

# Solar power project for auction in South Pakistan



Pakistan is entering into a new era of attracting power projects through competitive bidding to provide cheaper electricity to end-consumers, as Sindh government is all set to auction the first-ever project through the bidding process by March 2020. To date, the country has attracted power projects by offering incentives to investors under the cost-plus tariff formula, which ensured a fixed internal rate of return (IRR) to investors.

The achievement of surplus installed capacity of power production in recent times allowed authorities to make a shift towards new power projects through the tariff-based competitive bidding. "We are set to auction the first 50-megawatt (MW) solar power project at Manjhand (district Jamshoro) through competitive bidding by February-March," Sindh Solar Energy Project (SSEP) Project Director Mehfooz A

Qazi said. The 50MW project is part of the planned 400MW solar power park in Sindh that is estimated to attract new investment of around \$250mn. "We aim to auction all the potential 400MW solar power projects by 2021 and start supplying electricity to the national power grid within the next five years (2023-24)," he said. The World Bank is providing financial and technical support for establishing the solar park. "World Bank has provided an assistance of \$100mn for four different solar power projects, including \$30mn for establishing the 400MW solar park," he said. In this backdrop, the energy department of the government of Sindh appointed a consortium of foreign and local advisers to auction the 400MW power projects.

The consortium comprises Bridge Factor (Pakistan) and Tractebel Engie (Germany) in association with Renewable Resources Limited (Pakistan), Ashurst Law (Singapore) and Axis Law (Pakistan). On behalf of the government of Sindh, Qasim inked the contract with the consortium to hire its services in the presence of Provincial Energy Minister Imtiaz Ahmed Shaikh at Energy Department. The project director hoped the solar projects would attract an investment of around \$250mn, considering the country has recently attracted \$38mn investment for a 50MW solar project under the old formula of cost-plus tariff. "We are highly hopeful the projects will provide cheaper and clean energy in the country," he said. Earlier, the National Electric Power Regulatory Authority (Nepra) had announced an upfront tariff of 5.23 cents per unit (Kilowatt per hour) to attract solar projects under the old formula of cost-plus tariff. "The competitive bidding will surely attain a comparatively cheaper tariff than the upfront tariff," he said. The competitive bidding process allows the Sindh government to accept the lowest tariff-bid from new potential investors. Later-on, it may ask other investors to match the lowest bid to become part of the 400MW solar park. He said the investors would offer the much cheaper tariff than the upfront one, as cost of solar power projects has mas-

sively gone down over a period of time. “The government awarded a (high) tariff of 15-16 cents per unit for the first solar park (Quaid-e-Azam Solar Park of 100MW set up in Bahawalpur, Punjab) years back. The cost of solar power projects has further cut down since Nepra approved the up-front tariff of 5.23 cents per unit for solar power,” he said. Solar remains one of the low-cost sources of electricity generation in the energy mix in the country. More importantly, the federal government has planned to increase the share of solar power to around 25% by 2025 compared to around 4-5% at present. Qazi said the demand for electricity has been increasing by 5-7% per year. “The surge in demand may come comparatively higher and quicker considering the country is set to see acceleration in economic growth going forward.”

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## **Future of solar panel production will have two faces**



Solar customers increasingly want panels that capture energy from both their sunny and shady sides, as plummeting component prices finally allow such products to be cost-effective.

Panels that are bi-facial, as the technology is known, will probably become the industry standard, according to one of the

world's biggest solar manufacturers, LONGi Green Energy Technology Co. They already dominate in the Middle East and are making inroads in the U.S., Europe and elsewhere, according to another top maker.

The shift is being driven by ever-cheaper parts, which are making the products profitable even though adding solar glass on the underside of panels boosts power output by less than 10%, according to BloombergNEF. Bi-facials will likely make up 15% of the global market next year, up from 4% this year, BloombergNEF analyst Wang Xiaoting said Tuesday at the research firm's annual summit in Shanghai.

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**Germany faces power shortages  
if onshore wind grows too  
slow**



Germany's onshore wind crisis, which is already cutting into company profits and costing jobs, may also begin to weaken defenses against blackouts.

That's the conclusion of analysts who see electricity risks mounting in Europe's biggest economy, where construction of new onshore wind parks has dropped to a standstill because of a flood of environmental complaints. German industry will need new power sources in coming years to ensure security of supply as coal and nuclear stations are decommissioned.

Chancellor Angela Merkel's government is trying to coordinate the shutdown of thermal plants with a build-up of clean power to avoid potential supply shortages, said McKinsey & Co. Senior Partner Thomas Vahlenkamp. But that "entails pushing ahead with reaching clean energy targets – especially turning around stalled onshore wind," he said.

Coal power will start to come offline next year and Germany foresees completing its full exit from nuclear energy by the end of 2022. Those two sources of energy comprise about 43% of German power currently available around-the-clock that will disappear by 2030, according to Vahlenkamp.

Merkel's coalition government has set an ambitious green power growth target. It wants to generate almost two-thirds of its electricity with renewables over the next decade from about two-fifths today. Reaching that goal implies onshore wind adding about 4.6 gigawatts of fresh power annually.

The pace of net new onshore installations dropped to 0.3 gigawatts in January to June, down from 5.3 gigawatts in 2017 and 2.4 gigawatts last year. The drop in construction is already hurting turbine maker Enercon GmbH, which has a strong focus on the German wind market.

Until now, Germans have enjoyed one of the most resilient power grids in Europe. Consumers experienced just 12 minutes of power outages last year, according to the latest report of the Council of European Energy Regulators. That compares with some 6 hours of outages in Romania, the worst-performing country.

Merkel's coalition is counting on restoring wind power's trajectory by cutting through red tape that's holding up projects. Moves to extend the national grid to accommodate more clean power and expanding storage won't be ready until the middle of next decade.

Germany is counting on its status as a net exporter of power to help it brace it for potential shortfalls as nuclear and coal power wind down in stages. It transmitted about 53 terawatt-hours of power to its European partners in the nine months through September, compared with 31 terawatt-hours of imports, monitoring group AG Energiebilanzen reported Monday.

Yet with manufacturing and construction responsible for

producing a quarter of all German goods and services, the country can't afford to bump into security of supply issues, according to the country's Mechanical Engineering Industry Association VDMA, which wants the government to be more assertive in warding off potential blackouts.

Heading off blackouts and securing electricity "hangs on just how much power is available and when," VDMA spokeswoman Beatrix Fontius wrote.

"Renewable power will in the near future shoulder the job of supplying power – for that reason it's hard to understand why the government is dragging its feet," she said.

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## **Shell to Buy French Offshore Wind-Power Developer**



Shell to buy floating offshore wind energy developer EOLFI  
Shell has agreed to buy French floating wind power developer EOLFI for an undisclosed fee through its subsidiary Shell New Energies.

EOLFI was founded in 2004 and has a current portfolio of 145MW solar and 1GW onshore wind power. Since 2012, the company has focused on floating offshore windfarms in France and is part of a project with MHI Vestas to develop the pilot Groix & Belle-Ile windfarms off the coast of Brittany.

The deal is subject to the standard regulatory and ministerial approvals and should be completed by the end of December 2019.

Shell vice president for offshore wind Dorine Bosman said: "EOLFI has been a pioneer of floating wind development. We believe the union of EOLFI's expertise and portfolio with Shell's resources and ability to scale-up will help make electricity a significant business for Shell."

Shell's stock price currently stands at 2333p a share on the London Stock Exchange, lower than its 2019 peak of 2612p on 30



July.

EOLFI founder Alain Delsupexhe said: "EOLFI joins the Shell group at the time when the market of floating wind is taking off globally.

"EOLFI's heritage in floating wind combined with Shell's offshore expertise and global footprint will enable us to expand offshore, but also onshore with our wind and solar projects as part of the Shell New Energies division."

Shell New Energies

Shell has moved into the renewable energy sector since it announced that it would invest \$2bn a year into new energy schemes in 2018.

In 2019 it rebranded its energy supply business from First Utility to Shell Energy and switched its UK energy customers to 100% renewable energy, whilst Shell New Energies invested in a 20% in Indian solar company Orb Energy in October 2019.

Floating offshore wind farms

Floating offshore windfarms see wind turbines mounted on a floating buoyant structure, which require fewer materials to build and offer the ability to build offshore windfarms where water depths are as much as 50m to 60m.

The first operational floating offshore windfarm was the Hywind Pilot Park off the coast of Aberdeenshire in Scotland.

Several companies have signed agreements to develop and build more floating offshore windfarms. Equinor will invest \$550m to build the 88MW Hywind Tampen windfarm to power its oil and gas operations in the Norwegian North Sea, whilst Ideol and Taisei signed a memorandum of understanding (MoU) in February 2019 to develop a floating windfarm in Japan.

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# Amid climate worries, Mexico doubles down on fossil fuels



On the same September day that activist Greta Thurnberg gave a fiery speech in New York demanding world leaders tackle climate change, Mexico's president was touting achievements of a wholly different kind: increasing funding for oil production.

"We're investing in refineries. It hasn't been done for a long time," President Andres Manuel Lopez Obrador told reporters at a news conference in Mexico City.

"What was invested this year is going to be repeated next year," promised Lopez Obrador, noting that the government had already funnelled more than 12bn pesos (\$600mn) towards revamping oil production.

The leftist leader, who was elected in a landslide last July, has framed the investment as a way to wean Mexico off its dependency on foreign energy supplies, as well as fuelling economic development through increased oil production.

But at a time when countries are facing mounting pressure to curb emissions and stave off threats from a warming climate, environmental experts say the Mexican government is moving in the wrong direction.

"While Mexico should be abandoning (oil) production, they're rehabilitating refineries ... under a logic of national sovereignty," said Leon Avila, a professor of sustainable

development at the Intercultural University of Chiapas.

“It’s an archaic perspective, based on production in the 70s during the oil boom, and they think they can do the same thing – when really we’re in another context,” he told the Thomson Reuters Foundation.

Last Monday, Mexico’s government announced it would expand the rules of its “clean energy certificates” (CEL) programme to make them available to older hydroelectric plants operated by state utility company CFE.

The programme previously applied only to new projects, creating an incentive for local and foreign firms to invest in green energy.

The CEL-certified energy can be sold to big companies that are required to obtain a percentage of their electricity from clean sources.

But in a statement on Tuesday, CFE director general Manuel Bartlett Diaz said that, in line with the president’s vision for energy sovereignty, there was “no reason to subsidise private (electricity) generating companies”. Industry leaders and environmental experts said the move weakens incentives for renewable energy investment, and risks Mexico’s compliance with the 2015 Paris Agreement to fight climate change.

The Mexican CCE business council said on Tuesday that the change could jeopardise up to \$9bn in foreign and local clean energy investments tied to the original CEL rules.

“The decision detracts from the only mechanism considered by law to drive Mexico’s energy transition and meet the mandatory national clean energy adoption goals,” the CCE said in a statement.

The Lopez Obrador administration has emphasised its commitment to tackle climate change and adhere to the Paris accord.

At a UN climate conference last December, Sergio Sanchez, then undersecretary for environmental protection, said the government would implement “concrete policies and actions focused both on reducing emissions and adapting to climate change”.

The Mexican senate last week also called on the federal

government to declare a “climate emergency” and take necessary steps to address climate threats.

Those can range from wilder weather and rising seas to more crop-killing droughts that can drive worsening poverty and migration.

But at a press conference the following day, the president shied away from recognising climate change as a crisis.

“We have already considered a series of measures to face the climate change phenomenon in the Development Plan,” Lopez Obrador said.

But the president’s description of the plan – listing conservation efforts but omitting any policies to reduce emissions – irked environmentalists.

“There is a lack of understanding for the climate crisis we are confronting,” said Claudia Campero from the Mexican Alliance Against Fracking, an advocacy group.

According to Avila, the university professor, the president has prioritised ending Mexico’s entrenched poverty but is using oil as the primary engine to drive prosperity.

“He should care about climate change, but between climate change and going down in history for ending poverty...

well obviously he prefers that,” Avila said.

Among Lopez Obrador’s most important projects is the construction of a new oil refinery in his home state of Tabasco.

The project is set to cost \$8bn, and the government says it would generate up to 23,000 jobs.

But besides boosting Mexico’s carbon footprint, the refinery, at a coastal site, is vulnerable to climate threats, environmental experts said.

Local media reported this week that the property had flooded due to heavy rains.

Environmentalists also point with concern to the government’s proposed 2020 budget, which would see fossil fuel funding continue to increase.

Under the proposal, the energy ministry’s budget would jump more than 70% compared to last year, to 48.5bn pesos (\$2.4bn),

following a budget increase this year of over 900% compared to 2018.

According to an analysis of the budget published in September by a coalition of environmental groups, 96% of the money is intended to support oil and natural gas related projects.

“There is no room for more development of fossil fuel extraction,” said Campero, the fracking opponent.” (But) that’s far from being the vision of this government.”

The budget does include about 56bn pesos (\$2.8bn) for “adaptation and mitigation of the effects of climate change,” but of this, 70% is being set aside for transporting natural gas, a somewhat cleaner fossil fuel, Campero said.

A spokeswoman for the Mexican environment ministry did not respond to numerous requests for comment.

Conspicuously absent from the budget, advocates say, is funding for expanding renewables, despite the country’s potential to adopt clean energy.

According to a 2017 study from the Friedrich Ebert Foundation, which focuses on promoting democracy and social programmes, 80% of Mexico’s energy currently comes from fossil fuels.

But the country’s landscape and weather conditions mean it could supply its electricity needs entirely from renewable sources, the study noted.

The Lopez Obrador administration has appeared reticent to capitalise on this potential, however.

In January, the government cancelled a public auction for companies to bid on clean energy contracts.

“Mexico is a very rich country in terms of its potential in renewables,” said Pablo Ramirez, a campaigner at Greenpeace Mexico.

“But since the arrival of the new administration, that’s been completely scrubbed off the map.”

Mexico’s 2020 budget is awaiting final approval by congress this month. – Thomson Reuters Foundation.

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# **Qatar stresses role of natural gas in meeting economic and environmental challenges**



Qatar has stressed the importance of natural gas in meeting the economic and environmental challenges facing energy consumers around the world.

Many countries around the world are searching for the right balance of reliable and secure sources of energy, which can drive their growth, while addressing environmental concerns at the same time, HE the Minister of State for Energy Affairs Saad bin Sherida al-Kaabi told the 21st ministerial meeting of the Gas Exporting Countries Forum (GECF).

“In this effort, many are discovering the versatile, flexible, economic, and environmental qualities of natural gas as a key enabler in the journey to achieve a lower-carbon economy,” he said.

He stressed on Qatar’s commitment to ensuring the continued availability of reliable LNG (liquefied natural gas) supplies to world markets, and to promoting greater growth in the LNG industry, as well as to serving the growing needs of its

clients.

“We all have the same objective: To place natural gas at the heart of the energy industry as a fuel of the future to affirm our true belief that natural gas is a cornerstone in the energy transition and a destination fuel, not merely a transition fuel,” he said.

Drawing attention to unprecedented recurrent climatic conditions, including mean temperatures, turbulent seasonal cycles and extreme events, al-Kaabi had recently said it is time to take another look at natural gas and the number of advantages it has to make it a pivotal element in any strategy to tackle environmental challenges.

Qatar has highlighted the efforts to reinforce its position as the world’s leading LNG producer, which include the North Field expansion to increase the LNG production capacity to 110mn tonnes per annum by 2024, and a major ship-building campaign to build up to 100 LNG carriers over the next decade.

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## **Musk Says Tesla Has Finally Made a Ready-to-Deploy Solar Roof**



Almost three years after Tesla Inc. Chief Executive Officer Elon Musk unveiled solar roof shingles as part of his push to buy SolarCity, the automaker says it finally has a version of the tiles that it can mass produce.

“It’s been quite hard,” Musk said on a conference call late Friday. “Roofs need to last a long time. When you add electrification to the roof, it’s a fair bit of complexity.”

The sleek roof is a key part of Tesla’s push to revive its struggling solar business. Musk unveiled the product in 2016, but the company hasn’t been able to bring production up to full scale. The photovoltaic tiles are designed to resemble regular shingles, unlike solar panels atop a roof.

The latest version of the shingles was introduced after Tesla lost its status as the biggest U.S. rooftop solar company. It’s also been sued by Walmart Inc. over fires at a half-dozen of the big-box stores that had Tesla solar systems, and the company still faces litigation from shareholders over the controversial SolarCity acquisition.



## Signs of a Bounce Back

Tesla's quarterly solar installations increase for first time in a year

Tesla initially said it would have a slow roll-out of the solar roof. But issues with aesthetics, cost and manufacturing process have dogged production. At one point in 2018, Tesla was making enough solar-roof shingles for just three to five homes a week.

Earlier this year, Musk declared 2019 as "the year of the solar roof." In July, he tweeted that Tesla was "spooling up production line rapidly," and that he hoped to manufacture about 1,000 roofs each week by year-end.

On the call Friday to discuss the third version of the roof, he reiterated the goal of getting to 1,000 roofs per week in the next several months but acknowledged that there might be setbacks.

"It's an odd and weird product," he said. "Why would anyone make a solar roof? How strange. But it just is a thing that should be. So we're going to make it."

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## Green Climate Fund attracts higher pledges, open for more



LONDON (Thomson Reuters Foundation) – Wealthier countries on Friday promised nearly \$9.8 billion over the next four years to an international fund to help poorer nations develop cleanly and adapt to climate stresses, with nearly a dozen nations doubling their previous commitments.

The total was slightly higher than the \$9.3 billion committed to the Green Climate Fund (GCF) at its first pledging conference in 2014, and came despite the absence of commitments by previous major donors such as the United States.

Climate finance analysts welcomed the stepped-up pledges – 11 of the 27 donor governments doubled their previous commitments – but said the totals were not rising as fast as the climate-change threats poor nations must deal with.

“It’s quite clear we have governments all over the world declaring climate emergencies, and far more finance from all sources is needed to adequately address the challenge,” said Joe Thwaites, a finance researcher with the U.S.-based World Resources Institute.

In its first five years the fund received total promises of a little over \$10 billion.

But because the United States, under President Donald Trump, reneged on two-thirds of its initial \$3 billion pledge, and currency values changed, it effectively had only \$7.2 billion to spend, said Yannick Glemarec, its executive director.

The new commitments, if fulfilled, will effectively give it 70% more money to spend each year, with additional pledges likely in coming months, he said.

The funding is still a drop in the ocean compared with the estimated \$3 trillion to \$7 trillion a year needed to shift the world's economy onto a more sustainable and climate-friendly path, Glemarec said.

But if used to show what is possible in developing nations and cut risks for private investors there, it could help spur the much larger investments needed to make that shift, he said.

"We are very excited because we should be able to prevent a lot of climate hurt" with the additional funds, he told the Thomson Reuters Foundation.

The GCF so far has allocated about \$5.2 billion to 111 projects in 99 countries.

They range from green, low-cost housing in Mongolia's polluted capital and a methane-fuelled rapid-transit bus system in Karachi to restoring climate-threatened ecosystems in Namibia.

The GCF has committed to spend half of its funding on efforts to help poorer countries adapt to climate threats, which rarely attract significant private or government finance.

## **'GOOD START'**

Most of the donors making fresh contributions came from Europe, though New Zealand, South Korea, Japan and Canada also

committed funds, with New Zealand and South Korea pledging to double previous donations.

“This is a good start but in no way adequate to meet the needs on the ground,” said Wendel Trio, director of Climate Action Network Europe, saying he hoped more pledges would come.

The fund will remain open for additional contributions throughout its next term, GCF officials said.

Thwaites said Belgium was expected to commit to doubling its previous \$100-million pledge to the fund in coming months, and Mexico had attended this week’s pledging conference in Paris too.

Gas-rich Qatar, at the U.N. Secretary-General’s climate summit in New York last month, pledged \$100 million to help least-developed countries and struggling small islands cope with climate threats, Thwaites said.

The money was not intended for the GCF but shows issues affecting poorer states “are on their radar”, he said.

Stepped-up GCF funding is considered key to encouraging poorer nations to boost the ambition of their national targets to hold the line on emissions and better adapt to climate threats, finance experts said.

Both rich and poor governments are expected to improve their climate action plans – created as part of the 2015 Paris Agreement on Climate Change – by the end of 2020.

Many developing-nation plans rely heavily on external funding to meet their most ambitious goals to put in place everything from renewable energy to storm early warning systems.

Liane Schalatek, a climate finance specialist with the Heinrich Böll Foundation North America, said the new GCF pledges were positive but “probably not enough to give developing countries the confidence to significantly raise

their ambition”.

They were also insufficient to pay for the roughly \$15 billion in projects already waiting in the fund’s pipeline for cash, she said in a statement.

GCF head Glemarec said a key role of the GCF’s spending was to show private investors that good investments are possible in poorer countries, and remove roadblocks to those, by setting an example or helping shift policies.

In developed countries, 98% of investment in renewable energy is private, he said, but in the least-developed countries it is under 1%, he said.

Thwaites said the GCF “comes in with money to do things the private sector isn’t yet comfortable doing. They have a demonstration effect and a de-risking effect and then you see a lot more private finance can flow in those regions”.

This is especially appropriate for projects like establishing feed-in tariffs for solar or wind power that help create a renewable energy market and give investors confidence.

The GCF has so far mobilized \$2.60 in additional financing for each dollar spent, though that figure is held down by its focus on adaptation projects, which struggle to attract private finance, Thwaites said.

He said the mobilization rate was particularly respectable given the fund is working “in really difficult environments”.

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# In blow to US, EU pledges quick move on tax for polluting firms



The European Commission will quickly start work on a tax on foreign polluting firms, the nominee for the EU's economic and tax commissioner said yesterday, a move that could hit US companies and deepen a trade war with Washington.

In his confirmation hearing before EU lawmakers, Italy's Paolo Gentiloni also pledged "adequate" fiscal efforts to counter an economic slowdown in the eurozone that he said could be longer than currently expected.

"We will try to be very quick and effective on a carbon border tax," Gentiloni, who is due to take office in November, said.

He warned of legal and technical hurdles in devising the levy, but said work would start immediately to make sure the tax would be compatible with World Trade Organisation rules.

The tax is meant to shield European companies from competitors based in countries where climate protection schemes are not as strict.

President Donald Trump intends to pull the United States out

of the international Paris climate protection deal that aims to reduce carbon emissions.

Under the terms of the pact, that cannot happen before November 4, 2020. Gentiloni's remarks come the day after the United States said it would slap 10% tariffs on European-made Airbus planes and 25% duties on French wine, Scotch and Irish whiskies, and cheese from across the continent as punishment for illegal EU aircraft subsidies..

Previous European commissions have resisted calls, led by steelmakers and traditionally protectionist France, for a carbon levy, but fresh momentum has come from increased prices in the EU Emissions Trading System (ETS), the European Union's flagship instrument for making polluters pay.

In separate comments to lawmakers, Gentiloni, a socialist former Italian prime minister, also said minimum corporate tax rates were one of the possible solutions to what he said was unacceptably excessive tax competition between EU states.

Currently, the 28 EU countries decide freely their national tax rates for firms, with the EU having limited powers only on minimum rates on sales taxes.

He reiterated the EU should move alone on an EU-wide tax on digital corporations if no deal was reached at global level in 2020.

He said he was confident, although "not fully optimistic", about an international agreement by that deadline.

In the event of no consensus, he said the European Commission would begin working on a proposal for an EU digital tax from next summer and would seek to take away from EU governments the veto power on tax matters that prevented the introduction of a digital levy in the bloc last year.

Gentiloni, who will also be in charge of the bloc's economic policy, said the EU should consider measures to favour growth at a time when the bloc faces risks of a prolonged economic slowdown.

"In this situation our economic policies should be strongly oriented towards growth and investment," he told lawmakers.

Gentiloni said the Commission's annual recommendation on the

eurozone's fiscal stance would depend on the "seriousness and duration of the slowdown" as estimated in the next set of EU forecasts due on November 7. That could last longer than six months or a year, as currently expected, he cautioned.

In its latest economic forecasts released in July, the Commission predicted eurozone growth would slow to 1.2% this year from 1.9% in 2018, but forecast growth rebounding to 1.4% in 2020.

The bloc currently has a "broadly neutral" fiscal stance, despite pressure from some countries for more expansionary plans to counter recession risks.

The European Central Bank also backs a more expansionary fiscal stance.

The ECB loosened monetary policy further last month to lift growth and inflation, cutting its key rate to minus 0.5%, inching closer to what is the effective bottom, a level beyond which it would be counterproductive to go.

Gentiloni reiterated he would seek to use the leeway allowed by EU fiscal rules to permit governments to invest for growth and would also target a reduction of public debt.

He called for a review of EU fiscal rules that would make them simpler and urged an "ambitious" funding plan for an EU unemployment reinsurance scheme.

The bloc is currently debating whether to fund this scheme with loans or with more generous grants to states with high unemployment levels.

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## **How to halt global warming for \$300bn**





The world needs to spend \$50 trillion on five areas of technology by 2050 to slash emissions and meet the Paris Agreement's goal of halting global warming, Morgan Stanley analysts wrote in a report.

To reduce net emissions of carbon to zero, the world would have to eradicate the equivalent of 53.5 billion metric tons of carbon dioxide a year, according to the report, which identified renewable energy, electric vehicles, hydrogen, carbon capture and storage, and biofuels as the key technologies that could help meet the target.

Carbon emissions from fossil fuels hit a record last year, but estimates vary of how much it would cost to meet the Paris target of keeping the global temperature rise to within 2 degrees. The International Renewable Energy Agency says \$750 billion a year is needed in renewables over a decade. United Nations scientists say \$300 billion spent on reclaiming degraded land could offset emissions to buy time to deploy zero-carbon technologies.

Here are Morgan Stanley's estimates for the five key technology areas and some of the companies leading the drive.

## **Renewables**

- Renewable power generation will require \$14 trillion by 2050, including investments in energy storage.
- Renewables would need to deliver about 80% of global power by then, up from 37% today, meaning an additional 11 000 gigawatts of capacity, excluding hydro-power.
- Solar energy's rapidly falling cost will make it the fastest-growing renewable technology over the coming decade with a 13% compound annual growth rate.
- Stocks that could benefit include: CGN New Energy Holdings Co., China Resources Power Holdings Co. and China Suntien Green Energy Co.

## **Electric vehicles**

- With passenger cars currently pumping out about 7% of greenhouse gas emissions, some \$11 trillion will be needed to build factories, expand power capacity and develop the batteries and infrastructure needed to switch to electric vehicles.
- With increased investment, annual EV sales could grow from 1.3 million units in 2018 to 23.2 million in 2030, lifting the total number of electric vehicles to 113 million by 2030 and 924 million by 2050.
- Some of the companies to watch: Beijing Easpring Material Technology Co., Rohm Co. and Panasonic Corp.

## **Carbon capture and storage**

- Almost \$2.5 trillion would be needed for technologies that capture carbon and store it.
- While it currently costs about \$700 million to capture a million tons of carbon a year, the cost of building CCS plants is expected to drop 30% by 2050.
- With more than 200 000 megawatts of new coal-fired

generation capacity under construction, CCS is the only option to offset the emissions of these plants, Morgan Stanley says.

- The bank's top picks include Air Liquide SA and Bloom Energy Corp.

## **Hydrogen**

- About \$5.4 trillion is needed for electrolyzers to make the gas, which can help provide clean fuel for power generation, industrial processes, vehicles and heating.
- In addition, \$13 trillion would be required to increase renewable energy capacity to power the plants.
- Another \$1 trillion would be needed for storage, with additional investment for transportation and distribution.
- Leading players include: Johnson Matthey and Air Liquide.

## **Biofuels**

- Almost \$2.7 trillion should go into biofuels like ethanol, which are currently mixed with petroleum products but will spread eventually to areas such as aviation.
- About 4% of global transportation fuel will be biofuel in 2030.
- Ethanol, the most-used biofuel at the moment will grow at about 3% a year, while a type of biodiesel called hydro treated vegetable oil will achieve much faster growth, quadrupling production by 2030.
- Companies involved include Neste Corporation and Sao Martinho SA.