Medium-Term Renewable Energy market Report 2015

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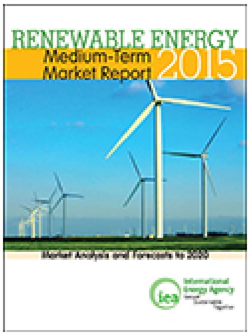
Corrigendum

Please note that despite our best efforts to ensure quality control, errors have slipped into the Medium-Term Renewable Energy market Report 2015



New pages 4, 8, 11, 29, 37, 38, 59, 68, 76, 78, 82, 88, 110, 215, 216, 217, 222, 263.
It should be replaced by the following pages .

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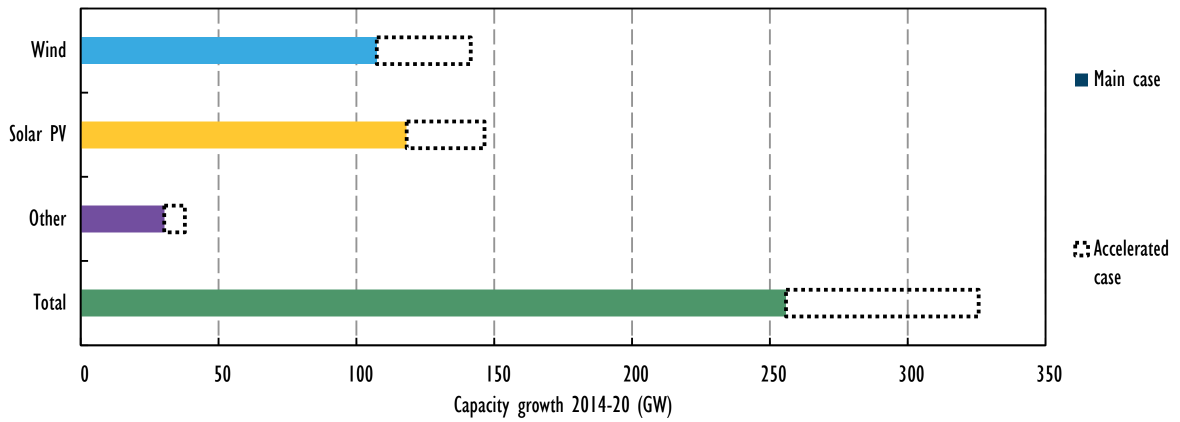
Figure 5 OECD incremental renewable capacity additions, main versus accelerated case



OECD Americas

Recent trends

In the OECD Americas, renewable power generation increased by more than 2% in 2014 over 2013 to reach near 1 060 TWh. Although the United States and Canada continue to dominate the overall statistics, their growth masks important changes emerging in Mexico and Chile. Renewables represented around 20% of regional power generation in 2014, slightly higher than in 2013. Meanwhile, the share of fossil fuel generation slightly decreased from 63% to 62%.

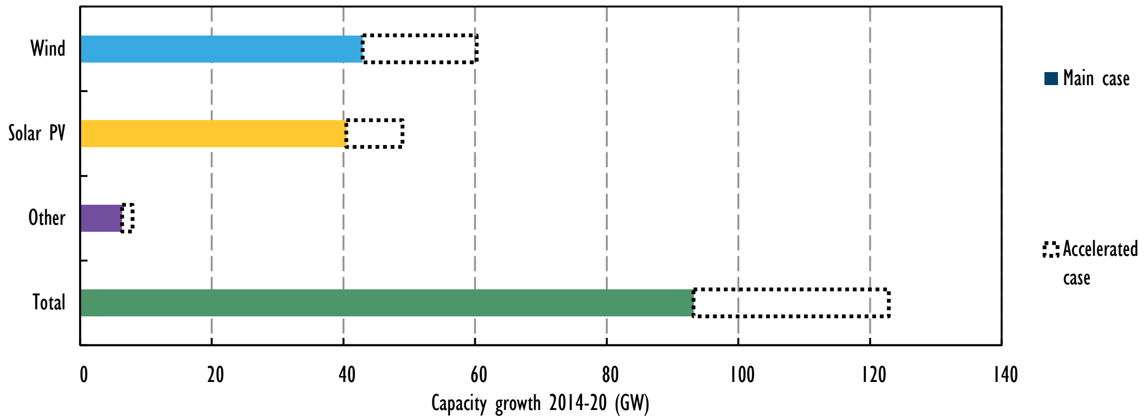
In the United States, renewables represented over 13% of power generation in 2014, up from less than 12% in 2013. Renewable capacity additions increased from 8 GW in 2013 to 11.7 GW in 2014 as new land-based wind (onshore wind) installations recovered from a very weak 2013 and solar PV growth was strong.

In mid-December 2014, the federal production tax credit (PTC) for new projects was extended only through the end of 2014. For new projects, this extension gave wind developers only two to three weeks to start construction in order to qualify. Accordingly, developers should commission their projects by 1 January 2017 in order to qualify for the PTC. Although the Obama Administration has proposed the permanent extension of the PTC and investment tax credit (ITC) as part of the 2016 budget, this is only an initial step towards the budget discussions in the congress, which will start in October 2015.

Despite uncertainty over last-minute renewal of the PTC, onshore wind additions picked up with close to 5 GW of wind capacity coming on line in 2014, significantly higher than 0.9 GW commissioned in 2013. Still, it is expected that more than 12 GW of wind projects are qualified for PTC as they started their construction in 2013-14. The largest additions came from Texas (1.75 GW) followed by Oklahoma, Iowa and Colorado. Overall, onshore wind generation increased by around 8.5% in 2014, reaching 184 TWh, accounting for over 4% of the power mix.

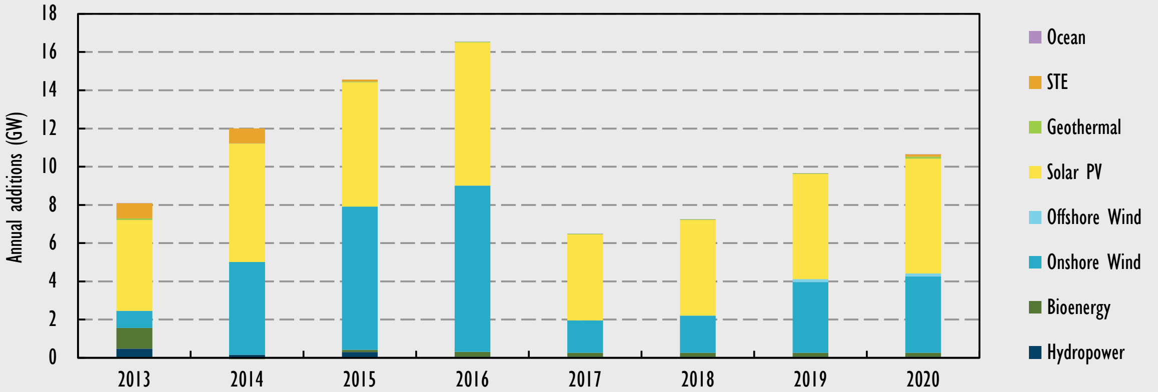
Backed by the ITC and state-level incentives for net metering, solar PV new additions increased to over 6 GW in 2014 versus 4.8 GW in 2013. Solar PV capacity reached over 18.7 GW by the end of 2014, generating over 22 TWh, 54% higher than in 2013. Still, solar PV represented less than 1% of power generation in the United States. California alone installed more than 55% of new capacity, followed by North Carolina, Nevada, Massachusetts and Arizona. Additions in the top locations. Under these conditions, both onshore wind and solar PV cumulative capacity could be 300 MW to 500 MW higher in 2020.

Figure 8 OECD Americas incremental renewable capacity additions, main versus accelerated case



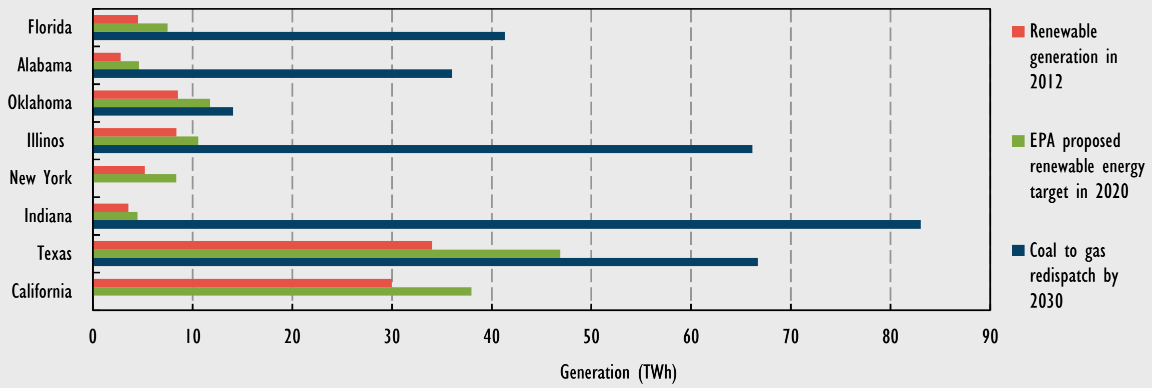
United States dashboard

Figure D.1 Annual net additions to renewable capacity (2013-20)



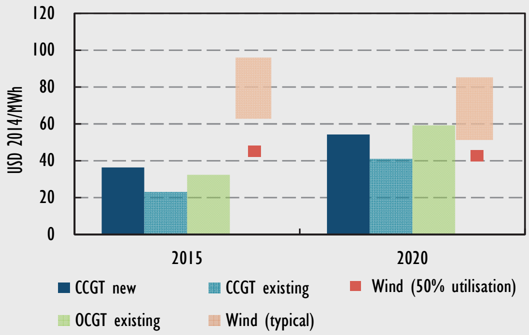
Source: Historical OECD capacity derived from IEA (2015a), "OECD - Net capacity of renewables", *IEA Renewables Information Statistics* (database).

Figure D.2 EPA's CPP summary for selected states



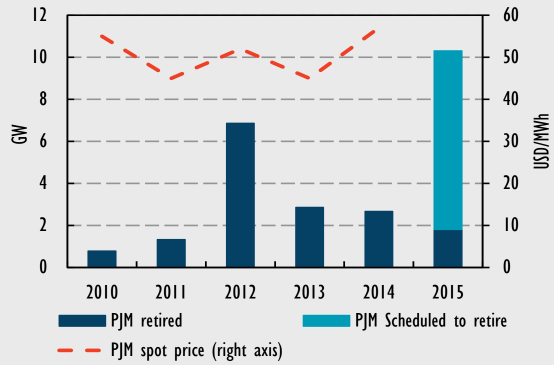
Source: EPA (2014), Clean Power Plan proposed rule.

Figure D.3 US wind versus gas, estimated LCOEs



Note: For CCGT and OCGT, fuel cost assumption is USD 2.85/MMbtu (May 2015 Henry Hub Spot Price) in 2015 and USD 6.2/MMbtu in 2020 (IEA [2015c], *Projecting Costs of Generating Electricity 2015 Edition*), discount rate 7%, capacity factor 65% and 15% (OCGT). For wind, typical utilisation rate is 30-36%, 50% utilisation is observed in the interior region.

Figure D.4 PJM coal plant retirements

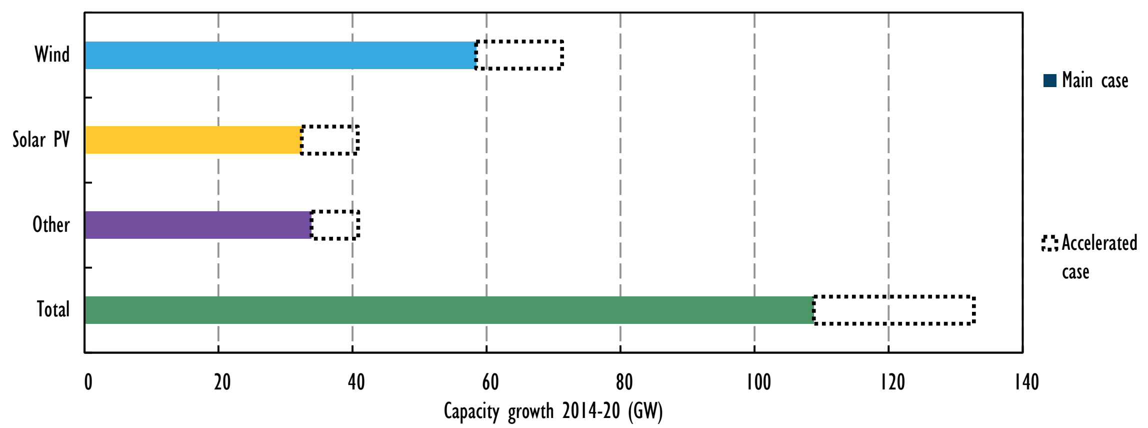


Source: PJM (2015), "Future deactivations as of June 29, 2015".

their potential impacts are mostly made in the broad sense. Under the accelerated case, renewable capacity growth over 2014-20 could be almost 30% higher versus the main case.

At the regional level, increasing the level of interconnection across Europe is probably the most significant step that could improve the value of renewable generation and facilitate development of a more effective pan-European renewable system, though this development would take place over the medium to long term (IEA, 2014). Financing such investment should be a priority within EU structural funding and in the activities of the European Investment Bank (EIB). Still, other challenges related to the permitting and local acceptance of new grid infrastructure would also need to be addressed in a number of markets, including Germany and the United Kingdom. Timely clarification of a credible mechanism to spur states to comply with a new EU-28 2030 renewable target could also help enhance investor certainty and spur new investment in both renewables and grid infrastructure. The development of indicative benchmarks that broke down the 27% renewables target at the member state level, accompanied by co-ordinated approaches to grid and renewable generation planning among groups of countries, could facilitate this transition (Held et al., 2014).

Figure 14 OECD Europe incremental renewable capacity additions, main versus accelerated case



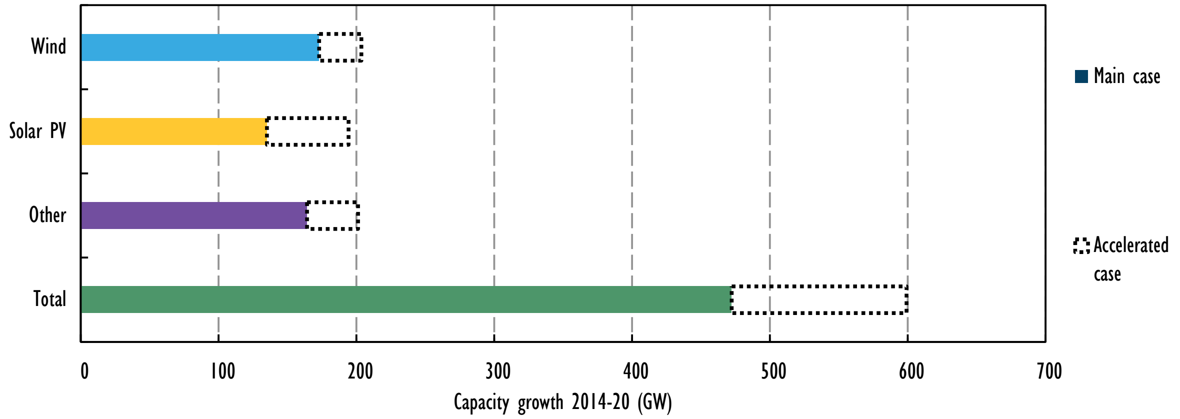
In the dynamic power systems of the region, countries would need to further reduce non-economic barriers to development. Notably, in Turkey, solar PV deployment could be higher with streamlined permitting procedures, clear net metering rules and the acceleration of further capacity auctions for utility-scale capacity. In more stable power systems facing significant electricity sector transitions, some policy uncertainties persist. A clarification by governments of wide-ranging reforms ahead, potential future revisions to support schemes (e.g. the United Kingdom), the pace and transitional measures related to future auctions for new generation (e.g. Germany), and regulatory questions over distributed generation and the allocation of fixed network costs (e.g. Belgium, France, Spain) could enhance investor certainty. Power systems with clear overcapacity and reduced prospects for new renewable deployment need to avoid retroactive measures on existing generators.

Greater-than-expected development of grid connections, transmission capacity, interconnections, other forms of flexibility (such as storage) and improved grid codes and operations would be needed for the timely scale-up of wind power, with further cost reductions required for offshore wind in particular. The easing of some non-economic barriers to deployment in some countries should also support further deployment. Faster-than-expected cost reductions could also drive an acceleration of distributed solar PV for self-consumption under conditions of socket parity. Lastly, greater progress in the establishment of sustainable feedstock supply chains could raise the outlook for bioenergy.

- **In India, ambitious new government targets and an improved policy environment** suggest renewable growth could accelerate there. Total renewable capacity growth, at over 65 GW (+85%) from 2014-20, is some 35% higher than in *MTRMR 2014*, due to onshore wind and solar PV. The reinstatement of key financial incentives from the central government are catalysing new wind development, but the stability of these measures, which had been subject to stop-and-go policy making, will be key for consistent development. Meanwhile, competitive state- and central-government-level auctions are driving more cost-effective utility-scale solar PV development, as contracted prices have fallen over the past two years. Still, the upgrade and expansion of the grid; off take risks for generation, given the cash-strapped position of some state electricity boards; and the cost and availability of financing represent challenges. In all, India is estimated to require investment of more than USD 80 billion for new renewable capacity during the forecast period.

- **Renewable development accelerates in other regions, though with significant differences.** The non-OECD Americas and Asia, outside of China and India, are the largest contributors. In the Americas, with a high penetration of hydropower, severe droughts and limited infrastructure for scaling gas generation suggest non-hydro renewables will play an important diversification role, supported by the award of long-term contracts to wind, solar PV, STE and bioenergy capacity under competitive auctions in a number of markets. In Asia, strong demand growth and diversification needs support a robust expansion of hydropower, complemented by a portfolio of non-hydro sources. In Africa, acute demand needs, excellent resources and supportive policy frameworks should support continued hydropower expansion and an acceleration of non-hydro deployment in some countries (e.g. Morocco, Egypt, South Africa). Still, the pace of government-backed tender schemes and grid and financing constraints represent challenges. In the Middle East, despite excellent resources, persistent regulatory barriers and uneven implementation of renewable support policies have hampered development. Yet some renewables are being developed at very low costs in several countries, supported by market frameworks of competition over long-term contracts. Meanwhile, renewable development remains relatively weak in non-OECD Europe and Eurasia, where abrupt policy changes have contributed to past boom-and-bust cycles in several markets, and policy implementation remains only nascent in others.

Figure 17 Non-OECD incremental renewable capacity additions, main versus accelerated case



- **Under this report's accelerated case – which is market-specific to each region – renewable growth could be 25% higher over 2014-20 than under the main case.** In addition to faster-than-

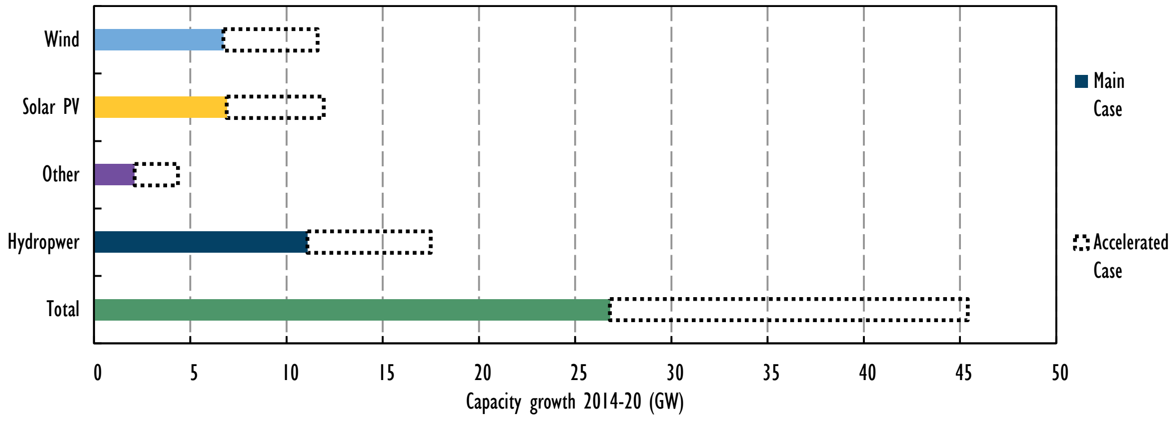
Medium-term outlook – accelerated case summary

Renewable capacity in Africa could be 30% higher by 2020 with increased speed of government action in moving through national plans for state-led projects, clarifying regulations and de-risking climates to attract private investment. There are a number of robust project pipelines in many countries emerging from ambitious plans, sowing the seeds of growth, yet the rate at which the capacity can reach financial close, begin construction and materialise into generating capacity remains the largest uncertainty to the forecast. Rapid and steady progression through the implementation of various procurement programmes and reduced technical or non-economic barriers would encourage higher growth. Improved access and cost of financing and planning necessary grid upgrades to accommodate new capacity in lockstep with support schemes could also unlock faster rates of deployment.

In South Africa, faster progress in grid maintenance is needed to connect additional capacity under the REIPPPP, and improved co-ordination during project selection in future bidding rounds could add 1-2 GW more of renewable capacity by 2020. Deployment could further increase should regulatory decisions increase electricity prices, carbon tax implementation and revised 2030 targets from an updated Integrated Resource Plan improve the economic attractiveness and support environment for renewables.

Egypt's capacity could be 2-4 GW higher by 2020 depending on the rate at which the country implements plans for additional capacity under the various procurement mechanisms. Faster annual deployment of solar PV and wind capacity under the FiT scheme could be seen if no major obstacles or grid delays are met during the implementation of the new programme. Clarification on contractual processes and associated grid connection and land leasing costs that would allow developers to assess project bankability early on could attract the additional wind capacity needed to meet the scheme's 2 GW target. Faster progress through the BOO auction scheme for large capacities without the delays the scheme initially experienced would add considerable capacity annually.

Figure 21 Africa incremental renewable capacity additions, main versus accelerated case



Outside of the FiT, roughly 4 GW of wind capacity from public and private projects are at various stages. Bringing the more developed projects into operation by 2020 might require additional grid upgrades and overcoming non-economic administrative barriers. Under these circumstances, wind could be 1-2 GW higher by 2020. Greater uncertainty surrounds the upper limit of potential of solar PV deployment. The FiT targets 2.3 GW and the government reportedly signed several MoUs with

South Africa dashboard

Figure D.15 South Africa annual net additions to renewable capacity (2013-20)

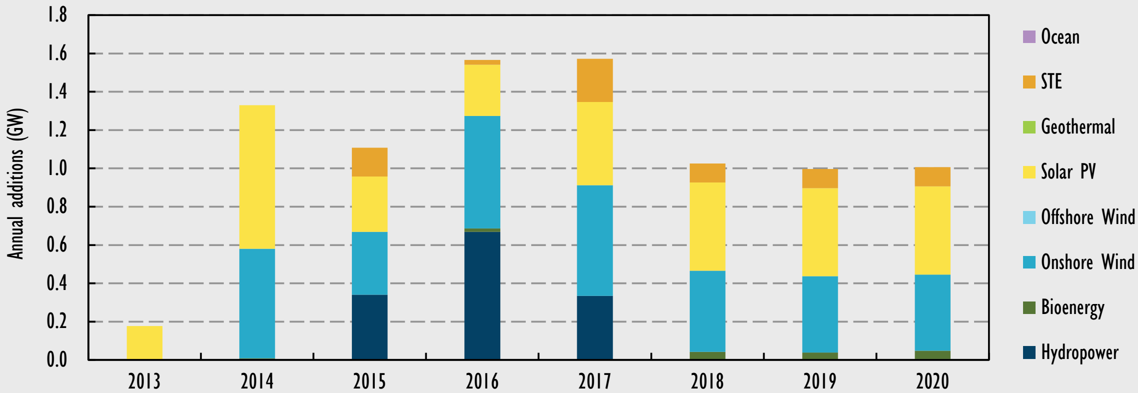
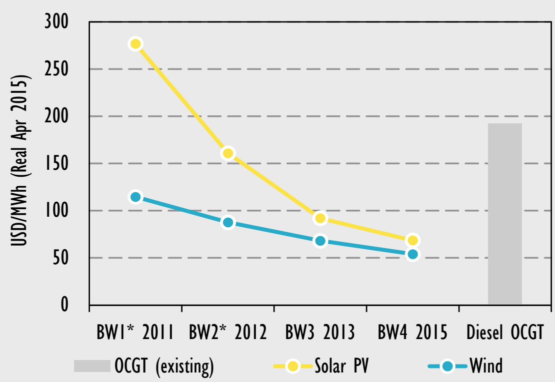
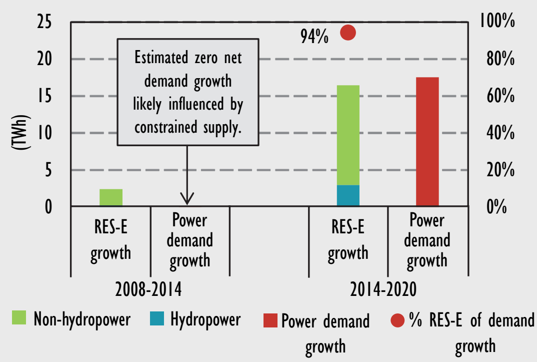


Figure D.16 Preferred bid prices from REIPPPP Bid Windows (BWs) 1-4



Note: OCGT = open-cycle gas turbine. *Average as reported in DoE (2015a), *Renewable Energy IPP Procurement Programme, Bid Window 4, Preferred Bidders' Announcement*.

Figure D.17 South Africa's new renewable generation versus power demand growth



Notes: Historical power demand from IEA (2015a). Growth over 2008-14 = 0.

Table D.7 South Africa renewable energy capacity (GW)

	2014	2016	2018	2020	2020*
Hydropower	2.3	3.3	3.6	3.6	3.8
Bioenergy	0.3	0.3	0.3	0.4	0.8
Onshore wind	0.6	1.5	2.5	3.3	4.0
Offshore wind					
Solar PV	1.0	1.5	2.4	3.3	4.4
STE/CSP		0.2	0.5	0.7	0.9
Geothermal					
Ocean					
Total	4.1	6.8	9.4	11.4	13.8

* Accelerated

- **Drivers**
  - **- urgent need for new capacity and excellent resource potential**
  - **- supportive policy environment with competitive auctions and long term PPAs**
  - **- good economic attractiveness**
  - **- rising power prices.**
- **Challenges**
  - **- grid integration of variable renewables**
  - **- long-term uncertainty in power sector plans**
  - **- financial sustainability of power utility.**

Other SSA dashboard

Figure D.20 SSA annual net additions to renewable capacity (2013-20)

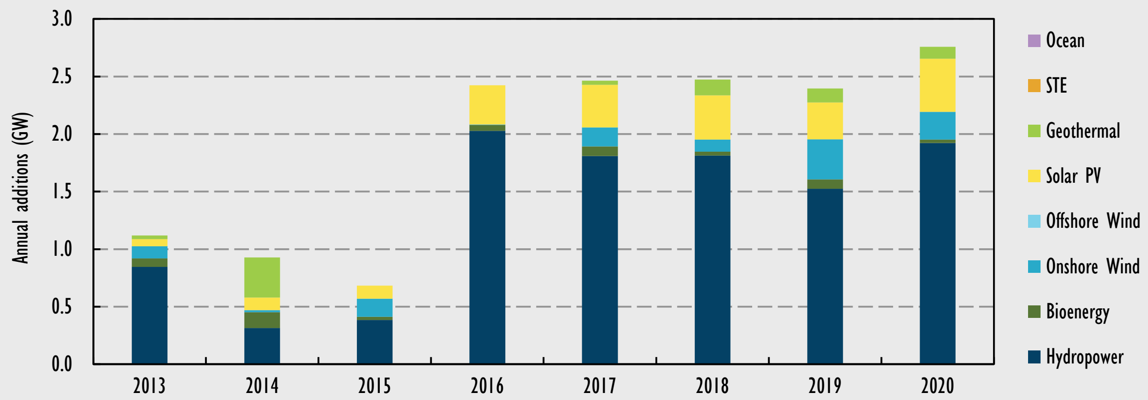


Figure D.21 Hydropower capacity by region (2014-20)

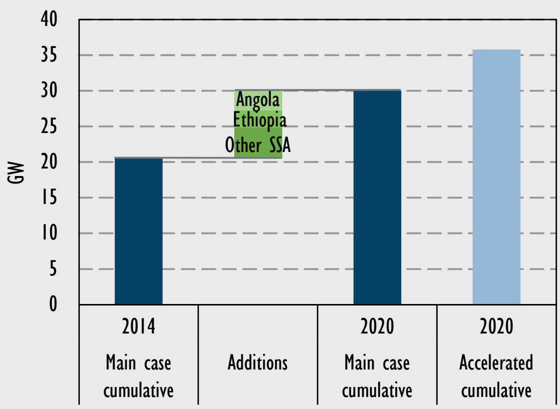


Figure D.23 Non-hydropower capacity additions by technology (2014-20)

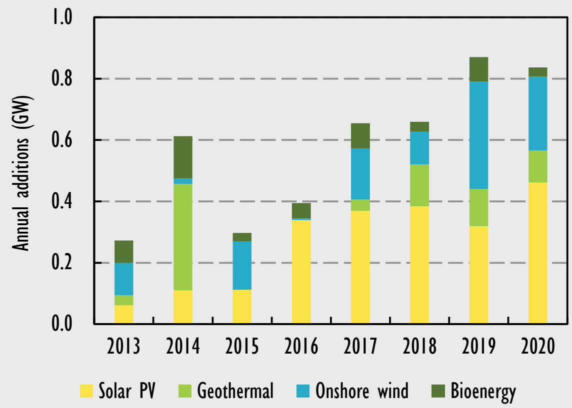


Table D.9 Sub-Saharan Africa renewable energy capacity (2014-20)

	2014	2016	2018	2020	2020*
Hydropower	20.6	23.0	26.6	30.0	35.8
Bioenergy	1.0	1.1	1.2	1.3	2.0
Onshore wind	0.3	0.4	0.7	1.3	2.5
Offshore wind					
Solar PV	0.3	0.8	1.5	2.3	3.7
STE/CSP					
Geothermal	0.6	0.6	0.8	1.0	1.5
Ocean					
Total	22.7	25.8	30.8	35.9	45.5

* Accelerated

- **Drivers**
  - **- rapid rising power demand, diversification needs and excellent resources**
  - **- emerging portfolio of policy frameworks**
  - **- cost-effective power in certain conditions**
  - **- electrification by distributed technologies.**
- **Challenges**
  - **- high upfront costs and financing, subsidised prices**
  - **- grid integration and interconnection**
  - **- policy uncertianties, regulatory barriers**
  - **- financial credibity of off takers, currency risk.**

Other SSA

Figure D.29 Sub-Saharan incremental renewable capacity additions, main versus accelerated case

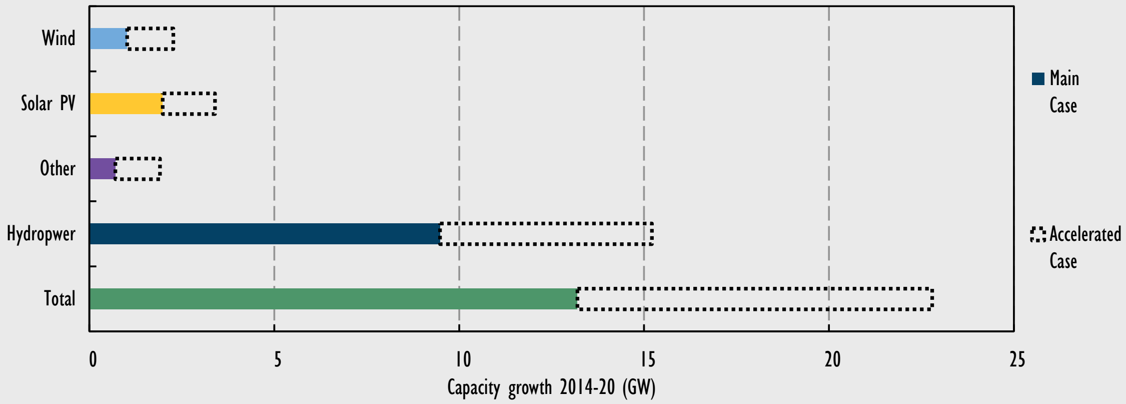


Table D.11 Sub-Saharan selected countries renewable energy capacity 2014-20

	2014				2020				2020 (Accelerated case)			
	Ethiopia	Kenya	Nigeria	Ghana	Ethiopia	Kenya	Nigeria	Ghana	Ethiopia	Kenya	Nigeria	Ghana
Hydropower	2.0	0.8	2.0	1.6	4.3	0.8	2.3	1.7	8.2	1.1	3.8	1.8
Bioenergy	0.2	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.5	0.3	0.1	0.1
Onshore wind	0.2	0.0	0.0		0.5	0.4	0.1	0.2	1.1	0.6	0.3	0.4
Solar PV	0.0	0.0		0.0	0.3	0.1	0.0	0.3	0.4	0.3	0.9	0.5
Geothermal	0.0	0.6			0.1	0.9			0.3	1.2		
Total (GW)	2.3	1.5	2.0	1.6	5.4	2.4	2.4	2.2	10.5	3.6	5.0	2.8

Note: Totals may not sum due to rounding.

Figure D.30 Renewable generation SSA (TWh)

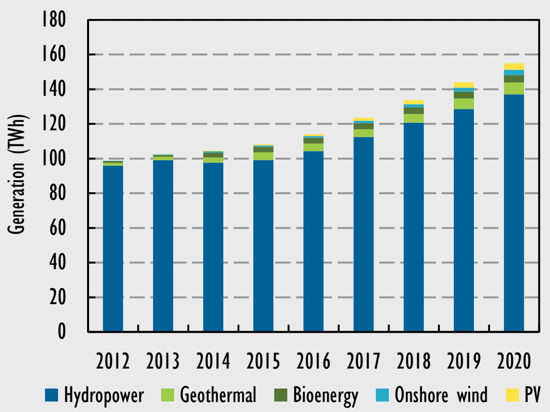
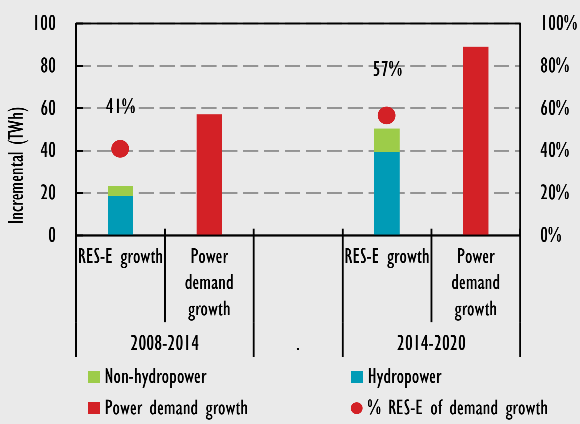


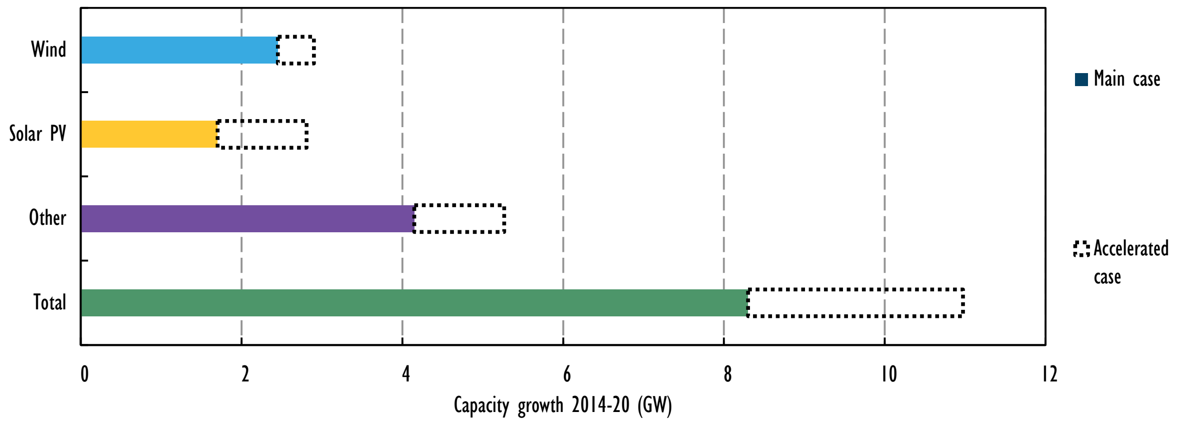
Figure D.31 Total RES-E versus demand in 2013 and 2020



Note: RES-E = renewable electricity generation.

Source: Historical renewable electricity generation and demand from IEA (2015a), "World energy statistics", *IEA World Energy Statistics and Balances* (database).

Figure 27 Non-OECD Europe and Eurasia incremental renewable capacity additions, main versus accelerated case



Middle East

Recent trends

Renewables are currently a small source of generation in the Middle East. Despite excellent resources for some technologies, persistent regulatory barriers in the power sector and uneven implementation of renewable support policies have hampered development. In 2013, total renewable power in the Middle East was 25 TWh, less than 3% of total power generation. Overall, renewable capacity additions were small in 2014, with the commissioning of the 320 MW Seymareh dam in Iran and some distributed solar PV in Jordan as the most notable developments. Still, significant renewable investment and project pipelines have emerged in several countries, supported by the advent of policy frameworks offering long-term contracts for large-scale renewables, some progress in opening markets to distributed generation, and increasingly attractive project economics versus other sources of new generation.

In Jordan, cumulative solar PV capacity rose to near 14 MW, with residential and commercial-scale projects being added under the country's net energy metering scheme, which was introduced in 2012. Though no new large-scale capacity came on line, 200 MW of utility-scale solar PV projects and the 117 MW Talifa wind farm signed PPAs under the country's direct proposal submission scheme, which, in the first round, offered attractive FiTs (USD 150-170/MWh for solar PV; USD 120/MWh for wind) (RCREEE, 2015). A second round was launched to tender 200 MW solar PV under a competitive bidding mechanism, with the four chosen bids reportedly ranging from much lower values: USD 61-77/MWh (Tsagas, 2015). No announcement to date has been made for further wind auctions, with grid integration concerns reportedly slowing development (Collins, 2015).

In the United Arab Emirates, renewable capacity remained steady in 2014, though generation rose with a full year of output from the 100 MW Shams 1 STE parabolic trough plant and the first phase (13 MW) of Dubai's Mohammed Bin Rashid Al Maktoum Solar Park. In early 2015, the second phase (200 MW) was tendered for commissioning in 2017. The preferred bidder signed a 25-year PPA at USD 58.4/MWh – to date, the lowest contracted solar PV price observed globally. Aside from the long-term certainty provided by the PPA and the price competition from the auction, the bid benefited from excellent resources; reportedly attractive debt financing terms; a sizeable

RENEWABLE TRANSPORT

Summary

- **Global growth in biofuels production was achieved in 2014 despite a challenging environment**. Modest global expansion was underpinned by favourable feedstock crops in key markets such as the United States (US) and the European Union (EU), new and increased biofuel mandates in several countries, and emerging Southeast Asian biofuel production markets establishing new export relationships. The total production forecast for 2020 of 144 billion litres (L) is a slight upward revision from the *Medium-Term Renewable Energy Market Report 2014* (*MTRMR 2014*).

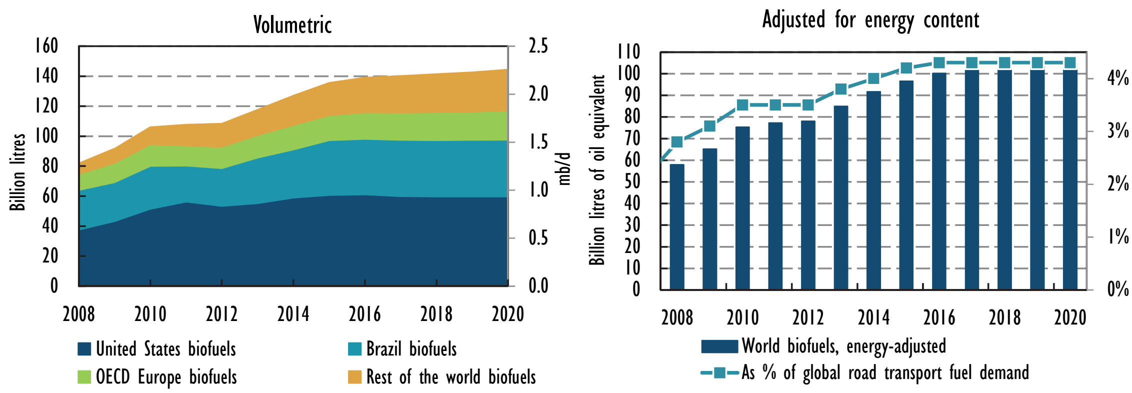
- **Mixed fortunes in the market-leading US and Brazilian biofuels industries.** In the United States, ethanol production increased in 2014, aided by a bumper corn crop improving ethanol production economics. The biodiesel industry contracted slightly, however, partly as a result of uncertainty regarding the availability of blending subsidies. Brazil registered low-level growth in ethanol production despite squeezed profit margins from higher production costs and competition from low, regulated gasoline prices. Prospects for 2015 are improved by an increase in the taxation of gasoline and also the anhydrous ethanol blending mandate rising to 27%. Brazil's biodiesel industry also received a boost from an increase in the blending mandate to 7%.

- **Biofuels policy uncertainty has reduced, but announcements provide mixed messages to key biofuels markets.** In the United States, with the exception of biodiesel, the Renewable Fuel Standard (RFS2) volumes announced by the US Environmental Protection Agency (EPA) propose reductions on previous statutory targets for transport biofuels. However, if achieved, the volumes proposed would still represent growth in renewable transport fuel consumption. Markets in member countries of the Organisation for Economic Co-operation and Development's (OECD) Europe region will be impacted by the decision to introduce a 7 percentage point (pp) cap on the contribution of conventional biofuels towards the EU 10% renewable energy in transport target for 2020. While this has provided much-needed clarity to the European biofuels industry on the prospects for medium-term production, the decision may dampen future investment prospects for conventional biofuels production capacity.

- **Significant impacts from the reduction in crude oil prices on biofuel production at a global level were not observed during 2014.** This was principally due to blending mandates protecting demand. However, the consequential impacts of a sustained period of low oil prices on blending economics, opportunities for discretionary blending above mandates and, in the case of Brazil, the price of ethanol compared with gasoline at the pump could undermine markets for conventional biofuels and cause a downward shift from the *MTRMR 2015* medium-term forecast.

- **A significant increase in advanced biofuels production capacity was achieved in 2014**, with five new commercial-scale plants commissioned, and a further two opening in 2015. The advanced biofuels industry is now at a crucial stage, with prospects for future expansion linked to the technical and financial performance of these pioneering plants. The US EPA's RFS2 volumes for cellulosic ethanol propose a decrease from statutory levels but still allow headroom for significant production increases. In the European Union, the cap on the contribution of conventional biofuels towards the 2020 target for renewable energy in transport has created an opportunity for advanced biofuel production to make an increased contribution to meeting this.

Figure 82 World biofuels production 2008-20



Sources: IEA (2015c) *Monthly Oil Data Service* (database); MAPA (Ministério da Agricultura, Pecuária e Abastecimento), *Ministério da Agricultura – Agroenergia*; US EIA, *Petroleum & Other Liquids*.

Global overview

Favourable policies and conditions limit the impact of reduced oil prices

Today biofuels provide 4% of world road transport fuel, and are expected to rise slowly, reaching almost 4.3% in 2020. The global context for biofuels is changing as a result of the significant reduction in crude oil prices observed in 2014. However, this had only a limited effect on 2014 production as biofuel consumption remains largely mandate-driven. Production volumes reached 127 billion L in 2014, up from almost 118 billion L in 2013. Despite lower oil prices, world biofuels production is still forecasted to rise in the medium term to almost 144.5 billion L.

Table 39 World biofuels production 2014-20

Billion L	2014	2015	2016	2017	2018	2019	2020	CAGR
OECD Americas	61.0	62.8	63.2	62.0	61.4	61.4	61.3	0.1%
United States	58.9	60.6	61.1	59.9	59.6	59.6	59.7	0.2%
OECD Europe	16.3	16.9	17.7	18.1	18.6	18.8	19.5	3.1%
OECD Asia Oceania	0.8	1.0	0.8	0.8	0.8	0.8	0.8	-0.3%
Total OECD	**78.1**	**80.5**	**81.8**	**80.9**	**80.8**	**81.0**	**81.6**	0.8%
Non-OECD Europe	0.2	0.2	0.2	0.2	0.2	0.2	0.3	2%
China	2.6	0.8	3.0	3.2	3.2	3.4	3.5	6%
Non-OECD Asia	8.2	9.0	10.1	10.9	11.6	12.1	12.5	7%
Non-OECD Americas	37.2	42.2	42.8	43.6	43.9	44.2	44.5	3%
Brazil	32.1	36.7	37.0	37.6	37.6	37.8	37.9	3%
Middle East	0.1	0.1	0.1	0.1	0.1	0.1	0.1	11%
Africa	0.5	0.8	1.0	1.1	1.3	1.3	1.5	19%
Total non-OECD	**49.0**	**55.4**	**57.4**	**59.3**	**60.7**	**61.7**	**62.8**	**4%**
Total world	**127.1**	**135.9**	**139.2**	**140.2**	**141.5**	**142.7**	**144.4**	**2%**

Note: CAAGR = compound average annual growth rate.

Sources: IEA (2015c) *Monthly Oil Data Service* (database); MAPA, *Ministério da Agricultura – Agroenergia*; US EIA, *Petroleum & Other Liquids* data sources.

World biofuel output in 2014 equated to approximately 92 billion L of conventional gasoline and diesel fuels, with an estimated associated wholesale value of USD 67 billion. This is forecasted to increase to 105 billion L by 2020 with a corresponding value of USD 74.5 billion. The cumulative 2014-20 value of conventional transport fuels offset by biofuels is forecasted at USD 500 billion.[1]

Table 40 Global main targets and support policies for liquid biofuels

Targets and quotas	Support scheme	Other support/specific requirements
Regulatory frameworks: EU Renewable Energy Directive (RED): 10% renewable energy in transport by 2020, with a 7 pp cap on conventional biofuels. US RFS2: renewable volume obligations for different categories of biofuels. Canada: Federal renewable fuel standard blending mandates for biofuels. **Key producer biofuel mandates and targets:** **Country / Biodiesel / Ethanol** United States: 36 billion gallons of biofuels by 2022 Brazil: 7% / 27% European Union: 10% renewable energy in transport by 2020 Argentina: 10% / 10% China*: – / 10% Canada**: 2% / 5% Indonesia: 15% / 3% Thailand: 7% / – Colombia: 10% / 8-10% India: – / 10% Malaysia: 7% / – Philippines: 2% / 10%	**Tax incentives on retail sales of ethanol:** Argentina, Australia, Austria, Bulgaria, Brazil, Czech Republic, Denmark, France, Finland, Germany (only ethanol exceeding quota and E85), Hungary, Ireland, Latvia, Lithuania, Luxembourg, Malta, Romania, Slovak Republic, Slovenia, Spain, Sweden, Japan, Korea, New Zealand, Thailand, United States (certain states). **Tax incentives on retail sales of biodiesel:** Argentina, Australia, Canada (Quebec, Nova Scotia), Austria, Belgium, Bulgaria, Czech Republic (different exemptions depending on blend %), Denmark, France, Hungary, Ireland, India, Latvia, Lithuania, Romania, Slovak Republic (certain blends), Spain, Sweden, Korea, Thailand, United States (certain states). **Tax credits:** US: tax credit for cellulosic ethanol and other qualifying advanced biofuels. **Production-linked payments:** Canada.	**Sustainability requirements for biofuels:** European Union: all biofuels used to meet RED 2020 target must comply with defined sustainability criteria. This includes GHG reductions and criteria relating to land where biofuels are sourced. Switzerland: tax exemptions for renewable fuels meeting environmental and social standards. United States: specific life-cycle emissions reduction standards under RFS2. **Incentives for infrastructure development:** Some EU member states have grant programmes for biofuels distribution infrastructure. USDA funding for E15 and E85 fuel distribution infrastructure. Sweden: large retail fuel stations must sell fuel from renewable sources. Thailand: retail stations selling E20 receive financial premium. **RD&D programmes:** European Union: funding available through NER 300, Horizon 2020. A number of countries provide RD&D for the development of advanced biofuels, biofuel feedstocks and supply chains.

*in some provinces; **federal: higher mandated blends in some provinces.

Notes: GHG = greenhouse gas; USDA = US Department of Agriculture; RD&D = research, development and demonstration. E15/E20/E85 refer to the ethanol percentage, with the remainder being gasoline, i.e. E15 = blend of 15% ethanol and 85% gasoline; B100 = pure biodiesel. For further information, refer to IEA *Policies and Measures Database*: www.iea.org/policiesandmeasures/renewableenergy.

Sources: Bahar et al.(2013), "Domestic incentive measures for renewable energy with possible trade implications", *OECD Trade and Environment Working Papers*, No. 2013/01.

With gasoline and diesel prices reducing in line with crude oil from mid-2014, biofuels could become less competitive when compared with conventional fuels in certain markets. While this new price

[1] IEA analysis based on energy-adjusted volume figures and average 2014 wholesale prices for gasoline and diesel in global markets from IEA IEA (2015c) *Monthly Oil Data Service* (database). USD values for 2020 and medium term (2014-20) were calculated using average 2014 prices.

hydrous ethanol and flex-fuel vehicles account for more than 55% of the total light vehicle fleet, and the market share of these vehicles has the potential to reach over 80% by 2020 (USDA, 2014).

Ethanol production in Brazil increased only modestly by 1.25 billion L year-on-year in 2014. Production was affected by a period of drought in early 2014 resulting in a smaller cane harvest than previous years, which raised sugar cane prices and consequently ethanol production feedstock costs. This was partially alleviated, however, by reduced world sugar prices, which drove many sugar cane mills to shift more of their output towards ethanol.

A boost for the industry was received from the increase in the nationwide blending mandate from 25% to 27% in March 2015. In addition to the increase in domestic ethanol demand, the higher mandate offers producers the opportunity to sell more anhydrous ethanol, used for blending, which sells at a premium compared with hydrous ethanol, which is used unblended. Since there is limited scope to increase the sugar cane harvest substantially, any significant increase in domestic demand in the medium term, e.g. stimulated through even higher blending mandates or favourable national or state level taxation, may need to be satisfied by reduced sugar production, lower ethanol exports or higher imports. Ethanol exports to the United States may be affected by the proposed RFS2 advanced biofuel target adjustment. Sugar cane ethanol is eligible to count against the advanced biofuel target due to its lower GHG intensity compared with corn-based ethanol.

In 2014, many mills continued to struggle due to low profits from the production of both sugar and ethanol. In the case of the latter, ethanol producer margins were squeezed by the combination of increasing production costs and regulated government gasoline prices aimed at controlling inflation levels. However, in February 2015 Brazil raised taxes on gasoline and diesel. This increased retail prices for these fuels and allowed ethanol producers to raise prices that were previously effectively capped by regulated gasoline prices, allowing for increased ethanol production profits (Platts, 2014).

Due to its lower energy content when ethanol prices are generally more than 70% of the gasoline prices, flex-fuel vehicle consumers favour gasoline. The increase in taxation for gasoline has raised its retail price and stimulated consumer switching to ethanol. As a result of this change hydrous ethanol has been at its most price competitive level compared with gasoline since 2010 and between January and June 2015 consumption was 41% higher than over the same period in 2014 (Platts, 2015b), with the sugar cane industry producing more ethanol at the expense of sugar.

Despite these positive developments, the overall context for the industry remains challenging. In addition to approximately 70 plants that have stopped production on a temporary or permanent basis since 2008 (F.O. Licht, 2014), the Brazilian sugar cane industry association Unica has indicated that up to ten more mills may suspend operations in 2015-16 due to challenging economic conditions.

The Brazilian biodiesel outlook is more upbeat as a result of the increase in the domestic blending requirement from 5% to 7%. This has brought the mandate more in line with available biodiesel production capacity and should lead to a 0.6 billion L year-on-year increase in biodiesel production in 2015, reaching around 4 billion L. Over the medium term, production volumes are forecasted to increase to 4.7 billion L, driven primarily by an increase in diesel demand.

Table 48 Total renewable electricity generation (TWh)

	2014	2015	2016	2017	2018	2019	2020	CAAGR 2014-20
World	**5423**	**5700**	**6028**	**6316**	**6596**	**6877**	**7156**	**4.7%**
OECD Total	**2416**	**2569**	**2676**	**2770**	**2856**	**2946**	**3038**	**3.9%**
OECD Americas	1057	1121	1169	1211	1240	1271	1308	3.6%
Canada	396	417	423	430	438	443	449	2.1%
Chile	32	37	39	44	48	53	56	10.1%
Mexico	52	51	56	60	63	66	71	5.2%
USA	577	617	652	677	691	709	732	4.1%
OECD Asia Oceania	238	254	271	287	301	315	328	5.4%
Australia	37	34	36	39	42	45	48	4.4%
Israel*	1	2	2	3	4	5	6	37.2%
Japan	154	169	182	193	202	209	215	5.8%
Korea	12	14	15	17	19	21	22	10.7%
New Zealand	34	34	35	35	35	36	36	0.8%
OECD Europe	1121	1194	1235	1273	1315	1359	1402	3.8%
Austria	54	55	56	57	57	59	60	1.8%
Belgium	14	15	15	17	19	21	23	9.0%
Czech Republic	10	10	10	10	10	10	10	0.2%
Denmark	18	21	22	24	26	27	29	8.1%
Estonia	1	3	3	3	3	3	3	15.2%
Finland	26	28	28	29	31	32	32	3.8%
France	95	98	101	103	106	111	115	3.2%
Germany	166	196	206	214	223	232	242	6.5%
Greece	12	14	15	15	15	15	15	4.0%
Hungary	3	3	3	3	3	4	4	2.7%
Iceland	18	19	19	19	19	19	19	1.2%
Ireland	7	7	8	9	11	12	14	13.0%
Italy	120	114	116	117	118	119	120	0.0%
Luxembourg	1	1	1	1	1	1	2	0.7%
Netherlands	12	13	14	15	17	19	21	10.6%
Norway	139	139	140	141	143	143	144	0.6%
Poland	20	23	25	26	27	29	31	7.1%
Portugal	32	30	31	32	33	33	34	0.6%
Slovak Republic	6	6	6	6	6	6	7	1.7%
Slovenia	7	6	6	6	6	6	6	-1.0%
Spain	114	105	105	105	106	106	106	-1.2%
Sweden	85	94	96	98	99	101	103	3.4%
Switzerland	42	41	42	43	44	45	46	1.5%
Turkey	52	84	90	96	102	108	113	13.8%
United Kingdom	67	71	77	82	89	96	103	7.4%
Non-OECD Total	**3008**	**3131**	**3352**	**3546**	**3740**	**3931**	**4118**	**5.4%**
Africa	132	139	148	163	180	196	213	8.3%
Other sub-Saharan Africa	105	108	114	124	134	144	155	6.8%
South Africa	7	9	12	16	19	21	23	23.0%
Asia (excluding China)	449	483	518	565	612	654	692	7.5%
India	207	229	250	276	305	330	351	9.2%
China Region	1321	1393	1502	1594	1683	1776	1872	6.0%
Europe and Eurasia	343	349	353	357	361	365	368	1.2%
Non-OECD Americas	739	744	805	841	876	909	939	4.1%
Brazil	425	421	474	502	528	554	576	5.2%
Middle East	24	24	25	26	29	31	35	6.7%

Notes: TWh = terawatt hour. Renewable electricity generation includes generation from bioenergy, hydropower (including pumped storage), onshore and offshore wind, solar PV, solar CSP, geothermal, and ocean technologies. For OECD member countries, 2014 generation data are based on IEA statistics published in *Renewables Information 2015*.

* The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

The paper used has been produced respecting ecological, social and ethical standards.

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