market conditions and policy frameworks. In Brazil, with good resource and financing conditions, onshore wind has consolidated its competitive position, continuing to outbid new-build natural gas plants in auctions over the last year. In South Africa, with good wind resource and long-term power purchase agreements (PPAs), onshore wind is preferred against new gas and coal power plants to meet growing demand. In Chile, high wholesale electricity prices and good irradiation levels have opened a new merchant solar PV market. There, the world's first merchant utility-scale solar PV plant was interconnected and another was financed over the past year; both projects are to sell electricity to the wholesale market without a PPA.

Falling solar PV costs are supporting the emergence of competitive market segments in both commercial and residential sectors linked to the concept of socket parity – when the LCOE of distributed PV systems becomes lower than the variable portion of retail electricity prices that system owners would otherwise pay (see "Special focus: Solar PV reaching socket parity" in chapter "Renewable electricity: Global technologies"). Increasingly strong deployment is raising debates over the system integration of distributed generation, especially in the United States and Europe. As more rate-payers generate their own electricity from PV,

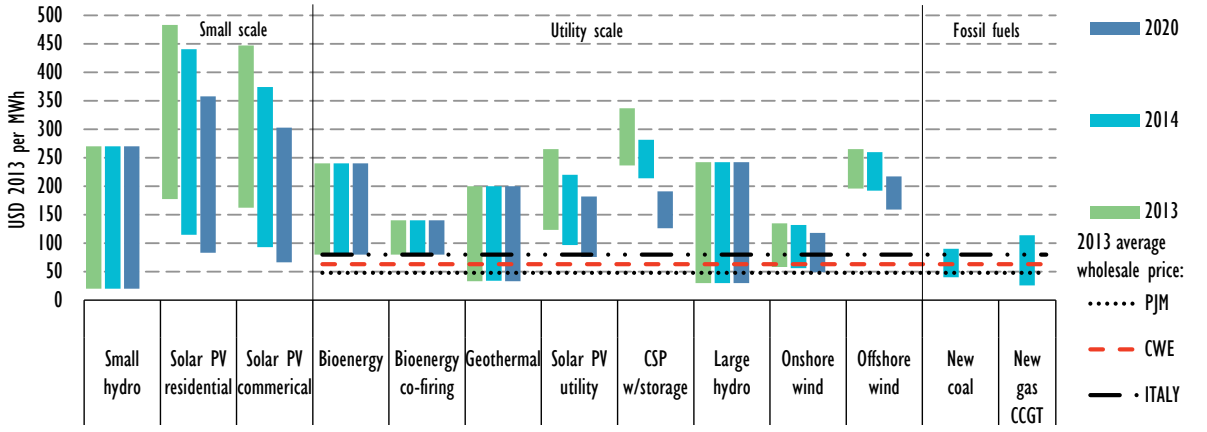
they consume less grid electricity, contributing less to remuneration of overall grid costs when these are charged per unit of energy consumed. This situation is raising issues concerning fair rules and appropriate electricity rate design for allocating the costs (e.g. recovery of fixed grid costs) and benefits from distributed PV.

Figure 5 Weighted average annual renewable investment costs, historical and projected



Note: kW = kilowatt. Average unit investment costs are based on gross additions, which include capacity refurbishments that are typically lower cost than new capacity. Costs vary over time due to technology changes as well as where deployment occurs in a given year.

Figure 6 Levelised costs of electricity (USD per megawatt hour [MWh]), beginning year



Notes: CSP = concentrated solar power; CCGT = combined cycle gas turbine. Wholesale power prices are expressed as the annual average of daily traded, day-ahead base-load power prices. CWE (Central Western Europe) refers to annual average of power prices in France, Germany, Austria and Switzerland. United States (US) PJM refers to the regional transmission organisation covering parts of 13 states in the mid-Atlantic and Midwest portion of the United States. LCOEs reflect typical system costs for selected technologies. Costs are indicative and ranges reflect the system cost, resource and financing differences among countries. Geothermal LCOE range includes only conventional and binary plants.

Source: IEA analysis with 2013 wholesale electricity price data from Bloomberg LP (2014), accessed 01 June 2014; and EIA (Energy Information Administration) (2014), Wholesale Electricity and Natural Gas Market Data accessed 20 May 2014, Washington D.C.

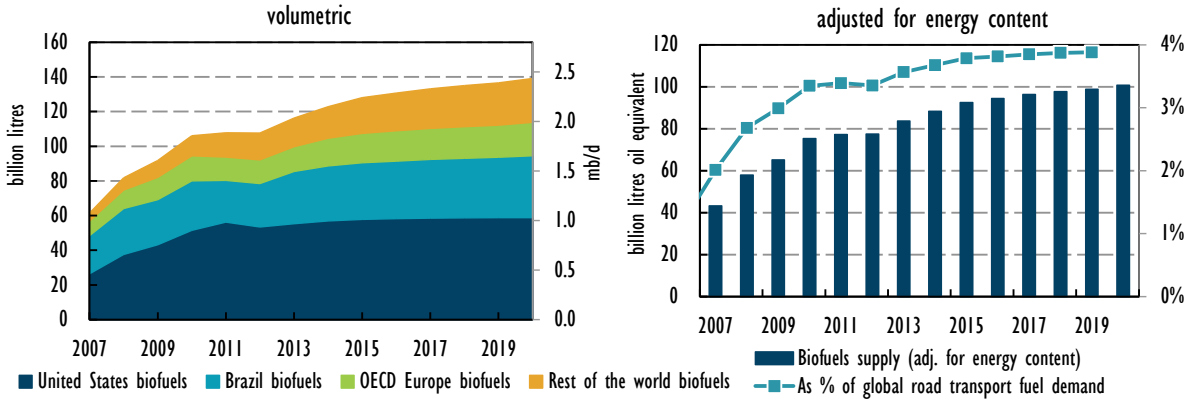
Overall, policy remains vital to the competitiveness of renewable technologies. Even in s ituations of good competitiveness, policy, market and technology risks can undermine project viability. Policy uncertainty remains a key challenge to renewable deployment. Unanticipated changes to incentive schemes represent a risk that investors cannot manage, and can lead to elevated financing costs and boom-and-bust development patterns. In addition, non-economic barriers, integration challenges, grid connection risk, and macroeconomic and currency risks can all increase financing costs and weigh upon investments. In markets based on short-term marginal cost pricing, remuneration flows can be uncertain,

and capital-intensive technologies, such as renewables, can often require policy incentives. By contrast, renewable power capacity is being deployed with little financial support in some areas with rising energy needs, good resources and predictable long-term policies. Market design based on competition over long-term contracts (as being developed in Brazil and some other Latin American countries, for example) is one way that is sustaining investment.

Biofuels for transport and renewable heat expanding, though with challenges

After a period of rapid growth, biofuel production and consumption in the United States, the European Union and Brazil appear to be shifting gears. In the United States, the design shortcomings of previous biofuel mandates have become manifest, leading to policy reviews that have introduced uncertainty in the market. In Brazil, the ethanol industry's economic situation is worsening, partly due to inflation-targeted gasoline price regulations that undermine ethanol economics. In the European Union, ongoing controversy about the sustainability of biofuels has led to a proposed cap on conventional biofuel use that is leaving the industry in limbo until a final decision on the proposal is taken. At the same time, policy support is burgeoning in non-OECD countries, notably oil-importing economies in Southeast Asia and Africa that subsidise fuel consumption, where rising domestic biofuel production promises a valuable option to lowering fuel import bills.

Figure 7 World biofuels production, historical and projected



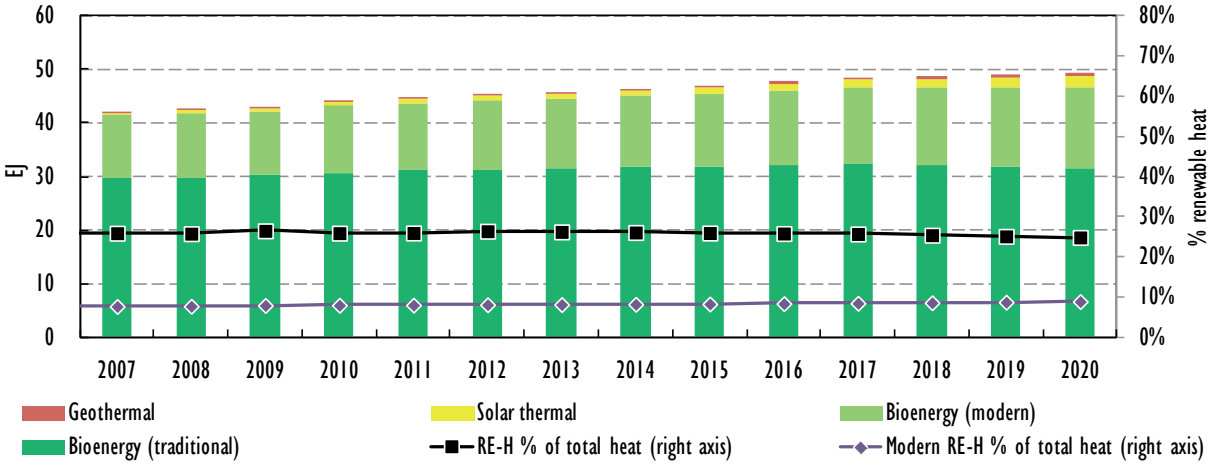
Global biofuel production is seen reaching 139 billion litres in 2020. For 2018, the forecast is 2 billion L lower than in *MTRMR 2013*. With a less optimistic outlook for the United States and Brazil, world ethanol output is now forecast to reach 104 billion L in 2020. For 2018, the ethanol forecast has been cut by almost 4 billion L from levels projected last year. By contrast, expectations of biodiesel production have been revised marginally upwards. World biodiesel production is expected to edge up to 33 billion L, roughly 0.6 billion L higher than projected in the *MTRMR 2013*, as stronger growth in non-OECD Asia outweighs downward revisions in the non-OECD Americas. Meanwhile, the advanced biofuels industry faces headwinds, but capacity is expanding. Operating capacity reached almost 2 billion L in 2013, and could reach 4 billion L in 2020, if projects under development come on line as planned. Growth is slower than projected in *MTRMR 2013*. A number of companies have cancelled or postponed projects as they struggle to secure investments in light of an increasingly uncertain policy framework in the two key markets, the European Union and the United States. Developments in advanced biofuels also continue to remain limited to these two regions.

Global renewable energy use for heat, including traditional biomass, is expected to grow by 3.5 EJ[1] to 49.7 EJ in 2020 (1.0% per year). This year's projections for renewable heat are based on a new bottom-

[1] 1 EJ = 23.9 million tonnes of oil equivalent = 277.8 terawatt hours thermal = $947*10^6$ million British thermal units.

up modelling structure, which allows for projections of the energy use of different renewable energy sources by sector (industry, buildings, and others) on a country-by-country basis. While traditional biomass use is expected to decline in most non-OECD countries as a r esult of urbanisation and enhanced access to modern energy sources, modern renewable energy sources are expected to grow from 14.5 EJ in 2013 t o 17.9 EJ in 2020 (3.0% per year), driven by support policies in 50 countries around the world, as w ell as i ncreasing cost-competitiveness with fossil fuel-based heating in a growing number of countries. Modern renewable energy use for heat in the buildings sector grows from 6.1 EJ in 2013 t o 8.3 EJ in 2020 (5.1% per year), much stronger than in the industry sector, where the continued absence of policy drivers leads to only a 0.8 EJ increase to 8.9 EJ in 2020.

Figure 8 World final renewable energy use for heat (including commercial heat) 2007-20



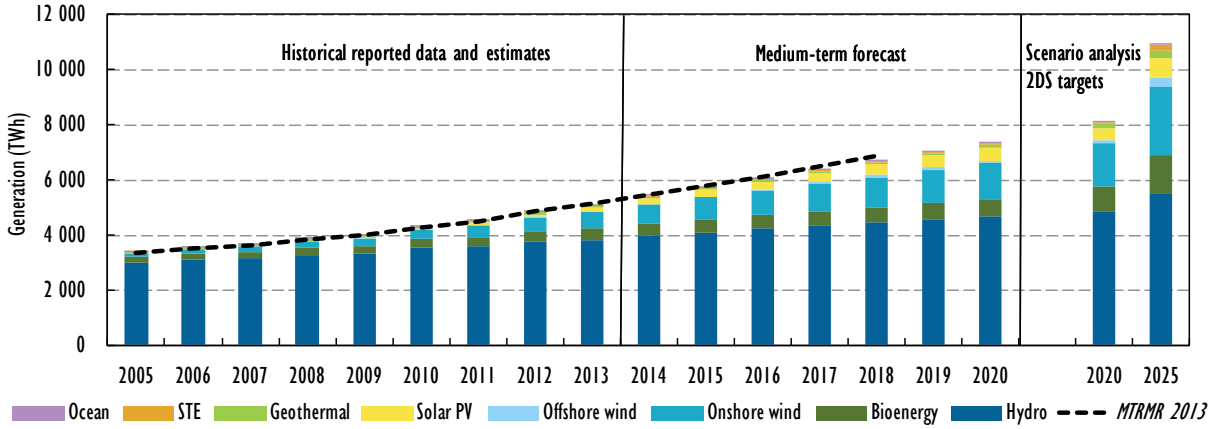
Note: RE-H = renewable heat. Traditional biomass is estimated here – in line with the methodology used in the IEA *World Energy Outlook* (*WEO*) – as the use of solid biomass in the residential sector of non-OECD countries, excluding countries in non-OECD Europe and Eurasia.

Renewables at risk of falling short versus long-term clean energy scenarios

Despite the growing competitiveness of a portfolio of renewable technologies, renewable power is increasingly at risk of falling short of global climate change objectives, i.e. the interim 2020 and 2025 targets in the IEA *Energy Technology Perspectives 2014* (*ETP 2014*) 2°C Scenario (2DS), in absolute generation levels (IEA, 2014b). That scenario assumes nearly 8 100 TWh of renewable generation in 2020 (versus total generation of 27 720 TWh) and over 10 900 TWh in 2025 (compared with total generation of 30 315 TWh). Biofuels for transport face a more challenging path. Overall biofuels production must triple, and advanced biofuels need to increase 22-fold to meet 2DS targets by 2025.

Among renewable power technologies, solar PV is the only source expected to exceed global 2DS targets in 2020, boosted by cost declines and an increasingly rapid scale-up in non-OECD markets. Meanwhile, notable shortfalls may occur in bioenergy for power, onshore wind and hydropower, which are all mature and relatively cost-effective technologies. Policy support for bioenergy has waned in some OECD countries, and developments face the challenge of establishing sustainable feedstock supply chains. Onshore wind can face challenges related to local acceptance, as in some European markets, and requirements for the build-out of the grid and further integration measures to reach higher levels of penetration, as in China and Europe. Hydropower, with long development lead times, is experiencing challenges in some emerging markets related to environmental licensing and financing. Other technologies at risk of falling short, offshore wind and solar thermal electricity (STE), require faster cost reductions to achieve higher levels of development. To meet 2025 objectives, a more rapid rate of scale-up would be needed across a number of technologies.

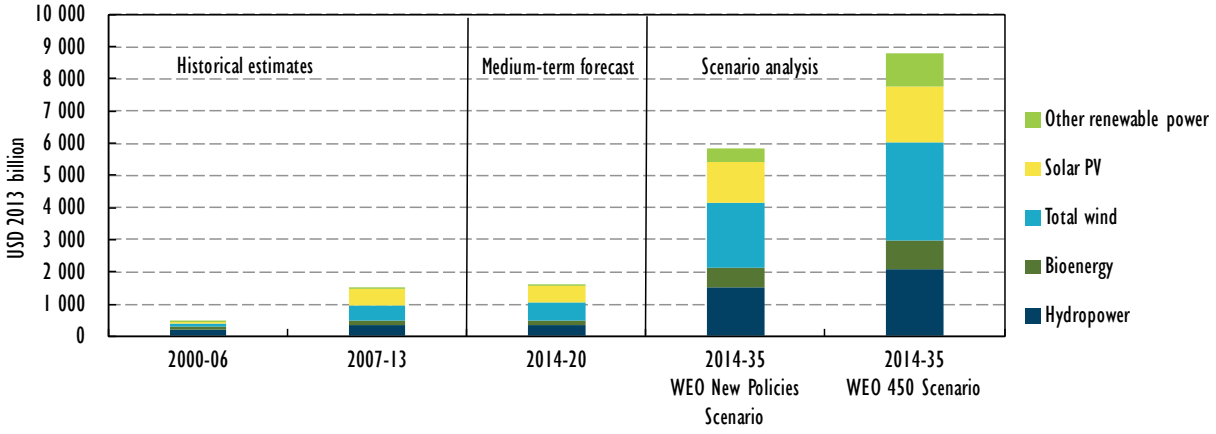
Figure 9 Global renewable electricity generation, the *MTRMR 2014* forecast versus *ETP 2014* 2DS



Note: *MTRMR 2014* data and forecasts as well as the 2DS targets include output from pumped hydro storage.

Overall, policies will remain vital to stimulating investment in capital-intensive renewables and stimulating greater development. To realise the high levels of renewables required to meet long-term climate change objectives, as in the *WEO* 450 scenario (which models similar objectives as the 2DS), cumulative investment of almost USD 9 trillion would be needed by 2035 (IEA, 2014c).

Figure 10 Cumulative investment in new renewable power capacity



Note: New Policies and 450 Scenario data are reported in USD 2012 billion.

Sources: 2014-20 investment is derived from *MTRMR 2014* estimates, while New Policies and 450 Scenario data are from IEA (2014c), *World Energy Investment Outlook*, OECD/IEA, Paris.

Mobilising this high-level capital would require resolving some of the specific challenges described above. More generally, it would need stable, long-term oriented policy frameworks from governments and a market design that more effectively prices the value that renewable investments can bring to energy systems and increases power system flexibility to ensure system adequacy with higher levels of variable renewables. Recent IEA research – *The Power of Transformation* – suggests that such aims can be achieved in a secure and cost-effective manner (IEA, 2014d). However, this result would require a system-wide approach to energy policy, one that promotes the deployment of integration-friendly variable renewables, fosters better operation of existing power assets and creates incentives for investment in additional flexibility options – grid infrastructure; dispatchable generation, such as gas-fired or hydro power; demand-side integration; and storage – when needed.

Table 1 World renewable electricity capacity and projection (baseline case) (GW)

	2013	2014	2015	2016	2017	2018	2019	2020
Hydropower	1 133	1 168	1 203	1 237	1 270	1 307	1 333	1 360
Bioenergy	88	93	97	104	111	118	125	133
Wind	319	363	407	449	491	536	583	630
Onshore	312	354	396	435	475	517	559	602
Offshore	7	8	11	13	16	20	24	29
Solar PV	137	176	214	253	289	326	364	403
STE	4	5	5	6	7	8	10	11
Geothermal	12	12	13	13	14	15	15	16
Ocean	1	1	1	1	1	1	1	1
Total	**1 692**	**1 817**	**1 940**	**2 061**	**2 182**	**2 311**	**2 431**	**2 555**

Notes: capacity data are rounded to the nearest GW and are generally presented as cumulative installed capacity, irrespective of grid-connection status. Grid-connected solar PV capacity (including small distributed capacity) is counted at the time that the grid connection is made, and off-grid solar PV systems are included at the time of the installation.

Table 2 World renewable electricity generation and projection (baseline case) (TWh)

	2007	% of total gen, 2007	2012	% of total gen, 2012	2013	2014	2015	2016	2017	2018	2019	2020
Hydropower	3 166	15.9%	3 756	16.5%	3 828	3 982	4 104	4 223	4 340	4 469	4 581	4 669
Bioenergy	233	1.2%	379	1.7%	396	433	457	483	514	547	581	615
Wind	171	0.9%	521	2.3%	633	721	830	936	1 042	1 156	1 279	1 409
Onshore	168	0.8%	505	2.2%	612	695	797	896	992	1 095	1 204	1 318
Offshore	3	0.0%	15	0.1%	21	26	32	40	50	61	75	90
Solar PV	7	0.0%	97	0.4%	131	188	237	286	334	382	431	482
Solar CSP	1	0.0%	5	0.0%	6	11	14	16	19	23	27	32
Geothermal	62	0.3%	70	0.3%	73	78	81	85	90	94	99	104
Ocean	0	0.0%	1	0.0%	1	1	1	1	1	2	2	2
Total	**3 641**	**18.3%**	**4 829**	**21.2%**	**5 068**	**5 414**	**5 724**	**6 030**	**6 340**	**6 672**	**7 000**	**7 313**

Notes: gen = generation. Hydropower includes generation from pumped storage, which was reported at 84 TWh for 2012. Data for 2013 are estimates; the split for onshore and offshore wind is estimated for historical data.

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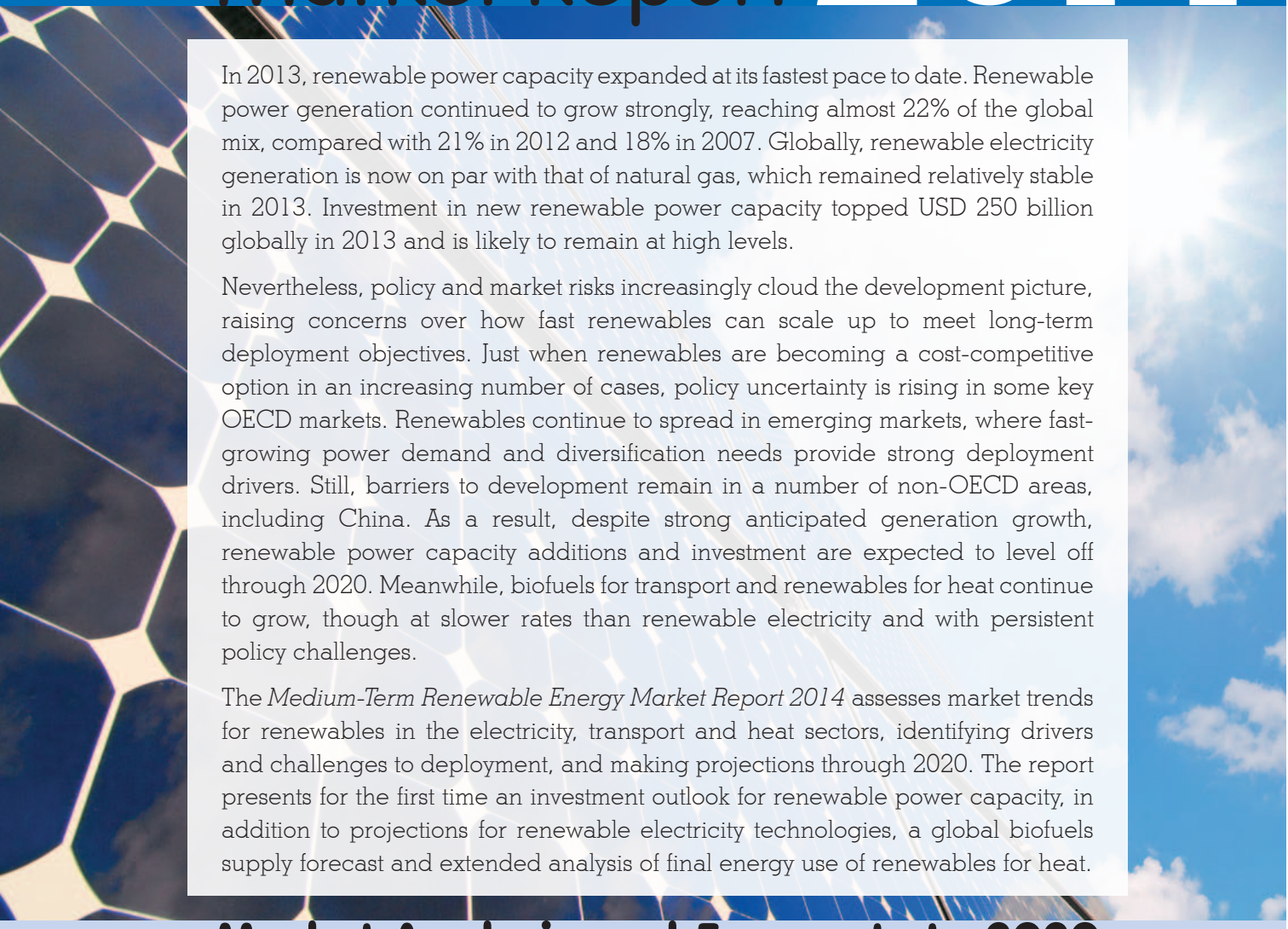
RENEWABLE ENERGY

Medium-Term Market Report 2014



In 2013, renewable power capacity expanded at its fastest pace to date. Renewable power generation continued to grow strongly, reaching almost 22% of the global mix, compared with 21% in 2012 and 18% in 2007. Globally, renewable electricity generation is now on par with that of natural gas, which remained relatively stable in 2013. Investment in new renewable power capacity topped USD 250 billion globally in 2013 and is likely to remain at high levels.

Nevertheless, policy and market risks increasingly cloud the development picture, raising concerns over how fast renewables can scale up to meet long-term deployment objectives. Just when renewables are becoming a cost-competitive option in an increasing number of cases, policy uncertainty is rising in some key OECD markets. Renewables continue to spread in emerging markets, where fast-growing power demand and diversification needs provide strong deployment drivers. Still, barriers to development remain in a number of non-OECD areas, including China. As a result, despite strong anticipated generation growth, renewable power capacity additions and investment are expected to level off through 2020. Meanwhile, biofuels for transport and renewables for heat continue to grow, though at slower rates than renewable electricity and with persistent policy challenges.

The *Medium-Term Renewable Energy Market Report 2014* assesses market trends for renewables in the electricity, transport and heat sectors, identifying drivers and challenges to deployment, and making projections through 2020. The report presents for the first time an investment outlook for renewable power capacity, in addition to projections for renewable electricity technologies, a global biofuels supply forecast and extended analysis of final energy use of renewables for heat.

Market Analysis and Forecasts to 2020