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FOUR TOUGH QUESTIONS ABOUT RENEWABLE ENERGY

AND THE ANSWERS THE NEXT GOVERNOR OF NEW YORK SHOULD KNOW

BUSINESSFORWARD

EXECUTIVE SUMMARY

Over the past eight years, Business Forward has organized hundreds of energy and climate briefings across the country. Mayors, governors, Members of Congress, senior White House officials, two Energy Secretaries, two EPA Administrators, and tens of thousands of business leaders have participated. **At these briefings, business leaders asked the same four questions.** Here are the questions — and the answers.

QUESTION 1:
Can wind and solar compete with fossil fuels on price, at scale?

Absolutely. Record investments at the start of this decade generated a "virtuous cycle" that is driving costs down and creating new demand. Technological breakthroughs are accelerating this cycle. The rapid drop in renewable energy prices is real, and those prices will keep dropping.

QUESTION 2:
Is renewable energy reliable?

Yes. It's getting easier to 1) produce energy when it's available and store it for when it's needed; 2) invest in secondary generators that can be turned off and on quickly; and 3) transmit surplus energy to markets that need it. Wind and solar electricity varies, with the weather, season, and time of day, but the progress we're making on 1, 2, and 3 is solving that problem. Moreover, we need to modernize our grid to make it more secure and resilient.

QUESTION 3:
Do government energy subsidies work?

Yes and no. The federal government has spent more than $1 trillion subsidizing energy producers since WWII, with 70 percent of that going to oil, gas, and coal. Some of this spending was meant to keep consumer energy prices low. Some was meant to make us less dependent on foreign oil. But taxpayers do best when the government supports high risk/high reward technologies likely to create new sources of energy. Recent investments in renewable energy are in line with prior investments in fracking, deep water oil rigs, and nuclear reactors: They make sense and are paying off.

QUESTION 4:
Is America still winning on energy?

No. The United States has fallen behind the EU and China on energy investment and research and development. These countries are building substantially more capacity. And this gap in investment, R&D, and capacity keeps growing. The United States still leads in early stage investing, but, under the current Administration, those early stage technologies are likely to be commercialized somewhere else.

THE 4 QUESTIONS

EXPLAINED

QUESTION #1: CAN WIND AND SOLAR COMPETE?

ANSWER: YES. The market forces at work in today's clean energy markets are more powerful—and promising—than simple supply and demand. A decade of record investment has created a "virtuous cycle" that is reshaping our energy economy: falling prices drive more demand, which attracts more investment, which drives prices down further, which creates even more demand, and so on.

NEW CAPACITY

Between 2008 and 2015, wind power capacity more than tripled, and solar power capacity increased 40-fold.[1] The share of America's electricity generated by non-hydro renewables has increased from roughly two percent in 2005 to more than 9 percent in 2017. This share will grow quickly, given the enormous increase in renewable energy investment. In 2015, wind and solar accounted for 66 percent of new capacity installed in the United States In 2017, wind and solar accounted for nearly 95 percent of new capacity.[2]

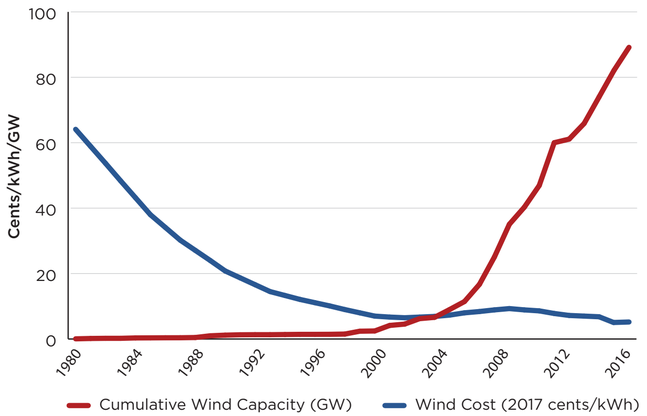
FALLING PRICES

The cost of wind power fell by 41 percent from 2008 to 2015. Industry experts predict those costs could drop another 35 percent by 2050. From 2008 to 2015, solar power installation prices fell by 64 percent for utilities and 54 percent for consumers. Industry executives predict those costs could fall another 16 percent to 33 percent by 2020.[3]

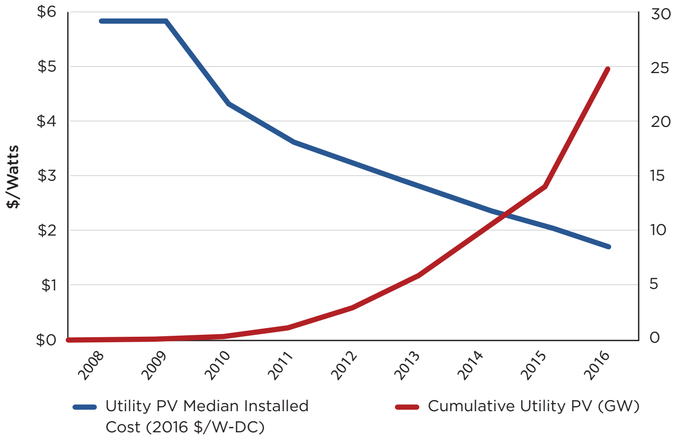
NEW DEALS

At the end of 2015, utilities and transmission operators had announced new investments representing an additional 110,000 MW of wind power and 21,000 MW of utility-scale solar. Industry experts estimate that wind power could, with projected advancements in efficiency, meet 20 percent of America's electricity needs by 2030 and 35 percent by 2050, while distributed solar (panels installed on homes and businesses) could provide as much as 42 percent of America's electricity needs, if deployed universally. By 2017, more than 17 percent of United States generation came from renewable sources.[4]

WIND POWER[5]



UTILITY & DISTRIBUTED SOLAR PV[6]



CAN WIND AND SOLAR COMPETE? VIRTUOUS CYCLES ARE KEY

TECHNOLOGICAL BREAKTHROUGHS

Virtuous cycles are particularly powerful in industries, like clean energy, with emerging technologies. Technological breakthroughs in materials, methods of production, and infrastructure can accelerate the cycle. For example, thanks to R&D, wind power companies are installing turbine blades twice as big as those used in 1999, while new 3-D printing technologies
are reducing the cost of producing them.

NEW MARKETS

As the virtuous cycle in clean energy progresses, wind turbines and solar panels become profitable in previously marginal markets. Solar panels are proliferating beyond California and Arizona, where they started, to the Southeast and Midwest. Wind turbines are operating profitably in areas with less reliable winds, and that energy is being transmitted greater distances.[7]

VIRTUOUS CYCLE IN WIND POWER

TALLER TOWERS, LONGER BLADES
Wind turbines are four times more efficient than those installed 20 years ago because today's models are one-and-a-half times taller and carry blades twice as large. Taller towers capture stronger, more consistent winds. Longer blades produce more energy from each rotation.

LIGHTER TURBINES
It can be expensive to build towers strong enough to hold heavy wind turbines and ship them from United States factories to their destination. Engineers reduced turbine weight, which reduced tower costs significantly.

CHEAPER PRODUCTION
The manufacturing of wind turbines has grown to a $2 billion industry in the United States, generating economies of scale that drive production costs down.

BETTER TRANSMISSION
States and utilities have invested billions to improve their grids, making it easier for renewable power producers to connect—and for producers in one market to sell their surplus energy to another market that needs it.

BETTER STORAGE
Battery costs for wind turbines are dropping quickly, driven by massive investments by automakers, improvements in battery chemistry and manufacturing, and greater competition among manufacturers.

SMARTER PLANNING
Smart meters (more than 70 million installed to date) make it easier for customers to manage their own usage and for utilities to demand. Meanwhile, more businesses are implementing energy management information systems, reducing their energy usage by between 10 to 20 percent per building.

NEW CUSTOMERS
Companies can now buy wind power directly from local producers, which allows them to reduce their electricity costs, meet their sustainability commitments, and support local jobs and investment.

FASTER TURNAROUND
Wind farms can be built in nine months, while coal and gas plants take several years.

VIRTUOUS CYCLE IN SOLAR POWER

MORE EFFICIENT PRODUCTION
Silicon is the most expensive input in the production process. Manufacturers have developed new techniques that create thinner solar cells that require less silicon.

LESS SILVER
All electronics rely on silver as an electrical conduit. Producers have been improving their production methods to reduce the amount of silver per solar panel by about five percent a year.

HIGHER CONVERSION RATIOS
Engineers are reducing the reflectivity of solar cells, lowering the ambient temperature (solar panels are most efficient in cool weather), and optimizing the design of the cell.

CHEAPER INVERTERS
Solar energy must be converted into an AC current before it can be transferred to the electric grid. Cheaper inverters are reducing costs for rooftop solar and utility-scale installations.

FASTER INSTALLATION
Installing a coal or gas plant takes several years. Installing a solar farm takes three to six months. For homeowners, installing a set of rooftop solar panels can be done in an afternoon.

QUESTION #2: IS RENEWABLE ENERGY RELIABLE?

ANSWER: YES. Wind and solar electricity output varies with the time of day, season, and the weather, but it's getting easier to 1) produce energy when it's cheap and store it; 2) invest in secondary generators that can be turned off and on quickly; and 3) transmit surplus energy to markets that need it. Most of these improvements reduce the cost of every type of energy, not just renewables. Moreover, we need to modernize our grid to make it more secure and resilient with those same investments to accommodate renewable energy.

INTEGRATING VARIABLE POWER INTO THE GRID

Every hour of every day, utilities work to balance energy production with consumer demand. Utilities have developed increasingly effective forecasting tools to predict wind and solar energy output, which allows them to anticipate when they might need to call on a supplemental power generator. Utilities already have extensive experience managing variable output from existing sources, whether a hydroelectric dam that slows its generation because of a drought or a coal plant that is down for maintenance. As renewables' share of electricity production rises, the importance of balancing grows.

Utilities have four means of balancing the grid, and each is improving rapidly:

1. Add conventional generation capacity that can be turned on quickly to cover short-term gaps. Utilities are developing fast-reacting fossil fuel technologies like gas-powered turbines that can be turned off and on more rapidly. Hydro-electric stations can replenish their reservoirs when solar and wind power are near capacity, then release water to generate electricity when solar and wind power capacity wanes.

2. Use grid "interconnectors" to pipe electricity from locations with surplus power to those with shortfalls, in real-time. More than $10 billion in improvements to the grid have been made in the past eight years enabling the long-distance transfer of renewable energy.

3. Manage demand by varying electricity pricing to encourage big users to reduce consumption during peak times. New energy management information systems are helping companies capture these savings, while big data analytics, driven by smart meters, are allowing utilities to calibrate incentives more efficiently.

4. Use batteries and other solutions to store surplus wind and solar energy so that it can be used later. As battery costs continue to drop, utilities can pair them with renewables to provide more reliable generation. Other solutions include using surplus energy to compress air, wind flywheels, or pump water, then releasing the potential energy to power turbines when demand requires it.

QUESTION #3: ARE GOVERNMENT ENERGY SUBSIDIES WORKING?

ANSWER: YES & NO. We subsidize energy companies with government tax incentives, loan programs, grants, purchase programs, and other financial benefits. For example, the federal government offers oil and gas companies tax credits for drilling expenses, domestic manufacturing incentives, depletion allowances, exploration incentives, below-market rates for leases on federal lands, accelerated depreciation for drilling and exploration expenses, and a "marginal well" tax credit. Taxpayers have subsidized the cost of manufacturing oil tankers and paid for the dredging of United States ports to make it easier for those tankers to operate. Taxpayers have also paid for $31 billion in government research and design to make coal cleaner, cheaper, and safer to mine and burn.

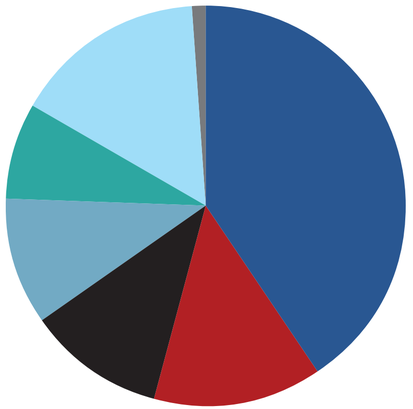
SUBSIDIZING HIGH RISK/HIGH RETURN ENERGY EXPLORATION WORKS.

The bulk of federal subsidies go to energy production, but the federal government also promotes new energy technologies. For example, during the late 1990s, the United States government helped promote deep water drilling by offering additional tax incentives from oil pumped from deep water wells. Without this support, the risks associated with such drilling would have prevented oil companies from creating what has since become a highly profitable and productive source of energy.

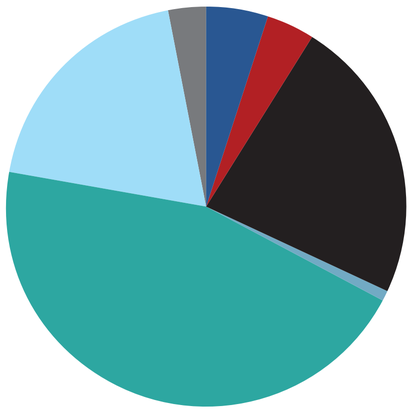
Federal investment in fracking technologies made today's shale oil boom possible. Early investments in nuclear energy helped create today's $60 billion industry.

TAXPAYERS HAVE SPENT $1 TRILLION SUBSIDIZING ENERGY PRODUCTION SINCE WWII, AND NEARLY 70 PERCENT WENT TO OIL, GAS, AND COAL COMPANIES.[8]

Summary Of Federal Incentives, 1950-2010 ($ Billions, 2010)



Allocation Of Federal R&D Expenditures, 1950-2010



ARE GOVERNMENT ENERGY SUBSIDIES WORKING?

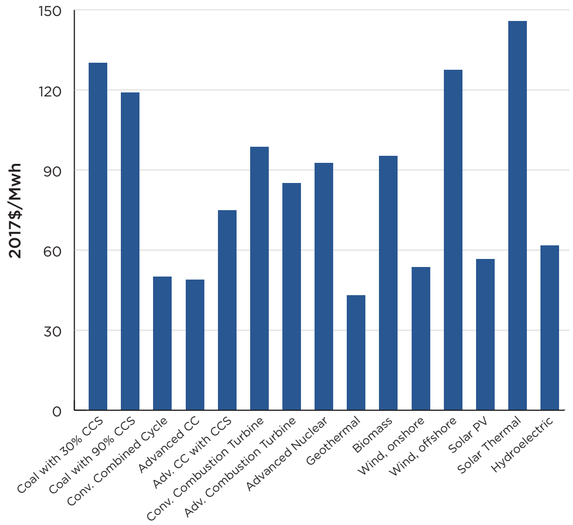
INVESTMENTS IN SOLAR AND WIND ARE COMPARATIVELY SMALL, BUT THEY HAVE GENERATED GREAT RESULTS.

Spending on solar, wind, and other renewables represents about 9 percent of historic Federal energy spending. For example, over the 35 years during which the federal government spent $31 billion on coal R&D, it spent just $4.5 billion on solar R&D and $2.2 billion on wind R&D. To measure the cost competitiveness between energy technologies, experts calculate the per-kilowatt-hour cost of building and operating a power generating plant (including capital costs, fuel costs, maintenance, operations, and financing). This is called the "levelized cost of energy" (LCOE).
Estimates vary, but experts agree that solar and wind power have reached cost parity with fossil fuels in many markets and are approaching cost parity in many more.
The Department of Energy and International Energy Agency project that wind and solar power could be on par or below that of new coal production by 2020, without factoring in environmental savings. In some markets, wind power is already at par with new coal production.

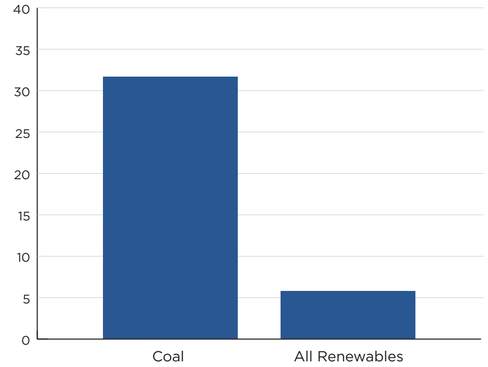
ENVIRONMENTAL SAVINGS MAKE WIND AND SOLAR EVEN MORE AFFORDABLE.

LCOE analysis fails to account for the environmental costs of fossil fuels. In other words, the price of a gallon of gas does not include the cost of the carbon it adds to the atmosphere. If it did, the price of a gallon of gas (or a coal-powered utility bill) would be higher. This would increase the comparative value of clean energy investments. In 2016, wind power in the United States reduced annual carbon dioxide emissions by more than 159 million metric tons. It also saved more than 87 billion gallons of water. In 2015, utility-scale solar saved 17 million metric tons of carbon dioxide and conserved 7.6 million gallons of water. The bulk of these water savings occurred in drought-stricken southwestern states, like California.[9]

Comparison Across Generation Technologies, 2022 forecast[10]



Federal Research and Development, 1976-2010 ($ Billions)[11]



QUESTION #4: IS AMERICA STILL WINNING?

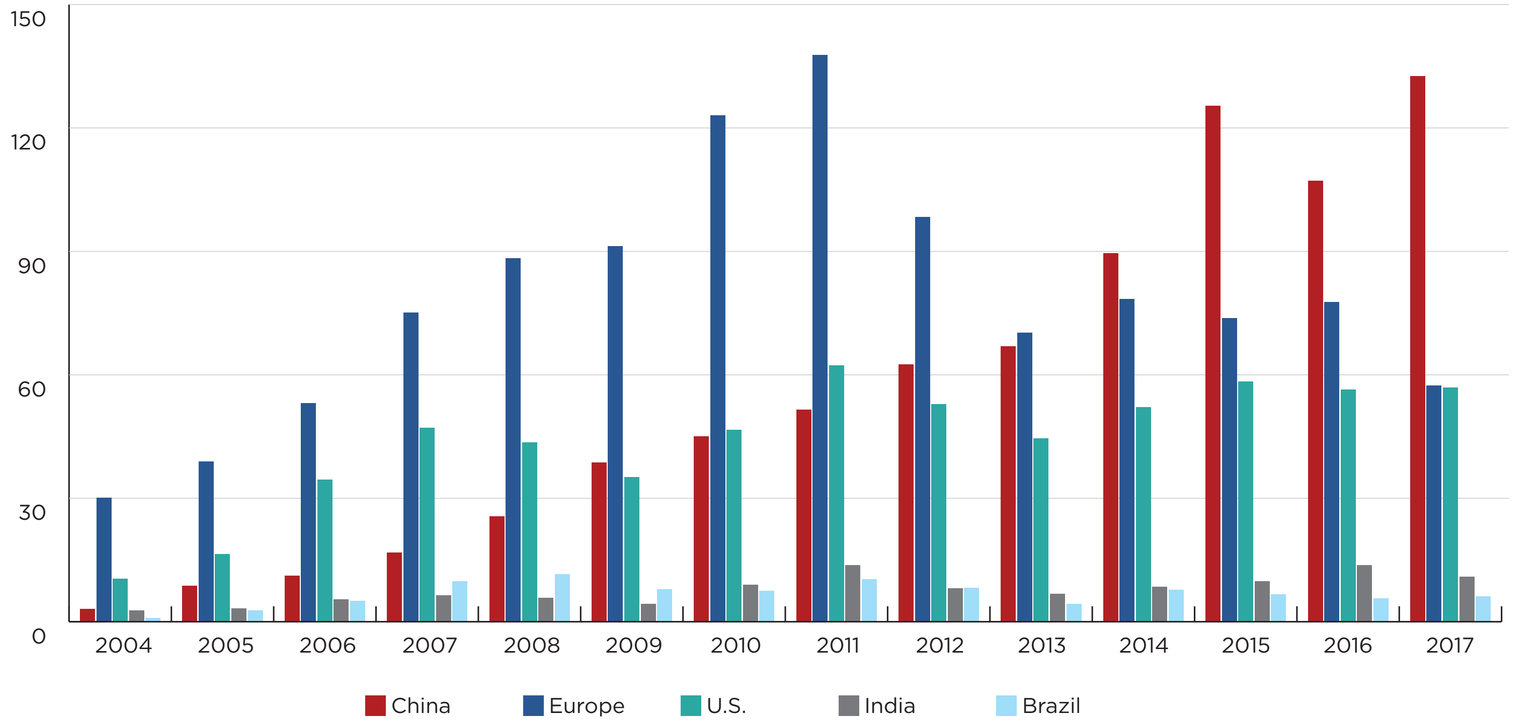
ANSWER: NO. The United States ranks third in renewable energy investment, behind China and the EU. China invested three times more than the United States last year ($126.6 billion vs. $40.5 billion). The United States ranks second in renewable energy R&D behind the EU ($2.1 billion vs. $2.7 billion).[12]

GLOBAL INVESTMENT, CAPACITY AND COMPETITION IS UP

Global investment in renewable energy rose again in 2017, up 2 percent to $280 billion (and $2.2 trillion in investment since 2010). Energy producers added twice as much renewable energy capacity last year as fossil fuel-based capacity (157 gigawatts vs. 70 gigawatts). Renewable energy produced 12.1 percent of the world's energy in 2017, twice its share in 2010 (6.1 percent).

Competition among countries is also growing. In 2015, for the first time, developing countries invested more money in renewable energy projects than developed countries.

Global Trends in Renewable Energy Investment, by Geography ($ Billions)[13]



IS AMERICA STILL WINNING?

UNITED STATES INVESTMENT IS FLAT, OUR LEAD IN EARLY STATE INVESTMENT IS FALLING.

Renewable energy investment in the United States peaked in 2011 (with more than $60 billion invested) and has been flat for three years at approximately $40 billion.

Global private equity and venture capital investment (VC/PE) in renewable energy has fallen for three years, in part, because the industry is maturing, barriers to entry are rising, and large companies are doing more of the investing. The United States ranked first, with $770 million of the world's $1.8 billion in VC/PE investment (about 43 percent). However, the United States accounted for 65 percent of this market just two years ago.

GLOBAL RESEARCH AND DEVELOPMENT IS UP; UNITED STATES RISES FROM THIRD TO SECOND

Thanks to a 12 percent increase in corporate research and development, total worldwide spending on renewable energy research and development rose six percent from 2016 to 2017 to reach a record high of $9.9 billion. (Spending is split about equally between governments and private sector.) From 2011 through 2016, the United States ranked third behind the EU and China. Last year, the United States beat China ($2.1 billion to $2.0 billion). Our spending rose 8 percent and China's remained flat. The United States ranks second behind the EU ($2.1 billion vs. $2.7 billion, respectively).

COMPARISON WITH CHINA

Wind market: China installed 40 percent of global wind capacity in 2015. In 2016, China installed nearly three times as much wind power as the United States. China owns five of the world's ten largest wind-turbine manufacturers. The country installed 18 off-shore wind projects in 2017. Six of those projects counted among the 20 largest wind deals worldwide. The United States, by comparison, has only one offshore wind project in operation and few in development.

Solar market: China accounted for 60 percent of global solar cell production in 2017. China owns five of the world's six largest solar manufacturing companies, and those companies have acquired a number of their international competitors in recent years. China installed at least 50 GW of new solar capacity in 2017, compared with the United States's addition of 10.6 GW solar capacity. China also recently surpassed the United States as the largest market for electric vehicles.[14]

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