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This experiment at MIT will be the first controlled fusion plasma to produce net energy output.

Photo: by Ken Filar

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Dick Flanagan
flanagan@world-gen.com

As renewables age into retirement, next up in the energy batter's box is fusion power. MIT, Commonwealth Fusion Systems and ENI are carrying out fusion experiments leading to the development of alternative energy. Fusion is completely sustainable and is potentially inexhaustible.

Their work complements ITER currently under construction in France as the world's largest fusion experiment. Also, in the on-deck batter's circle are TAE Technologies in California who raised over \$500 million and General Fusion in Vancouver, BC who recently commissioned the world's largest plasma injector, page 4.

World-Gen covered Li Zhenguo, president of Longi Solar, at a press conference during Bloomberg's New Energy Finance 2018 Summit in New York City. He predicts 90 percent of the industry will be using bifacial technology in the next three to five years on page 6.

Lyn Corum writes from California that on May 3, the California Public Utilities Commission released its "Green Book." The "book" only asks questions rather than make recommendations. It starts with the premise that current policy shifts are reshaping California's electricity markets, without a plan on page 8.

Andrew Slaughter of the Deloitte Center for Energy Solutions writes about a new study "Supercharged: Challenges and Opportunities in Global Battery Storage Markets." He explores eight market drivers and four barriers on page 9.

Lee Graham of IHS Markit identifies eight trends in solar. He sees 20 countries surpassing 500 solar megawatts; bifacial and half cell technologies gaining a stronger foothold and E.V.'s paving new synergies on page 10.

GTM Research and the Energy Storage Association issued a report on home energy storage systems deployed for Q1, 2018. Changing net-meter rules and increased customer interest drove the residential market on page 11.

Five international agencies issued a report on energy targets for 2030 as part of the Sustainable Development Goals (SDG7). Renewables are making impressive gains in the electricity sector but transportation and heating which account for 80 percent of consumption are not matching gains. See page 12.

John Moran looks at the energy employment market and contrasts coal and solar jobs. He details the decline of coal mining jobs to 55,000 in the US and the reasons why. In contrast, solar jobs employ over 200,000, growing over 123 percent between 2009-2015. He'd like to see coal miners retrained for solar and wind installations on page 13.

Marlene Motyka, Class of 2017, proclaims that businesses are outpacing government on addressing climate change. The number of companies with carbon footprint goals has jumped to 61 percent in 2018. Almost 60 percent of businesses generate some portion of their electricity on-site using renewables, cogens and battery storage. See page 14.

Hanan Fishman, CEO of Alencon, explains the benefits of electromagnetic solutions. The ability to isolate a troubled solar array while the whole solar storage system continues is an example of a huge benefit. He summarizes other benefits on page 15.

Jing Tian, Class of 2018, updates Trina Solar on page 16.

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WORLD-GENERATION
521 FIFTH AVENUE • SUITE 1700
NEW YORK, NY 10175
212.292.5009 • flanagan@world-gen.com

FAST TRACK TO FUSION POWER

BY DAVID L. CHANDLER, MIT

CAMBRIDGE, MA - Progress toward the long-sought dream of fusion power — potentially an inexhaustible and zero-carbon source of energy — could be about to take a dramatic leap forward.

Development of this carbon-free, combustion-free source of energy is now on a faster track toward realization, thanks to a collaboration between MIT and a new private company, Commonwealth Fusion Systems. CFS will join with MIT to carry out rapid, staged research leading to a new generation of fusion experiments and power plants based on advances in high-temperature superconductors.

CFS announced that it received an investment of \$50 million from the Italian energy company Eni. In addition, CFS will fund fusion research at MIT as part of this collaboration, with an ultimate goal of rapidly commercializing fusion energy and establishing a new industry.

“Today is a very important day for us,” says Eni CEO Claudio Descalzi. “Thanks to this agreement, Eni takes a significant step forward toward the development of alternative energy sources with an ever-lower environmental impact. Fusion is the true energy source of the future, as it is completely sustainable, does not release emissions or long-term waste, and is potentially inexhaustible. It is a goal that we are increasingly determined to reach quickly.”

“This is an important historical moment: Advances in superconducting magnets have put fusion energy potentially within reach, offering the prospect of a safe, carbon-free energy future,” says MIT President L. Rafael Reif. “As humanity confronts the rising risks of climate disruption, I am thrilled that MIT is joining with industrial allies, both longstanding and new, to run full-speed toward this transformative vision for our shared future on Earth.”

“Everyone agrees on the eventual impact and the commercial potential of



Martin Greenwald, Dennis Whyte, and Zach Hartwig lead MIT researchers teaming up with a newly formed company to launch a new approach to fusion power.

Who's who: L to R: Martin Greenwald, Dan Brunner, Zach Hartwig, Brandon Sorbom, Bob Mumgaard, Dennis Whyte.

Image: Bryce Vickmark

fusion power, but then the question is: How do you get there?” adds Commonwealth Fusion Systems CEO Robert Mumgaard SM '15, PhD '15. “We get there by leveraging the science that’s already developed, collaborating with the right partners, and tackling the problems step by step.”

SUPERCONDUCTING MAGNETS ARE KEY

Fusion, the process that powers the sun and stars, involves light elements, such as hydrogen, smashing together to form heavier elements, such as helium — releasing prodigious amounts of energy in the process. This process produces net energy only at extreme temperatures of hundreds of millions of degrees Celsius, too hot for any solid material to withstand. To get around that, fusion researchers use magnetic fields to hold in place the hot plasma — a kind of gaseous soup of subatomic particles — keeping it from coming into contact with any part of the donut-shaped chamber.

SPARC

The new effort aims to build a compact device capable of generating 100 million watts, or 100 megawatts (MW), of fusion power. This device will, if all goes according to plan, demonstrate key technical milestones needed to ultimately achieve a full-scale prototype of a fusion power plant that could set the world on a path to low-carbon energy. If widely disseminated, such fusion power plants could meet a substantial fraction of the world’s growing energy needs while drastically curbing the greenhouse gas emissions that are causing global climate change.

CFS will support more than \$30 million of MIT research over the next three years through investments by Eni and others. This work will aim to develop the world’s most powerful large-bore superconducting electromagnets — the key component that will enable construction of a much more compact version of a fusion device called a tokamak. The magnets, based on a superconducting material that has only recently become available commercially, will produce a magnetic field four times as strong as that employed in any existing fusion experiment, enabling a more than tenfold increase in the power produced by a tokamak of a given size.

Once the superconducting electromagnets are developed by researchers at MIT and CFS — expected to occur within three years — MIT and CFS will design and build a compact and powerful fusion experiment, called SPARC, using those magnets. The experiment will be used for what is expected to be a final round of research enabling design of the world’s first commercial power-producing fusion plants.

SPARC is designed to produce about 100 MW of heat. While it will not turn that heat into electricity, it will produce, in pulses of about 10 seconds, as much power as is used by a small city.

That output would be more than twice the power used to heat the plasma, achieving the ultimate technical milestone: positive net energy from fusion.

(continued page 6)



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LONGI SOLAR PREDICTS

BY DICK FLANAGAN

Longi Solar was founded by Li Zhenguo in 2000 and is headquartered in Xi'an, China. Zhenguo also serves as Longi's president. He addressed the media at a press conference on April 9 during the Bloomberg New Energy Finance 2018 Summit and highlighted his company's position in manufacturing mono-crystalline solar cells and modules.

There are eight operating factories, one under construction in India and nine sales offices. The 2018 capacity planning measured in gigawatts is: 8 in cells, 12 in modules, and 28 in silicon wafers. The company enjoys a leading 48% market share in mono wafers and 16% in mono modules.

Longi Solar has 275 patents on ingot, wafer, cell and module technology staffed with over 700 technicians. It invests up to 7 percent of total revenue in R&D and boasts a 100 percent growth rate for the past three years. Gross revenue in 2016 was \$1.67 billion; net profit was \$224 million. Longi has been listed on the Shanghai exchange since 2012 under an IPO. In 2014, Longi acquired LERRI.

Longi recently rolled out bifacial technology. Li Zhenguo said, "Last year we shipped 20 megawatts of bifacial modules. This year we are likely to sell over a gigawatt of bifacial technology in regions where utility scale is popular, like the US and Mexico. In the next three to five years, we expect to see 90 percent of the industry using bifacial technology." Longi's bifacial mono-PERC solution offers an average energy yield issuance of 3.93 percent, lowers LCOE by 10 percent and increases product lifespan by 20 percent.

Li Zhenguo also touched on the company's close technology partnerships with DuPont and others including 3M, HUAWEI and Applied Materials. The collaboration with DuPont led to the launch of the new HI-MO2 bifacial module. Longi uses DuPont Tedlar backsheets on PV modules.

DuPont innovated a clear breathable Tedlar PVF film backsheet material for bifacial modules. Compared to a double glass module structure, the new backsheets allow for higher reliability, lower operating temperatures, up to 30 percent lighter weight and a lower module installation cost. Since the merger, DuPontDow integrated the Dow Corning brand of PV silicone products into the portfolio of solar solutions.

TUV Rheinland, a world leader in compliance testing and certification randomly selected module samples and simulated energy yield in five different cities globally. Mono Perc module of Longi Solar won first place in the mono group among all modules. In Pucheng, Shaanxi, China, power generation by bifacial module plus fixed tilt was 12.4% higher than Multi Module; In Kubuchi, Inner Mongolia, power generation by bifacial module plus tracker plus sand was 17.3% higher than Multi Module; and in Taizhou, Jiangsu, China, power generation by Hi-MO2 plus fixed tilt was 11.5% higher than Hi-Mo1.

ABOUT BLOOMBERG NEW ENERGY FINANCE

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FAST TRACK TO FUSION POWER CONTINUED FROM PAGE 4

COMPLEMENTARY TO ITER

The project is expected to complement the research planned for a large international collaboration called ITER, currently under construction as the world's largest fusion experiment at a site in southern France. If successful, ITER is expected to begin producing fusion energy around 2035.

By using magnets made from the newly available superconducting material — a steel tape coated with a compound called yttrium-barium-copper oxide (YBCO) — SPARC is designed to produce a fusion power output about a fifth that of ITER, but in a device that is only about 1/65 the volume. The ultimate benefit of the YBCO tape is that it drastically reduces the cost, timeline, and organizational complexity required to build net fusion energy devices, enabling new players and new approaches to fusion energy at university and private company scale.

The way these high-field magnets slash the size of plants needed to achieve a given level of power has repercussions that reverberate through every aspect of the design. Components that would otherwise be so large that they would have to be manufactured on-site could instead be factory-built and trucked in; ancillary systems for cooling and other functions would all be scaled back proportionately; and the total cost and time for design and construction would be drastically reduced.

Because the magnets are the key technology for the new fusion reactor, and because their development carries the greatest uncertainties, work on the magnets will be the initial three-year phase of the project — building upon the strong foundation of federally funded research conducted at MIT and elsewhere. Once the magnet technology is proven, the next step of designing the SPARC tokamak is based on a relatively straightforward evolution from existing tokamak experiments.

(continued page 10)



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CALIFORNIA'S ELECTRICITY MARKET IN TRANSITION

BY LYN CORUM, CLASS OF 2003



The national press reported on May 9 and 10 that by 2020 California would require all new housing in the state to have solar panels on rooftops. And it would increase the cost of a new home an additional \$9,000 plus.

What the press missed was the release by the California Public Utilities Commission on May 3 of its draft “Green Book.” I don’t blame the press for missing it – probably more likely ignored it. The Green Book only asks questions. It is “designed as a platform for conversations with and among a wide range of stakeholders and interests about the future of California’s electricity market rather than make specific recommendations.”

“We are seeing disaggregation of the energy market affecting reliability and procurement, creating warning signs such as fragmented decision making, and a dispersed supply system to supply customers at all times. The answers will be complex,” authors of the Green Book say.

For those who were involved in California’s energy industry in the early 1990s you may remember the “Yellow” and “Blue” books which outlined the CPUC’s plan for retail and wholesale competition. What resulted after the state legislature got involved was the Energy Crisis in 2000 and 2001.

The CPUC’s Green Book starts with the premise that current policy shifts are reshaping California’s electricity markets without a plan. “We could drift into another crisis,” it says. Fragmentation is coming from legislative actions, CPUC policies, distributed generation and expansion of community choice aggregation where cities or communities decide to provide electricity to its residents and businesses. Now many utility customers have choices outside the utility they never had before.

For example, the state mandate to decrease global greenhouse gases is driving major increases in renewable energy. And the proliferation of utility and rooftop solar plants is quickly reshaping the state’s daily electricity peak loads.

The Green Book assesses markets for help in New York, Illinois, Texas and Great Britain, but declares none of these provide a “cookie cutter” plan.

So the CPUC is looking for input to inform the next stage of the process. It wants to ensure reliable, clean and affordable electricity for customers while looking for equitable treatment for all market participants. This latter “want” is one of the issues that drove the plan behind the original yellow and blue books!

It is scheduled to release a final Green Book with a plan in summer 2018.

If you’re curious and want to read the Green Book, visit <http://www.cpuc.ca.gov/customerchoice/>

A POTENTIAL MODEL FOR THE STATE

An example of what disaggregation looks like is marching forward in the coastal region in Southern California north of Los Angeles where electricity is supplied by two small transmission lines coming off one of the state’s major transmission lines and the two local power plants that are being forced to retire.

The CPUC and Southern California Edison will be attempting to find renewable

resources, energy efficiency, demand response and a small peaker, all of which will be owned by or the responsibility of various independent entities, to replace two large former utility plants. In the long term, as a result of this change in resources, will the area be subject to a reduction in reliability and resilience? And will this be a forerunner of what will happen in other parts of the state?

SCE signed a contract with NRG to in 2013 to buy electricity from the proposed 262-MW Puente project in response to a CPUC request for new capacity in the Moorpark sub-area. This area stretches from east of Ventura (about an hour’s drive north from Los Angeles) in the southern end of the area to Goleta north of Santa Barbara along the Pacific Coast. Also approved was 12 MW of preferred resources contracts for energy efficiency, demand response, renewables, and distributed generation.

The need arose because the older plants serving the area have to be retired by 2020 because they use once-through ocean cooling. The State Water Quality Control Board ruled in 2010 that this technique to cool power plants is killing small fish and plankton and it gave coastal power plants alternatives – one of which is to retire and replace the plants by a date certain. The two plants, along with a third small gas-fired plant located along the coastline in Oxnard, are part of the Moorpark sub-area and represent 318 MW.

However, for the past ten years, the city of Oxnard, environmental groups and community members have lobbied for the removal of all gas-fired power plants located along the coast within city limits, including the Puente Power Plant once it began review for certification at the California Energy Commission. The city and several environmental groups argued that all power needs could be furnished by renewable and distributed generation.

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THE BATTERY STORAGE SOLUTION

BY ANDREW SLAUGHTER



The drivers behind the rapid growth of battery storage around the world extend far beyond the technology's flexible, quick deployment and falling prices, according to Deloitte's new study, "Supercharged: Challenges and opportunities in global battery storage markets." The study explores the eight main market drivers and four remaining barriers for the technology.

EIGHT MAIN MARKET DRIVERS

Driver 1: Cost and performance improvements: Declining costs and improved performance, particularly relating to lithium-ion batteries. Lithium-Ion battery prices fell 80% from 2010-2017, according to BNEF.

Driver 2: Grid modernization: Batteries generate value by adding capacity, shifting load, and/or improving power quality and help unlock the full potential of smart technologies.

Driver 3: Global movement toward renewables: The critical role batteries can play in offsetting the intermittency of renewables and reducing curtailment is well known, but the strength and pervasiveness of the desire for clean energy among all types of electricity customers is growing.

Driver 4: Participation in wholesale electricity markets: Nearly every nation examined (Australia, Chile, Germany,

Japan, India, Italy, South Korea, UK and US) is revamping its wholesale market structure to allow batteries to provide capacity and ancillary services, such as frequency regulation and voltage control.

Driver 5: Financial incentives: The widespread availability of government-sponsored financial incentives further reflects policymakers' growing awareness of the range of benefits battery storage solutions can deliver.

Driver 6: Phase-outs of FITs or net metering: Low or declining feed-in-tariffs (FITs) or net metering payments emerged as a driver of behind-the-meter battery deployments, as consumers and businesses seek ways to obtain greater returns from their solar photovoltaic (PV) investments.

Driver 7: Desire for self-sufficiency: A growing desire for energy self-sufficiency among residential and C&I customers emerged as a somewhat surprising force behind storage deployment. Self-sufficiency is a strong driver in Germany, Italy, the UK, and Australia.

Driver 8: National Policy: Many countries see renewables plus storage as a new way to lessen their dependence upon energy imports, fill gaps in their generation mix, enhance the reliability and resiliency of their systems, and move toward environmental goals and de-carbonization targets.

Although "storage" and "renewables" are often used interchangeably, battery solutions can be used to make the overall grid more efficient and resilient, regardless of the generation sources. This makes the storage story all the more compelling.

CHALLENGES

Though market drivers are converging to propel storage deployment forward, challenges still exist. The more prominent barriers can be traced to the speed with which battery storage technologies and their applications are evolving, and to the multiplicity and flexibility of battery storage.

REGULATORS

Overall, while regulators are generally amenable to opening up markets to new participants and compensating providers for multiple value streams, it can take years to redesign retail and wholesale electricity markets, which has left storage providers searching for ways they can add value and grow in the meantime.

BARRIERS FOR THE TECHNOLOGY

Barrier 1: Perceptions of high prices: Costs have been dropping so quickly that decision-makers may have outdated notions about the price of systems.

Barrier 2: Lack of standardization: Participants in early stage markets must contend with diverse technical requirements as well as varied processes and policies.

Barrier 3: Outdated regulatory policy and market design: Regulatory policy is lagging the energy storage technology that exists today. One regulatory construct that may need to change is to enable storage to be classified as generation, load or transmission and distribution infrastructure.

Barrier 4: Incomplete definition of energy storage: Energy storage is having an identity crisis, with stakeholders and policymakers around the world wrestling with how to define fast-acting battery storage.

ABOUT THE AUTHOR

As an executive director for the Deloitte Center for Energy Solutions, Deloitte Services LP, Andrew Slaughter works closely with Deloitte's Energy, Resources & Industrials leadership to define, implement, and manage the execution of the Center strategy; develop and drive energy research initiatives; and manage the development of the Center's eminence and thought leadership. During his 25 year career as an oil and gas leader, he occupied senior roles in both major oil, gas, and chemicals companies and consulting/advisory firms.

SOLAR TRENDS TO WATCH

BY LEE GRAHAM

LONDON – Annual solar installations grew almost 20 percent year over year in 2017, and the solar industry is also edging within 100 gigawatts, a milestone the industry will reach this year, according to IHS Markit.

A new white paper from IHS Markit, identifies the following eight significant trends with the most impact on the global solar market:

1. Twenty countries will surpass 500 megawatts in annual solar installations — The number of significant solar photovoltaic markets has been growing steadily over the past 10 years, alongside an increasing volume of installations in new markets. Ultimately, how solar demand in 2018 unfolds will hinge on global module prices, steered by events in the top three markets, as well as by local policies and developer activity.

2. Floating solar moves beyond niche applications — Floating solar photovoltaic systems are increasingly deployed on dams, reservoirs, lakes and other water bodies across the world.

In 2018, the technology for these systems will move from niche applications to steady market uptake.

3. Bifacial and half-cell technologies are the new rising module stars — Because bifacial technology enables power to be generated from both the front side and rear side of the panel, it can potentially generate 10 to 15 percent more electricity than standard modules, accompanied by only a limited increase in costs; while half-cell technology allows more cells to be placed into a module of a given size, increasing power output by 5 to 10 watts.

For both technologies, the increased output from a single module will also contribute to system cost reductions on a per-watt basis.

4. Diamond wire implemented for multicrystalline wafer cutting — The main cause of the resurgence of multicrystalline wafer cutting is the massive implementation

of diamond wire sawing. The use of diamond wire saws for cutting multicrystalline wafers will reach significant penetration rates, with major manufacturers entering mass production in 2018.

5. US and India trade policies impact module prices and procurement trends — Recent trade developments in the United States and India, the second- and third-largest solar markets, are expected to have broad implications on manufacturing investment and expansion over the next few years in both local and international markets.

6. PV inverter suppliers race to build new digital business models — Many suppliers are looking to create new business models, including the creation of a digital services platform that combines the core strength of suppliers in providing PV inverter hardware, with the addition of a software and cloud platform.

This way, suppliers can work seamlessly with new partners in parallel industries, such as e-mobility, energy storage, lighting, heating and cooling.

7. Utility-scale solar plus storage takes center stage — Intermittency is the inherent challenge with solar technology as a large-scale energy generator. The combination of solar and batteries has long been recognized as a solution to this problem, smoothing the variations in a plant's output and storing electricity during the day, which enables the system to provide power into the evening.

8. Electric vehicles pave the way for new synergies with stationary energy storage — The growth and future promise of electric vehicles has been a major factor in driving down the cost of batteries for energy storage, thanks to huge investments in battery technology and scale.

EV growth will continue, but the various synergies between stationary energy storage and the reuse of “second-life” batteries from electric vehicles will also be increasingly explored.

ABOUT IHS MARKIT

IHS Markit (Nasdaq: INFO) is a world leader in critical information, analytics and solutions for the major industries and markets that drive economies worldwide. The company delivers next-generation information, analytics and solutions to customers in business, finance and government, improving their operational efficiency and providing deep insights that lead to well-informed, confident decisions. IHS Markit has more than 50,000 business and government customers, including 80 percent of the Fortune Global 500 and the world's leading financial institutions. Headquartered in London, IHS Markit is committed to sustainable, profitable growth.

FAST TRACK TO FUSION POWER CONTINUED FROM PAGE 6

MITEI PARTICIPATION

Commonwealth Fusion Systems is a private company and will join the MIT Energy Initiative (MITEI) as part of a new university-industry partnership built to carry out this plan.

The collaboration between MITEI and CFS is expected to bolster MIT research and teaching on the science of fusion, while at the same time building a strong industrial partner that ultimately could be positioned to bring fusion power to real-world use.

“MITEI has created a new membership specifically for energy startups, and CFS is the first company to become a member through this new program,” says MITEI Director Robert Armstrong, the Chevron Professor of Chemical Engineering at MIT.

WOODMAC SEES NEW HIGHS

BY GTM RESEARCH & ESA

BOSTON, MA and WASHINGTON DC – Deployments of home energy storage systems reached record heights in the first quarter of 2018. According to the report from GTM Research and the Energy Storage Association (ESA), 36 megawatt-hours of grid-connected residential energy storage systems were deployed in the first three months of this year, which is equivalent to the amount of residential storage deployed in the previous three quarters combined.

The report notes that California and Hawaii together constitute 74 percent of residential deployments on the quarter.

“Changing net-metering rules and increasing customer interest in backup and solar self-consumption drove the residential energy storage market’s record quarter. More solar installers are offering residential storage products than ever before and

see residential storage as an important area of business growth, particularly as utilities implement time-of-use rates and reduce net-metering compensation,” said Brett Simon, senior analyst at GTM Research and project manager for the U.S. Energy Storage Monitor report. These policy trends are expected to continue as utilities and regulators work to deal with increasing levels of solar PV penetration, which are driving increasing residential storage demand. Several residential solar installers already claim storage attachment rates for new solar PV of up to 20 percent in select regions such as southern California, indicating a strong market for the technology.”

Residential storage systems made up 28 percent of all deployed megawatt-hours on the quarter, a record for the segment, but second behind the front-of-the-meter segment which accounted for 51 percent of

deployments. The non-residential segment experienced a quiet quarter with 21 percent of megawatt-hours deployed, though nevertheless this segment almost tripled year-over-year.

In total, 126 megawatt-hours of energy storage were deployed across all segments during the first quarter of the year. This is up 26 percent over the fourth quarter of 2017, but down 46 percent year-over-year. However, the analysts at GTM Research cite Q4 2016 and Q1 2017 as “anomalies” due to the Aliso Canyon deployments during those quarters.

“With the U.S. energy storage market demonstrating a continued upward growth trajectory in the first quarter of 2018, the industry is moving closer to its vision of 35 GW of new energy storage installations by 2025,” said Kelly Speakes-Backman, CEO of ESA. “The growing list of states and markets ready to take action and remove barriers to cost-effective energy storage deployment promises the remainder of 2018 will yield similarly positive results.”

New this quarter, the U.S. Energy Storage Monitor adds Colorado and Nevada to its growing list of markets covered on a quarterly basis. Additional markets covered each quarter include Arizona, California, Hawaii, Massachusetts, New Jersey, New York, PJM and Texas.

Key Findings from the report include:

- 35.8 MWh of residential storage were deployed in Q1 2018.

- The U.S. energy storage market grew 26% QOQ, from 100.2 MWh in Q4 2017 to 126.3 MWh in Q1 2018.

- Year-over-year, the market declined 46%. Q1 2017 saw multiple long-duration systems deployed under the Aliso Canyon program, which led to a record in MWh terms.

- Behind-the-meter deployments accounted for 49% of deployments in MWh terms.

- GTM Research forecasts that annual

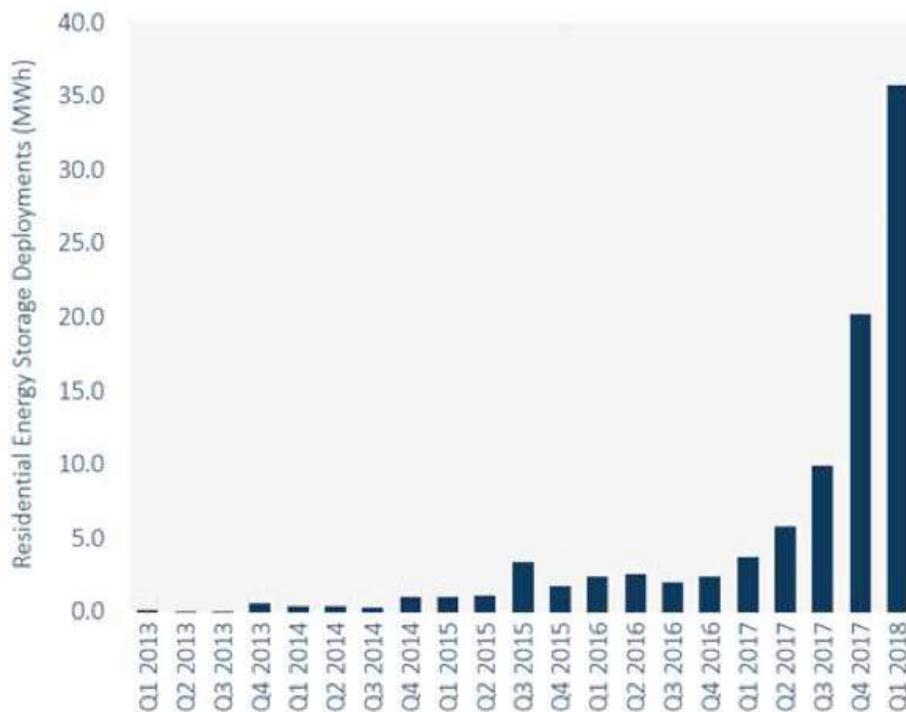


FIGURE: U.S. Quarterly Residential Energy Storage Deployments (MWh)

Source: GTM Research / ESA U.S. Energy Storage Monitor

(continued page 13)

TRACKING SDG7

BY TIM HURST

LISBON, PORTUGAL - The world is not on track to meet the global energy targets for 2030 set as part of the Sustainable Development Goals (SDG7), but real progress is being made in certain areas, particularly expansion of access to electricity in least developed countries, and industrial energy efficiency, according to a new report from five international agencies.

Renewable energy is making impressive gains in the electricity sector, although these are not being matched in transportation and heating – which together account for 80% of global energy consumption.

While global trends are disappointing, recent national experiences around the world offer encouraging signs. There is mounting evidence that with the right approaches and policies, countries can make substantial gains in clean energy and energy access, and improve the lives of millions.

The following are some of the main findings of the report.

ACCESS TO ELECTRICITY

One billion people – or 13% of the world's population – still live without electricity. Sub-Saharan Africa, and Central and South Asia continue to be the areas of the world with the largest access deficits. Almost 87% of the world's people without electricity live in rural areas.

The number of people gaining access to power has been accelerating since 2010, but needs to ramp up further to achieve universal access to electricity by 2030. If current trends continue, an estimated 674 million people will still live without electricity in 2030.

Some of the strongest gains were made in Bangladesh, Ethiopia, Kenya and Tanzania, which all increased their electricity access rate by 3% or more annually between 2010 and 2016. Over the same

period, India provided electricity to 30 million people annually, more than any other country. Sub-Saharan Africa's electrification deficit has begun to fall in absolute terms for the first time.

Tens of millions of people now have access to electricity through solar home systems or connected to mini-grids. However, these remain concentrated in about a dozen pioneering countries where penetration of solar electricity can reach as much as 5-15% of the population.

CLEAN COOKING

Three billion people – or more than 40% of the world's population – do not have access to clean cooking fuels and technologies. Household air pollution from burning biomass for cooking and heating is responsible for some 4 million deaths a year, with women and children at the greatest risk.

Parts of Asia have seen access to clean cooking outpace growth in population. These positive outcomes were driven largely by widespread dissemination of LPG or piped natural gas. In India, Pakistan, Indonesia and Vietnam, the population with access to clean cooking technologies grew by more than 1% of their population annually.

In Sub-Saharan Africa, however, population growth in recent years has outstripped the number of people gaining access to clean cooking technologies by a ratio of four to one.

Clean cooking continues to lag the furthest behind of all the four energy targets, due to low consumer awareness, financing gaps, slow technological progress, and lack of infrastructure for fuel production and distribution. If the current trajectory continues, 2.3 billion people will continue to use traditional cooking methods in 2030.

ENERGY EFFICIENCY

There is mounting evidence of the uncoupling of growth and energy use. Global gross domestic product (GDP) grew nearly twice as fast as primary energy supply in 2010-15. Economic growth

outpaced growth in energy use in all regions, except for Western Asia, where GDP is heavily tied to energy-intensive industries, and in all income groups. However, progress continues to be slow in low income countries, where energy intensity is higher than the global average.

Globally, energy intensity – the ratio of energy used per unit of GDP – fell at an accelerating pace of 2.8% in 2015, the fastest decline since 2010. This improved the average annual decline in energy intensity to 2.2% for the period 2010-2015.

However, performance still falls short of the 2.6% yearly decline needed to meet the SDG7 target of doubling the global rate of improvement in energy efficiency by 2030.

Improvement in industrial energy intensity, at 2.7% per annum since 2010, was particularly encouraging, as this is the largest energy consuming sector overall. Progress in the transport sector was more modest, especially for freight transportation, and is a particular challenge for high-income countries. In low and middle-income countries, the energy intensity of the residential sector has been increasing since 2010.

Six of the 20 countries that represent 80 percent of the world's total primary energy supply, including Japan and the US, reduced their annual primary energy supply in 2010-15 while continuing to grow GDP – indicating a peak in energy use. Among the large energy-intensive developing economies, China and Indonesia stood out with annual improvement exceeding 3 percent.

RENEWABLE ENERGY

As of 2015, the world obtained 17.5% of its total final energy consumption from renewable sources, of which 9.6% represents modern forms of renewable energy such as geothermal, hydropower, solar and wind. The remainder is traditional uses of biomass (such as fuelwood and charcoal).

Based on current policies, the renewable share is expected to reach just 21%

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FROM COAL TO SOLAR: A FAMILY AND A NATION

BY JOHN MORAN

NEW YORK, NY- My grandfather was a coal miner. His name was John Moran, same as mine. He was born in Ireland and started working in the coal mines in England at an age that would be illegal now. He found his way to New York City where he married, settled in the Bronx and had five sons.

The damage to his lungs from working in the coal mines forced him to uproot his family and move to a tiny copper mining town in southern Arizona where he might find it easier to breathe. I never met my grandfather. He died too young of emphysema, most likely from his days as a coal miner.

I work in the solar industry and have for over a decade. I've thought a lot about my grandfather over the last year as the issue of coal mining jobs in the United States became a political talking point.

Coal mining jobs in the United States are on the decline and have been for quite some time. In 1920, 784,000 people worked in coal mines, by mid- 2016 coal mining jobs were down to 55,000. These jobs are not coming back despite what our President promised. The reasons are many and not easily reduced to a soundbite: technological advances in mining, a shift from underground mines in Appalachia to surface mines in Wyoming and Montana that need a tenth of the man power, the fracking revolution and switch to cheaper natural gas, energy efficiency gains, dramatic declines in the price of wind and solar, pollution and climate change concerns, and the complete unwillingness of capital to invest in new coal burning power plants just to name a few.

In contrast, Solar jobs in the United States are growing rapidly, with over 200,000 people employed and solar employment having grown 123% between 2009 and 2015. The price of installing solar since I started in 2006 has gone from \$8/watt to \$1/watt. In many locations Wind and Solar

are now the cheapest sources of electricity with no fuel cost for the next 25 years (the length of warranties on the equipment), and probably much longer than that since panels only degrade at a half of a percent a year. Renewables allow energy to become a domestically sourced, clean, fixed rather than variable, source of electricity. No wonder Google, Apple, Amazon Facebook etc. are signing up hundreds of megawatts a year from wind and solar farms. We should retrain our coal miners for solar and wind installation, operations and maintenance jobs. These jobs cannot be outsourced.

Coal fueled the Industrial Revolution and powered the world into the modern age. The United States is deeply indebted to coal and the hard-working people, people like my grandfather, people who mined it, shipped it and burned it in steel and power plants. This is why we cannot lie to them now. We need to ensure their pensions and retrain them. We do not need to make hollow campaign promises that are at best ill-informed and at worst lies. I hope to meet my grandchildren one day and to tell them how their great, great grandfather helped power the Industrial Revolution and how their grandfather had a small part in powering the Clean Energy Revolution.

ABOUT THE AUTHOR

John Moran has been in the solar industry since 2006, working across various functions from physically installing residential and commercial projects, to negotiating SREC and EPC contracts, to permitting and developing projects, to financial modeling and selling panels for utility scale projects. Prior to joining sPower, John was a Project Developer for enXco Development Corporation and in Utility Scale sales for Suntech. For the last 3 years, John has been a Project Manager for SPower. He's a Notre Dame grad.

WOODMAC SEES NEW HIGHS CONTINUED FROM PAGE 11

residential energy storage deployments will surpass 1,000 megawatt-hours in 2020.

ABOUT U.S. ENERGY STORAGE MONITOR

Delivered quarterly, the U.S. Energy Storage Monitor is the industry's only comprehensive research on energy storage markets, deployments, policies and financing in the U.S.

These in-depth reports provide energy industry professionals, policymakers, government agencies and financiers with consistent, actionable insight into the burgeoning U.S. energy storage market.

ABOUT GTM RESEARCH

GTM Research is now Wood Mackenzie, providing critical and timely market analysis in the form of research reports, data services, advisory services and strategic consulting. Its coverage spans the green energy industry, including solar power, grid modernization, energy storage and wind power.

ABOUT THE ENERGY STORAGE ASSOCIATION

The Energy Storage Association is the national trade association dedicated to energy storage, working toward a more resilient, efficient, sustainable and affordable electricity grid – as is uniquely enabled by energy storage.

With more than 160 members, ESA represents a diverse group of companies, including independent power producers, electric utilities, energy service companies, financiers, insurers, law firms, installers, manufacturers, component suppliers and integrators involved in deploying energy storage systems around the globe.

DELOITTE SURVEYS

BY MARLENE MOTYKA, CLASS OF 2017



Deloitte US and Global Renewable Energy Leader

NEW YORK, NY – Spurred by consumer demand for eco-friendly practices, many businesses across the U.S. are moving aggressively to reduce their carbon footprint, including a major embrace of renewable energy and alternative-fueled vehicles, according to Deloitte’s annual Resources Survey.

The survey shows that businesses see addressing climate change as key to long-term industry resilience. Sustainability seems no longer optional – it has become important to fostering business growth and satisfying a wide range of stakeholders, including customers, suppliers, partners, employees and investors.

Although 86 percent of residential consumers believe the government should be active in setting a vision and path for energy strategy, it is the private sector that is advancing the cause to manage resources for cleaner, more resilient, secure and affordable energy supplies.

Businesses are not waiting for government to act on addressing climate change. They have picked up the gauntlet. They are now driven to double down on their energy management efforts as they view their long-term viability through the climate lens.

KEY FINDINGS

Of the 87 percent of businesses familiar with the U.S. pulling out of the Paris climate agreement, 4 in 10 are reviewing or changing their energy management policies in response, with 75 percent of those increasing their commitment and investment in energy management.

About 70 percent of customers are demanding companies procure a certain percentage of electricity from renewable sources.

The number of companies with carbon footprint goals has jumped to 61 percent in 2018, from just over half the year before.

Sixty-eight percent of residential consumers say they are concerned about climate change and their personal carbon footprints, outpacing the previous high of 65 percent in 2016.

Nearly three-fourths (74 percent) of residential consumers stated that climate change is caused by human action, up six percentage points from 2017.

RENEWABLES RATED KEY TO ENERGY INDEPENDENCE, MILLENNIALS TIP THE SCALE

More than three-fourths (76 percent) of survey respondents cited renewables as key for achieving energy independence, jumping five percentage points from 2017. This seems to represent a change in mindset with many respondents now seeing a connection that was once widely thought to be implausible.

In addition, many millennials – greener and “techie” than other generations – see renewables as the answer to their environmental concerns. In fact, 64 percent rank utilizing clean energy sources among their top three most important energy-related issues. Also, they are more likely to adopt new solutions, such as electric vehicles, home automation systems and time-of-use rates.

BUSINESSES MAKING EVS AN EASY CHOICE

Many businesses not only say reducing their electricity consumption is important to staying competitive but they also are helping to transform the transportation sector as more consumers and employees eye electric vehicles and hybrids as a prime pick for their next vehicle.

Business respondents expect gasoline or diesel vehicles will make up less than half (49 percent) of their transportation fleets by 2020. If so, it would mark the first-time vehicles powered by alternative fuels will constitute a majority of corporate fleets. In fact, businesses are accelerating their efforts to support employees who drive electric vehicles, with well over half (56 percent), offering EV charging stations. Fifty-two percent of these businesses own the charging stations themselves, while 41 percent belong to the building owner.

BUSINESSES TURN TO SELF-GENERATION FOR GREATER CONTROL OVER ENERGY

On-site generation also is on the rise as distributed resources are increasingly viewed as being realistic and cost-effective, and as businesses desire greater control over their energy supplies in terms of price, quality and reliability. Fifty-nine percent of businesses now generate some portion of their electricity supply on-site, and of those businesses, 13 percent are using renewables, 13 percent use on-site co-generation and 10 percent are using on-site battery storage.

Nearly half of business respondents are working to procure more electricity from renewable sources, and nearly two-thirds (61 percent) said combining battery storage with renewable sources would motivate them to do more. Additionally, businesses are responding to increased power outages by purchasing backup generators, adding battery storage units, and expanding the amount of electricity they self-generate.

SMART HOME APPS NOT CATCHING ON, CYBER CONCERNS COOLING INTEREST

Despite support for more innovative

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ALENCON DEVELOPS

BY HANAN FISHMAN



*President & CEO
Alencon*

If you are designing a DC-coupled solar + storage system where you are using DC-DC optimizers to connect between the PV and DC bus connected to the batteries and inverter, you are going to want to make sure the DC bus is protected from any harmful possible faults in the PV array such as arc faults, ground faults or lightning strikes (among others). If the DC-DC optimizer does not have such protections built in, you are going to want to make sure to source additional balance of system (BoS) hardware that provides these protections.

At Alencon, we solve this issue within our DC-DC optimizer form solar + storage, the SPOT-ES, by providing a variety of protections in our device including cable arc and ground leak detection in addition to protection from lightning strikes as well as over voltage, current and temperate situations. Alencon's DC-DC Optimizer for Energy Storage, the SPOT-ES, is able to achieve these protections in a cost effective way as a result of the galvanic isolation built into the product by attaching an isolation transformer to each, individual PV string input. This unique feature pro-

vides all the benefits of DC coupling in a protected way while simplifying system design by assuring all the protections you need between the PV array and the DC bus are included in a single device.

"The ability to isolate a troubled solar array while the rest of the solar and obviously the whole solar plus storage system continues to operate is a huge benefit. Galvanic isolation of solar from the rest of the system simplifies the fundamental protection approach on a system level. Since our system is battery centric, we always have a battery on the DC bus, meaning that the fault issues are much more severe when high battery currents are taken into account," states Aleksey Toporkov, the President of ARDA Power, a pioneer in DC-microgrids.

Galvanic isolation is a unique feature of Alencon's SPOT and it is not available from other utility scale DC-DC optimizer on the market today.

The benefits of the electromagnetic isolation provided by the SPOT-ES can be summarized as follows:

1. Robustness:

The SPOT-ES galvanically isolates the PV strings from one another and from the DC bus. Thus, any faults that occur in the PV array such as lightning strikes, ground leaks or arc faults will be confined only to one string and will not affect the inverter, battery or other PV strings.

2. Fail-safe:

In the unlikely event of an electronic component failure (short of open), the SPOT-ES safely disconnects the failed input channel from the rest of the system.

3. Versatility

The SPOT-ES's galvanic isolation of each input channel allows complete independence of the grounding scheme of input channels and the output to the DC bus. Each PV string can have negative, positive or floating grounding while the output can be independently grounded in the mid-

dle, negative or positive terminals.

4. Wide control range

The SPOT-ES can be configured to map any input voltage regulation range to any output voltage range. For example a 1500 V PV string can be connected into a 600 volt storage DC bus. On the other hand, lower voltage PV can be connected to a higher voltage DC bus.

5. Interconnect Simplicity

The SPOT-ES is very simple to connect into a DC-coupled Solar + Storage system. The +/- PV cables plug directly into the input connectors and the DC bus cables plug directly into the SPOT's output connectors. With the SPOT-ES, there is no need to split the string in halves or use any other so-called "stretch" techniques.

6. Failure Pinpointing

In the case of a PV string fault such as a ground leak of arc fault, the SPOT-ES will indicate exactly which PV string is in a fault state as well as the severity of the fault.

ABOUT HANAN FISHMAN

Hanan Fishman is President & CEO of Alencon Systems and a member of its Board of Directors. He oversees company operations including sales and marketing, manufacturing and finance and accounting. Hanan has been charged with leading Alencon's drive to commercialize the products it has been developing over the past nine years. Prior to joining Alencon Systems, Hanan was the President of PartMaker Inc. Hanan led PartMaker Inc. from 1998 through to 2016 when it became the global leader in specialist computer aided manufacturing, software for production machining applications. He guided the company through two acquisitions, the second of which was by Autodesk Inc., the world's largest developer of engineering software for manufacturing and architectural applications.

DELOITTE SURVEYS CONTINUED FROM PAGE 14

energy savings, only 20 percent of respondents have automated home functions, such as smart thermostats. In fact, amid growing reports of hacked home devices, 21 percent of respondents cited privacy and security concerns as a barrier to upgrading their thermostats, compared to 15 percent last year. In addition, penetration of smart thermostats and automation systems remains very low with only 4 percent using a home automation system and just 8 percent utilizing a programmable thermostat.

A majority of both businesses and residential consumers want environmentally responsible, reliable assets, preferably close by, that they can control to optimize reliability, flexibility and cost. However, this year's survey seems to emphasize that privacy and security concerns should be addressed by providers soon to maintain the momentum for a clean secure energy future.

"Utilities are being challenged to get to know their customers better, and the industry has a long way to go," said Andrew Slaughter, executive director, Deloitte Center for Energy Solutions, Deloitte Services LP. "What appears clear is that the electric utility sector's transformation will likely be one of decentralization, digitalization, and decarbonization driven by business and residential consumer demand for a cleaner, more resilient, secure and affordable energy supply."

ABOUT DELOITTE

Deloitte provides industry-leading audit, consulting, tax and advisory services to many of the world's most admired brands, including more than 85 percent of the Fortune 500 and more than 6,000 private and middle market companies. Our people work across more than 19 industry sectors to make an impact that matters — delivering measurable and lasting results that help reinforce public trust in our capital markets, inspire clients to see challenges as opportunities to transform and thrive, and help lead the way toward a stronger economy and a healthy society.

CALIFORNIA'S ELECTRICITY IN MARKET TRANSITION CONTINUED FROM PAGE 8

Due in part from that local pressure and in part to a decision by the California Independent System Operator saying that local power needs could be met by alternative sources and new transmission, the CEC committee overseeing the certification recommended denial of the project. The permitting process has since been suspended.

Subsequently, SCE was asked by the CPUC to move forward with long term procurement and resiliency planning for the Santa Barbara/Goleta area encompassed by the Moorpark sub-area.

It released its RFP on February 28 for preferred resources (as identified above) and energy storage. It had already signed a contract in 2016 for 10 MW of energy storage in Goleta.

Its application describing its chosen bids is expected to be submitted to the CPUC for approval in the first quarter of 2019.

At the request of the CEC early in 2017, prompted by a demand of an intervenor, the California ISO produced an analysis of what preferred resources and energy storage and reactive power devices would be necessary to meet local capacity requirements in the Moorpark sub-area. SCE designed its RFP around those requirements.

Cal ISO also identified two distribution lines in the area, that run through rugged, mountainous terrain as critical – if they are lost due to storms or fire voltage collapse would result.

They are the only transmission lines that connect Goleta's substation with the rest of SCE's transmission system. Approximately 85,000 customers depend on this transmission system.

SCE proposed building another kV line between Moorpark in the southern end of this sub-area and a substation further east near a main transmission line.

That line would meet a 232 MW contingency, leaving the overall procurement need for 76 MW.

BACK ON CAMPUS BY JING TIAN, CLASS OF 2018

As we reach the halfway point of 2018, we want to share some important updates on the evolving market for solar photovoltaic (PV) panels, along with how Trina Solar is positioning itself for success within this changing landscape. In last week's AD/CVD announcement, Trina was given the lowest AD/CVD rate amongst all participants, we're globally launching new and exciting products like TrinaPro, and we're expediting the re-launch of the next phase of Trina thru an IPO on the Shanghai Stock Exchange. Trina will continue to be your source for the highest quality products and services in the US via our US team with an un-interrupted 10+ year presence in the US market.

OUR CONTINUED COMMITMENT TO THE U.S. MARKET

In recent months, US tariffs on solar modules under Section 201, Chinese FIT program reductions combined with various international tariff trade spats have caused significant disruption to the international trade of solar PV panels. These shifts have affected panel price and market demand, forcing suppliers to recalibrate their strategies and focus on markets offering sustainable opportunities.

Trina Solar remains committed to the U.S. market despite the ongoing regulatory changes (AD/CVD, Section 201 and Section 301 investigations). Last week's final ruling on the 4th review period (covering goods imported in 2016) of the Department of Commerce ("DOC") anti-dumping/counter-vailing duties (AD/CVD) investigation significantly reduced the DOC preliminary combined rate of 72% to a more accurate 27% combined rate in line with Trina's historical annual results (23.75%; 30.61%; and 25.14%). Other Chinese manufacturers have similar percentage rates. Trina's consistent performance in obtaining similar results since the DOC case began in 2012 emphasizes the stability and predictability of Trina Solar's operational and financial performance in the US market.

TRACKING SDG7 CONTINUED FROM PAGE 12

by 2030, with modern renewables growing to 15%, falling short of the substantial increase demanded by the SDG7 target.

Rapidly falling costs have allowed solar and wind to compete with conventional power generation sources in multiple regions, driving the growth in the share of renewables in electricity to 22.8% in 2015. But electricity accounted for only 20% of total final energy consumption that year, highlighting the need to accelerate progress in transport and heating.

The share of renewable energy in transport is rising quite rapidly, but from a very low base, amounting to only 2.8% in 2015. The use of renewable energy for heating purposes has barely increased in recent years and stood at 24.8% in 2015, of which one third was from modern uses.

Since 2010, China's progress in renewable energy alone accounted for nearly 30% of absolute growth in renewable energy consumption globally in 2015. Brazil was the only country among the top 20 largest energy consumers to substantially exceed the global average renewable share in all end uses: electricity, transport and heating. The UK's share of renewable energy in total final energy consumption grew by 1% annually on average since 2010 – more than five times the global average.

FIVE AGENCIES

The Energy Progress Report is a joint effort of the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), United Nations Statistics Division (UNSD), the World Bank, and the World Health Organization (WHO).

“It is clear that the energy sector must be at the heart of any effort to lead the world on a more sustainable pathway,” said Dr Fatih Birol, the Executive Director of the International Energy Agency (IEA). “There is an urgent need for action on all technologies, especially on renewables and energy efficiency, which are key for delivering on three criti-

cal goals – energy access, climate mitigation and lower air pollution. The IEA is committed to leading this agenda and working with countries around the world to support clean energy transitions.”

“Falling costs, technological improvements and enabling frameworks are fueling an unprecedented growth of renewable energy, which is expanding energy access, improving health outcomes, and helping to tackle climate change, while also creating jobs and powering sustainable economic growth,” said IRENA Director-General Adnan Z. Amin. “At the same time, this tracking report is an important signal that we must be more ambitious in harnessing the power of renewable energy to meet sustainable development and climate goals, and take more deliberate action to achieve a sustainable energy future.”

“This detailed report describing the progress so far on SDG7 is a testament to the collaboration of the five international agencies on providing quality and comprehensive data and delivering a common message regarding the progress towards ensuring access to affordable, reliable, sustainable and modern energy for all,” said Stefan Schweinfest, Director of the Statistics Division of UN DESA. “Still, there is a need for improving statistical systems that collect energy information in those countries where the most pressing energy issues remain to be addressed. Better data are needed to inform policy accurately, particularly developing countries, least developed countries, landlocked developing countries, and small island developing States. For this, investments in energy statistical systems are essential.”

“The experience of countries that have substantially increased the number of people with electricity in a short space of time holds out real hope that we can reach the billion people who still live without power,” said Riccardo Puliti, Senior Director for Energy and Extractives at the World Bank. “We know that with the right policies, a commitment to both on-grid

and off-grid solutions, well-tailored financing structures, and mobilization of the private sector, huge gains can be made in only a few years. This in turn is having real, positive impacts on the development prospects and quality of life for millions of people.”

“It is unacceptable that in 2018, 3 billion people still breathe deadly smoke every day from cooking with polluting fuels and stoves. Every year, household air pollution kills around 4 million people from diseases including pneumonia, heart disease, stroke, lung disease and cancer,” said Dr Maria Neira, Director, Department of Public Health, Environmental and Social Determinants of Health, at the World Health Organization (WHO). “By expanding access to clean affordable household energy, the global community has the power to lift a terrible health burden from millions of marginalized people – in particular women and young children who face the greatest health risks from household air pollution.”

“As we take stock of progress towards the global goal on sustainable energy, this latest data clearly shows more action and political leadership is needed if we are to live up to our promise to leave no one behind,” said Rachel Kyte, Special Representative of the UN Secretary-General and CEO of Sustainable Energy for All. “To meet 2030 targets, we must make every unit of energy work harder. We need to increase investment in the technologies and business models that make electricity access affordable for everyone, place even bigger bets on the remarkable capacity of renewable energy and build big markets for clean fuels and cooking access. World leaders put the promise of leaving no one behind at the heart of the Sustainable Development Goals, and now is the time for that promise to become reality.”

The report was formerly known as the Global Tracking Framework (GTF).

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