

June 6, 2016

APPENDIX A

ECONOMICS OF CLEAN ENERGY

TO JOINT COMMENTS OF COUNCIL ON INTELLIGENT ENERGY & CONSERVATION POLICY (CIECP) and PROMOTING HEALTH AND SUSTAINABLE ENERGY (PHASE)

**Re: New York Department of Public Service (DPS)
Clean Energy Standard White Paper – Cost Study
CASE 15-E-0302 Large-Scale Renewable Program and Clean Energy
Standard**

NOTE: These Appendices are intended as an overview of selected reports, studies, analyses, articles, and visuals. Research information is presented in annotated appendix form to support brevity in the core of the filed Comments.

These Appendices are presented in a format we hope may be easy to peruse. We present materials by year and alphabetically by institution or publication, since those factors tend to be more readily recollected by readers unfamiliar with the names of specific researchers and writers in diverse disciplines and news publications.

Bracketed synopses of specific points following citations have been added in consideration of the readers' time, for the purpose of advocacy, and to support points of emphasis in the core of the Comments. They are not intended to be summaries. Whenever possible we include the link to the source and encourage the full review thereof.

Key to References & Sources

References & sources listed by year, then alphabetically by institution or major publication. United States executive, legal and legislative branch entities are denoted by "U.S." Other Courts and associated pleadings are denoted by "Court." National laboratory documents are listed under the name of the lab. Other sources, conference papers and non-publication-affiliated opinion pieces are listed under the name of the author. Internal footnote and table references are excluded.

2016

AGORA ENERGIEWENDE: Graichen P, Kleiner MM, and Podewils C, The energy transition in the power sector: State of affairs 2015, Agora Energiewende Report, Jan 7, 2016. http://www.agora-energiewende.de/fileadmin/Projekte/2016/Jahresauswertung_2016/Agora_Jahresauswertung_2015_Slides_web_EN.pdf.

[Agora Energiewende is a German think tank. This report reviews major energy developments in Germany in 2015.

Renewable energy is at a record level. In 2015 renewables produced more power than any energy source ever produced in Germany.” (p 2) “Renewable energies produce 30 percent of German power and are by far the strongest energy source.” (p 12)

As of Jan 2016, renewable cover ~32.5% of demand and “dominate the power system.” (pp 2 & 8) Power production from renewables is nearly 10 times greater than in 1990, with wind power having the largest share. (p 18) Power production from wind rose by around 50% in 2015 due to strong growth in new onshore and offshore wind plants and a lot of wind. (p 19)

Electricity use rose slightly in 2015 due to weather conditions compared to 2014, while the economy grew by 1.7%. Nuclear and gas power plants produced somewhat less power in 2015 than in 2014. (p 8) The Grafenrheinfeld nuclear plant permanently shut in June 2015. (p 22)

Electric market power prices remain in “free-fall.” Germany had the second lowest marked price for power in Europe (31.6€ per megawatt hour) after Scandinavia. On the futures market, electric power is trading at 30€ per megawatt hour. In 2016, household prices are expected to rise slightly to 2014 levels due to a rise in levies and fees.

On August 23, 2015, the share of renewables reached its highest level: Between 1pm and 2pm, 83.2% of all power demand in Germany was covered by renewables. The litmus test for the power system came on March 20, 2015 during a partial eclipse of the sun. “The power system dealt extremely well with the sharp fluctuations in nationwide solar power production.” (p 10)

“Popular sentiment: A large majority of the population supports the energy transition: 90 percent of all citizens consider the Energiewende as ‘important’ or ‘very important’. Solar (85 percent) and wind (77 percent) power are the most popular choices to be the main pillar of the energy system, while only 5 percent of the population favour nuclear and coal power.” (p 10)

“Outlook 2016: In production, the share of nuclear energy will decline slightly, while renewables will continue to expand, due to the continued build-up in wind power plants.” (p 10) Despite the decline in market power prices, household power prices are likely to rise slightly due to higher levies and fees, nearing the 2014 level.

“Renewables produce more in 2015 than nuclear power at its peak.” (p 11)

However decarbonization is stagnating and the CO2 balance of the power sector hardly changed compared to 2014. Power exports (including coal) rose considerably in 2015. Measured by trade flows, net exports amounted to around 61 terawatt-hours, 50 percent more than in the previous year. (pp 8 & 9) “Changes from 2014 to 2015: Renewables post record

growth, nuclear and natural gas retreat slightly, coal is steady and is pushed into exports.” (p 14) Greater momentum is needed for 2020 efficiency goals. (p 16)]

AMERICAN WIND ENERGY ASSOCIATION: Wind Industry Annual Market Report Year Ending 2015, American Wind Energy Association report, Apr 12, 2016.
<http://www.awea.org/amr2015>.

[In 2015, wind turbines in the US generated 190.9 million MWh of electricity, enough to power 17.5 million homes.

American wind power now supports 88,000 well-paying American jobs. Wind power added 15,000 jobs in 2015 – a 20% rise over 2014 – and 21,000 workers have positions at over 500 factories in the US.

The vast amount of wind projects are located in rural areas and 70% are in low-income counties. Lease payments to farmers hosting turbines provide a stable income source and enable family farms to survive by effectively harnessing wind as a drought resistant cash crop.

Wind projects avoided an estimated 132 million metric tons of CO₂ in 2015 and also avoided hundreds of thousands of metric tons of sulfur dioxide and nitrogen oxide. By cutting these emissions, wind delivered \$7.3 billion in public health benefits in 2015.]

BBC: McGrath, Matt, Renewable energy surges to record levels around the world, BBC News, Jun 1, 2016. <http://www.bbc.com/news/science-environment-36420750>.

[About 147 gigawatts (GW) of renewables capacity was added globally in 2015. China, the US, Japan, UK and India were the countries adding on the largest share of green power. Despite the significant fall in fossil fuel prices. Christine Lins, executive secretary of REN21, an international body made up of energy experts, government representatives and NGOs, who produced a Renewables Global status Report, said: "The fact that we had 147GW of capacity, mainly of wind and solar is a clear indication that these technologies are cost competitive (with fossil fuels. ...They are the preference for many countries and more and more utilities and investors and that is a very positive signal. ...It clearly shows that the costs have come down so much that the emerging economies are now really focusing on renewable."]

CITYLAB: Spector, Julian, A Requiem for the CFL Light Bulb, CityLab, Feb 4, 2016.
<http://www.citylab.com/tech/2016/02/general-electric-cfl-led-light-bulb/459804/>.

[Industrial giant General Electric announces is phasing out compact fluorescent light bulb (CFL) production and focusing its energy into LEDs which offer better efficiency light quality and even programmable features. LED bulb prices have plummeted from \$40-\$50 in 2012 to a little more than \$3.

Thomas Edison invented the incandescent light bulb in 1879 and they remained the primary light source through the 20th century. But incandescent are inefficient, wasting 90% of their energy as heat.]

DONG ENERGY: Doing Energy in the UK: Wind Power, DONG Energy webpage accessed Mar 11, 2016. <http://www.londonarray.com/wp-content/uploads/DONG-Energy-Factsheet.pdf> London Array 1.

[DONG Energy, a Denmark energy company in partnership with UK concerns, has 5 operational wind farms in the UK providing 1.3 GW of power. Its London Array 1 wind farm has capacity of 630 MW. More wind projects are under construction.]

ECOLOGIST: Diesendorf, Mark, Dispelling the nuclear 'baseload' myth: nothing renewable can't do better! Ecologist, Mar 18, 2016. <http://reneweconomy.com.au/2016/dispelling-the-nuclear-baseload-myth-nothing-renewables-cant-do-better-94486>.

[Underlying the claim that nuclear is needed for baseload are three key false assumptions: (1) That baseload power is actually a good and necessary thing. "In fact, what it really means is too much power when you don't want it, and not enough when you do. What we need is flexible power (and flexible demand too) so that supply and demand can be matched instant by instant." (2) That nuclear power is a reliable baseload supplier. "In fact it's no such thing." All nuclear power plants cut off "trip" for safety reasons or technical faults. When they do, their power needs to be matched at moment's notice by more costly power. (3) That the only way to supply baseload power is from baseload power stations, such as nuclear, coal and gas, designed to run flat-out all the time regardless of whether their power is actually needed. That is also wrong.

Inflexible baseload power plants are unsuitable for following the variations in demand and supply on timescales of minutes and hours, so they have to be supplemented with flexible peak-load and slightly flexible intermediate-load power stations.

The assumption that baseload power stations are necessary to provide a reliable supply of grid electricity has been disproven in practical experience in electricity grids with high contributions from renewable energy. (Examples are reviewed in the article.)

A major computer simulation by a large team of scientists and engineers found that 80-90% renewable electricity is technically feasible and reliable. (They did not examine 100%.) Findings were published by the US National Renewable Energy Laboratory (NREL) in a 2012 report ([*Renewable Electricity Futures Study. Vol.1. Technical report TP-6A20-A52409-1*](#)) which states: "renewable electricity generation from technologies that are commercially available today, in combination with a more flexible electric system, is more than adequate to supply 80% of total U.S. electricity generation in 2050 while meeting electricity demand on an hourly basis in every region of the United States." The NREL study also states: "RE (Renewable Energy) Futures finds that increased electricity system flexibility, needed to enable electricity supply-demand balance with high levels of renewable generation, can come from a portfolio of supply- and demand-side options, including flexible conventional generation, grid storage, new transmission, more responsive loads, and changes in power system operations."

Similar results have been found in hourly simulation modeling of the Australian National Electricity Market with 100% renewable energy (published by Ben Elliston, Iain MacGill and I in 2013 and 2014) based on commercially available technologies and real data on electricity demand, wind and solar energy.

In actual practice, fluctuations in variable wind and solar PV can be balanced by flexible renewable energy sources that are dispatchable, including gas turbines powered by “green” gas from composting municipal and agricultural wastes. In addition, “drawing on diverse renewable energy sources, with different statistical properties, provides reliability. This means relying on multiple technologies and spreading out wind and solar PV farms geographically to reduce fluctuations in their total output. This further reduces the already small contribution from gas turbines to just a few percent of annual electricity generation.”

Reliability can be achieved via new transmission lines and introduction of smart demand management to handle demand peaks and periods of low electricity supply. Smart meters and switches controlled by both electricity suppliers and consumers, and programmed by consumers to switch off certain circuits for short periods can help in this endeavor. when demand on the grid is high and/or supply is low.

Transformation to a flexible, renewables-based approach would render conventional baseload power plants unnecessary. This is why industry promoters falsely denigrate renewable energy.

“In the words of former Australian Greens’ Senator Christine Milne: ‘*We are now in the midst of a fight between the past and the future*’.”]

ELECTREK: Weaver, John Fitzgerald, New Milestone: 95% of German electricity provided by renewable on Sunday at 11 AM, electrek, May 9, 2016.
<http://electrek.co/2016/05/09/new-milestone-95-of-german-electricity-provided-by-renewables-on-sunday-at-11-am/>.

[Agora-Energiewende reports that, at 11 am on May 8, 2016, 95% of German electricity demand was met by renewable energy. In 2015, German energy records were in 70-80% range. In the fall of 2015, Denmark generated 140% of its electricity demand with wind power.]

FRANKFURT SCHOOL–UNITED NATIONS ENVIRONMENT PROGRAMME and BLOOMBERG NEW ENERGY FINANCE: Global Trends in Renewable Energy Investment 2016, Frankfurt School-UNEP Collaborating Centre for Climate & Sustainable Energy Finance and Bloomberg New Energy Finance Report, March 24, 2016. http://fs-unep-centre.org/sites/default/files/publications/globaltrendsrenewableenergyinvestment2016_lowres_0.pdf.

[United Nations-backed report on renewable energy generation in 2015. Renewables include “wind, solar, biomass and waste-to-energy, biofuels, geothermal, marine and small hydro (including wave and tidal, but excluding large hydroelectric projects of >50 megawatts).

In 2015, renewables added 134 gigawatts (GW) of additional energy capacity – more global energy generation capacity than all other technologies *combined*. Were it not for renewable (excluding large hydro) annual global CO2 emissions in 2015 would have been an estimated 1.5 gigatonnes higher.

The renewable energy market was dominated by solar photovoltaics and wind, which together added 118 GW in generating capacity.

A record total of \$285.9 billion was committed to wind, solar and other renewables in 2015. The 2015 total was more than 6 times the figure set in 2004 and investment in renewables has been running at more than \$200 billion per year for 6 years. Over the 12 years since 2004, global markets have invested \$2.3 trillion in renewable energy. (Figure 1, p 12, sum unadjusted for inflation).

Global investment in renewable power capacity (at \$265.8 billion) was more than double dollar allocations to new coal and gas-fired electric generation in 2015. “So far, the drivers of investment in renewable, including climate change policies and improving cost-competitiveness, have been more than sufficient to enable renewable to keep growing their share of world electricity generation at the expense of carbon-emitting sources.” (p 11)

The global energy sector “has changed out of all recognition” since 2014. (p 18) “Meanwhile, renewable have their own advantages. Wind farms can be built in nine months or so, solar parks in three-to-six months, whereas coal and gas plants take several years, and nuclear even longer.” (p 18) Also, renewables concentrate lifetime costs at the development and construction stage then enjoy low cost during operation because their feedstock is essentially free (p 32) and upfront renewable generation costs continue to fall.

In the second half of 2015, the global average levelized cost of electricity (LCOE) for crystalline silicon PV was \$122 MWh, down from \$143 in H2 2014. Further cost reductions are on the way and these will come from technological and manufacturing improvements rather than squeezing of manufacturer margins. Economies of scale and facility upgrades point to a reduction of modular costs by at least 36% within 10 years, with an estimated average efficiency rise of 20%. (p 56) Bloomberg New Energy Finance “expects that by 2030 solar will undercut fossil electricity generation in all but the least promising locations.” (p 75)

“In the US, the boom in residential solar looks set to continue. The number of customers with PV is predicted to more than double nationally between 2015 and 2020. Build rates will average 1.7GW per year until the end of the decade, while the commercial and industrial sectors are expected to grow at a rate of 1.5GW per year over the same period.” (p 56)

The average levelized cost of electricity (LCOE) for wind has fallen by 14% over the past 6 years and is forecast to fall a further 18% over the next 10. “Again, relentless innovation has delivered both reduced capital cost and higher efficiency.” (p 76) The load factor (amount of energy produced as a % of nameplate capacity) continues to rise as the technology improves and operators optimize wind farm performance through big data analysis.

In comparison to the 134 GW of added energy generating capacity from renewables (62 GW from wind and 56 GW from solar), coal-fired plants added 42 GW, gas-fired plants added 40 GW, large hydro added 22 GW, and nuclear added only 15 GW.

“Renewable energy technologies such as wind and solar used to be seen by some critics as a luxury, affordable only in the richer parts of the world. This has been an inaccurate view for a long time, but 2015 was the first year in which investment in renewable excluding large hydro was higher in developing economies than in developed countries.” (p 14) For the first time, developing world investments was up 19%, topping developed nations’. Renewable investment in the US was also up 19%, with a total of \$24.4 billion. (p 20) China’s was up 18%, representing investment of \$95.7 billion – almost 4 times that of the US.

Nevertheless, emissions remain a cause for worry. “Policy support for renewable remains fickle.” (p 11) Two examples are the UK government support became less friendly after the May 2015 election and the US Supreme Court’s February 2016 decision to allow all legal objections to the Environmental Protection Agency’s Clean Power Plan to be heard before the plan can be implemented.

Hope for curtailing emissions comes from the UN climate change conference in Paris in December 2105, known as COP21, which produced an unprecedented agreement among 195 countries to act for zero net emissions by the second half of the century. Moreover, demand for energy, particularly electricity, is showing signs of coming under strong pressure from technological advances. The spread of efficient devices such as LEDs for lighting or energy-saving refrigeration could have a substantial impact. Innovation in the provision of finance for clean energy is key. One example is creation of platforms through which institutional investors could have exposure to the equity of clean energy assets but with the reassurance of having a technically experienced bank involved alongside them. Another innovation in Europe has been inflation-linked notes as a way for institutions to access the cash flows of wind and solar projects. (p 47)

The report does not cover energy smart technologies such as smart grid, electric vehicles and storage, but notes increasing attention is being paid to storage, which represents an adjunct to clean energy. One factor that could affect both emissions and electric demand is the growth of electric vehicles with their attendant battery recharging – something that could offer new potential for balancing renewable output. (p 30) Battery remains expensive but costs are falling rapidly, spurred by the growth of electric vehicles. “[L]ocal storage could enable wind and solar projects to provide electricity for a larger number of hours, with less in the way of fluctuation. This could be a powerful combination at both utility-scale and in developing economy microgrids.” (p 36) Utility-scale energy storage capacity projects announced in 2015 totaled 1.2 GW.

“Small distributed power systems are at the forefront of a transformation in the way we think about energy generation. Utility-scale wind and solar projects mimic the traditional model of a large, centralized generating plant, whereas small-scale systems take the opposite approach – they involve millions of people directly in the production of electricity for their own use (and sometime profit), whether they be in rural Tanzania or US suburbia.” (p 54) Notably, in 2015, a quarter – or \$67.4 billion – went towards projects of less than 1 MW, typically rooftop and small ground-mounted solar PV.]

GREENTECH MEDIA: Munsell, Mike, US Solar Market Sets New Record, Installing 7.3GW of Solar PV in 2015, Greentech Media, Feb 22, 2016.

<https://www.greentechmedia.com/articles/read/us-solar-market-sets-new-record-installing-7.3-gw-of-solar-pv-in-2015>.

[Solar PV outpaced natural gas addition in the US in 2015. GTM Research and Solar Energy Industries Association (SEIA) report ~7.3 gigawatts (7,286 megawatts) of solar PV was installed in the nation in 2015.]

HUFFINGTON POST: Waymouth, Belinda, Only Renewable Energy Revolution Can Reverse Runaway Climate Change, Huffington Post, Mar 15, 2016.

http://www.huffingtonpost.com/belinda-waymouth/only-renewable-energy-rev_b_9422770.html.

[The only way to reduce atmospheric carbon to the safe zone of 350 parts per million (ppm) by century's end (currently CO₂ is at 400ppm and climbing) is by transitioning to an electrified world running on wind, water and solar power.

Towards this aim, the Solutions Project details a renewable energy road map for all 50 US states. The plan is also to add 139 other countries – which, collectively with the US, would represent 95% of global emissions. Dr. Mark Jacobson, Director of the Atmosphere and Energy Program at Stanford University and a professor of civil and environmental engineering, is a co-founder of the project. It lays out a renewable energy transition in two rollout stages: 80% by 2030 and 100% by 2050. For much of the world, it would not be a transition but rather an opportunity to have electricity for the first time. Jacobson's calculus shows clean energy creating 2 million jobs in the US and 22 million globally.

Transition, Dr. Jacobson argues, requires not just elimination of fossil fuels, but elimination of combustion-powered electricity. Combustion creates black carbon particulate matter, which itself represents a major driver of climate change (and also causes millions of air pollution related deaths a year).

Economics also support renewables. "For starters sun, water and wind are free. Then there's the efficiency factor: Less than 1 percent of power generated from solar and wind gets lost as heat, while more than half the power produced from natural gas, and two thirds from nuclear and coal is heat loss. Because of this efficiency differential, switching to all renewables by 2050 would actually cut global energy demand by a third, according to Jacobson."

Dr. Peter Miller, Senior Scientist at the Natural Resources Defense Council, agrees a wholesale clean energy switch is completely feasible, especially given states like California already generate more solar than it can use.]

INSTITUTE FOR ENERGY ECONOMICS AND FINANCIAL ANALYSIS (IEEFA): Bandyk, Matthew, Renewables, Excluding Hydro, Surpass 10% of U.S. Electricity Generation for the First Time, Institute for Energy Economics and Financial Analysis, newsletter, Jun 2,

2016. <http://ieefa.org/renewables-excluding-hydro-surpass-10-u-s-electricity-generation-first-time/>.

[Renewable energy sources, excluding hydroelectricity, generated more than 10% of US electricity in March 2016, according to US Energy Information Administration data. “Widespread installations of new wind and solar facilities over the last decade explain much of the increase in renewables generation.” Renewables also came close to hitting the 10% mark in November 2015, when they generated 9.6% of electricity.

“In addition, the productivity of those facilities, not just their total numbers, also matters. Advances in renewable energy technology now allow wind farms and solar panels to generate more electricity.”]

INTERNATIONAL ENERGY AGENCY (IEA): decoupling of global emissions and economic growth confirmed, International Energy Agency article on data analysis, Mar 16, 2016. <http://www.iea.org/newsroomandevents/pressreleases/2016/march/decoupling-of-global-emissions-and-economic-growth-confirmed.html>.

[IEA analysis indicates energy-related emissions of CO2 stalled for the second year in a row “as renewable energy surged.” IEA Executive Director Fatih Birol noted, “Coming just a few months after the landmark COP21 agreement in Paris, this is yet another boost to the global fight against climate change.”]

Preliminary data suggest that “electricity generated by renewables played a critical role, having accounted for around 90% of new electricity generation in 2015; wind alone produced more than half of new electricity generation. In parallel, the global economy continued to grow by more than 3%, offering further evidence that the link between economic growth and emissions growth is weakening.”]

Leslie, Jacques, Nevada’s Solar Bait-and-Switch, New York Times, Feb 1, 2016. <http://www.nytimes.com/2016/02/01/opinion/nevadas-solar-bait-and-switch.html>.

[Jacques Leslie is a journalist and author of “Deep Water: The Epic Struggle over Dams, Displaced People, and the Environment.”]

Modular devices located close to consumers are undermining utility monopolies. “Cleaner, more energy-efficient and potentially cheaper than fossil fuels, these technologies include solar, wind, batteries, microturbines, microgrids and smart appliances. As they spread, they strike at the heart of utilities’ business models: To increase profits, utilities must expand operations, but the emergence of distributed energy reduces the need for expansion.”

“Three years ago, the Edison Electric Institute, the utilities’ trade group, published a report called ‘Disruptive Challenges’ that became famous in the utilities sector for its seeming candor. It describes how distributed forms of energy could send the industry into what has become known as the ‘utility death spiral.’ As more and more consumers switch to distributed energy, the utilities’ costs must be shared among a dwindling number of customers, whose rates

therefore increase, causing more of them to shift to distributed energy.” Even a small shift to distributed energy could devastate utilities’ business models.

Many utilities are trying to protect their revenue stream by limiting the growth of rooftop solar. They claim grid construction and maintenance costs as a rationale for hiking solar user costs. However solar input reduces the amount of power utilities need to generate or buy from conventional power plants, lowering the need for large capital investments and increasing grid resilience.

The utilities’ effort to fend off change is outdated and unsustainable. “Not only does it waste resources and stifle innovation, but it’s likely to be upended by a few pioneering state commissions that understand the overwhelming economic and environmental value of distributed energy.”

“Most notably, in April 2014, New York’s Public Service Commission began a process to transform utilities from monopolies into electricity distributors that increasingly rely on clean energy generated by numerous providers. In this grid of the future, energy costs will decrease and utilities will become, instead of climate change enablers, part of the solution to the problem.”]

NATURAL RESOURCES DEFENSE COUNCIL (NRDC): DeCostanzo, Donna, Passage of NYC Legislation Will Bring Greener City Buildings to the Big Apple, National Resources Defense Council blog, Mar 11, 2016.

http://switchboard.nrdc.org/blogs/ddecostanzo/passage_of_nyc_legislation_wil.html#.VuVk6a2ySLw.mailto.

[New legislation in NYC will require that most new and substantially renovated city-owned buildings reduce energy use by 50% and meet US Green Building Council’s LEED Gold standard. (NYC residential buildings will have to comply with the Enterprise green Communities Criteria.) The framework creates standards for what will be among the most energy-efficient municipal buildings in the US.

NYC has a huge real estate portfolio that makes up about 5% of the city’s building stock. And that building stock is responsible for nearly three quarters of the city’s total greenhouse gas pollution. Therefore reduced NYC building energy use will significantly reduce the City’s carbon emissions.

More importantly, “these ambitious standards will teach New York’s design and construction industry how to build to a much higher level of energy performance.”]

NEW YORK TIMES: Goode, Erica, New Solar Plants Generate Floating Green Power, New York Times, May 21, 2016.

<http://www.nytimes.com/2016/05/24/science/solar-power-floating-on-water.html>.

[Floating solar arrays – or floatovoltaics – on treated water ponds and other water bodies not used for recreation – are becoming more popular, with installations already operating and more planned or under construction.

“The growing interest is driven in part by huge growth in the solar market in recent years as the cost of the technology has dropped quickly.”

Aside from generating electricity, floating arrays help keep water from evaporating (an attractive feature for drought-plagued areas) and restrict algae blooms.

Floating solar arrays can also be more energy efficient than land-based solar, because water cools the panels. A floating solar farm in Jamestown Australia built by Infratech began operation in 2015 and will eventually cover 5 water treatment basins. The finished plant is expected to generate up to 20% more energy than a land solar array. Infratech is working on a similar project in the city of Holtville, California, which has suffered years of drought.

Rajesh Nellore, Infratech’s CEO said the technology is “limited by what incentives there are and what the government wants,” noting that the Los Angeles Water Department covered a reservoir with \$34.5 million worth of black plastic balls to slow evaporation, whereas floating solar panels could have served the same purpose while generating power.

In Japan, Kyocera, a company building a floating solar plant over a dam and reservoir, said that construction time and labor for a floating array was far less than for a land-based installation.

In Oakville, California, the Far Niente winery installed 994 on pontoons over an irrigation pond in 2008 as part of the objective to eliminate 100% of its energy cost. Greg Allen, a winemaker at the winery and mechanical engineer by training, said the investment was expected to pay for itself by 2020 or sooner. At least one other winery has followed suit, and Allen said the winery had received visitors interested in the technology from India, China, Singapore and New South Wales. Inhabitants of the pond seem unperturbed, he added. Allen explained that putting the panels on water saved vineyard space and did not disturb the water. “The fish are happy, the frogs are happy, the ducks came back,’ he said. ‘It’s a very healthy pond.’”]

NEW YORK TIMES: Cardwell, Diane, In Philadelphia, Batteries on Transit System Power More Than Just the Trains, New York Times, Jan 22, 2016.

<http://www.nytimes.com/2016/01/22/business/in-philadelphia-batteries-on-transit-system-power-more-than-just-the-trains.html>.

[Batteries have been used to capture power used in locomotives for years, but operators are now finding ways to recycle the energy into electricity to power their fleets. Amtrak, for instance, is replacing old locomotives with newer models that recycle all of the regenerated energy as electricity for its system, rather than wasting it as heat. The core technology of the system, known as regenerative braking, was one of the breakthroughs that allowed for the development of hybrid and electric cars.

“In Portland, Ore., a supercapacitor helps collect and dispense the energy on its light rail system. In Los Angeles, transit officials are testing the use of flywheel-based storage on the expanding Metro, part of efforts to reduce costs and increase the options to meet ambitious

environmental goals. London is exploring the use of regenerated energy for its Underground, as well.”

A new program in Philadelphia has even broader possibilities. There battery power is being used to not but power trains, but to send power to the grid.]

PHILLY VOICE: Tanenbaum, Michael, SEPTA announces subway battery project to capture and reuse energy, Philly Voice, Jan 22, 2016. <http://www.phillyvoice.com/septa-announces-groundbreaking-subway-battery-project-capture-and-reuse-energy/>.

[Cutting-edge innovations are being deployed by Philadelphia’s transit system and electric grid as part of a sustainability program. Batteries, managed by software, are plugging into kinetic energy of subway trains. As the trains brake, their energy is transmitted as electricity to battery banks at substations. The system can then use the energy to power trains or to help modulate grid electricity flows. The project is being implemented through a partnership with Viridity Energy and Constellation, the power provider that will own and operate the system for the transportation authority Southeastern Pennsylvania Transportation Authority (or SEPTA).

The project is expected to generate \$26 million of savings in efficiency improvements. Pilot battery storage projects, launched by SEPTA in 2012, have already saved about \$40,000 in electricity costs for each substation and brought in revenue of \$250,000 a year.]

RENEWABLE ENERGY POLICY NETWORK FOR THE 21st CENTURY (REN21): Renewables Global Status Report, Renewable Energy Policy Network for the 21st Century annual report, Jun 1, 2016. http://www.ren21.net/wp-content/uploads/2016/06/GSR_2016_Full_Report1.pdf.

[REN21 is the global renewable energy policy multi-stakeholder network, it seeks to facilitate knowledge exchange, policy development and joint action towards a rapid global transition to renewable energy. This report draws on an international network of over 500 authors, contributors and reviewers. (List at p 15) Funding was provided, inter alia, by the Inter-American Development Bank (IDB), the United Nations Environment Programme (UNEP) and the World Bank Group.

New renewables were added in 2015 at the fastest rate the world has seen, with investments in renewables more than double the amount spent on new coal and gas-fired power plants.

Renewable energy provided and estimated 19.2% of global final energy consumption in 2014 and growth continued in 2015. Some 147 gigawatts (GW) of renewable capacity was added globally in 2015, with China, the US, Japan, UK and India adding on the largest share. “For the sixth consecutive year, renewable outpaced fossil fuels for net investment in power capacity additions.” (p 17)

“The power sector experienced its largest annual increase in capacity ever, with significant growth in all regions. Wind and solar PV had record additions for the second consecutive year, accounting for about 77% of new installations, and hydropower represented most of the

remainder. The world now adds more renewable power capacity annually than it adds (net) capacity from all fossil fuels combined.” (p 18)

In 2015, the solar PV market was up 25% over 2014. In 2015, Morocco, South Africa and the US also all brought new concentrating solar thermal power (CSP) facilities online. (p 23)

In 2015, wind power was the leading source of new power generating capacity in Europe and the US and the second largest in China and most top turbine manufacturers broke their own annual installation records. “To meet rising demand, new factories opened or were under construction around the world.” (p 23)

“Around the world, technical, economic and market transformation of the electric power sector continued to accelerate, and many countries have begun to respond to the challenge of grid integration. Technological advances, expansion into new markets with better resources, and improved financing conditions continue to reduce costs in 2015.” (p 18)

Precedent-setting commitments to fight global warming and promote renewable and energy efficiency were also made national and internationally in 2015. These included commitments by both the G7 and G20 to accelerate access to renewable and to advance energy efficiency and the United Nations General Assembly’s adoption of a dedicated Sustainable Development Goal on Sustainable Energy for All (SDG7). The year culminated in December at the United Nations Framework Convention on Climate Change’s (UNFCCC) 21st Conference of the Parties (COP21) in Paris.

Although many of the initiatives announced in Paris and elsewhere did not start to affect renewable markets in 2015, rapid growth in renewables has already been driven by cost competitiveness, dedicated policy initiatives, better access to financing, energy security and environmental concerns. Global investment also climbed to a new record level, in spite of the plunge in fossil fuel prices, ongoing fossil fuel subsidies and other challenges, including regulatory barriers.

“For the first time in history, total investment in renewable power and fuels in developing countries in 2015 exceeded that in developed economies.” (p 25)

In the US, of 769,000 new renewable jobs added, 194,000 were in solar PV, 88,000 in wind, 35,000 in geothermal, and 10,000 in solar heating/cooling (direct and indirect) (p 41)]

SIERRA ATLANTIC: Grossman, Karl, At our house, the sun pays the electric bill, Sierra Atlantic, Winter 2016. <https://atlantic2.sierraclub.org/content/our-house-sun-pays-electric-bill>.

[Karl Grossman is a journalist, author and professor at the State University of New York/College at Old Westbury. His home in Sag Harbor, Long Island was solarized in 2009.

“Once the photovoltaic panels are up on your roof, nothing more needs to be done. They harvest electricity from the sun even on cloudy days. Never in the half-dozen years have the 38 panels on our roof needed any care. And frequently, looking at the Long Island Power Authority (LIPA) meter attached to the house, I see the numbers going backwards — we’re producing electricity for which LIPA reimburses us. ... Then there are the two thermal solar panels heating

up water and sending it — very well-heated — into the house. The other day, it was 64°F outside but the thermometer on the hot water tank in the basement showed water from the thermal panels coming down at 130°F. Amazing! And these panels are also care-free.”

The price of solar panels has plummeted and efficiencies have gone up since 2009. When Dean Hapshe of Harvest Power and his crew installed Prof. Grossman’s system in, the cost of the photovoltaic panels, which produce 7,500 watts — an average-size system — was \$6 a watt, now it’s down to \$3.65 and efficiency rate has risen to 21% — which means more electricity is generated for every ray of sunlight. The problem for utilities is that the sun sends no bill.]

U.S. DEPARTMENT OF ENERGY (DOE); LAWRENCE BERKELEY NATIONAL LABORATORY; and NATIONAL RENEWABLE ENERGY LABORATORY (NREL): Wiser R, Mai T, Millstein D, Macknick J, Carpenter A, Cohen S, Cole W, Frew B, and Heath G, On the Path to SunShot: The Environmental and Public Health Benefits of Achieving High Penetrations of Solar Energy in the United States, U.S. Department of Energy SunShot Project, Berkeley National Laboratory, and U.S. National Renewable Energy Laboratory Report, NREL/TP-6A20-65628; LBN-1004373. May 2016.
<http://www.nrel.gov/docs/fy16osti/65628.pdf>.

[The DOE’s 2012 SunShot Vision Study determined that solar could penetrate 14% of annual US electric demand by 2030 and 27% by 2050. This report seeks to quantify the general magnitude of three specific benefits which could be derived by achieving the SunShot Vision. These are: (1) substantial greenhouse gas emission reductions, (2) substantial air pollution reductions, and (3) substantial water use reductions.

“Solar technology, solar markets, and the solar industry have changed dramatically over the past five years. Cumulative U.S. solar deployment has increased more than tenfold, while solar’s levelized cost of energy (LCOE) has dropped by as much as 65%. New challenges and opportunities have emerged as solar has become much more affordable, and we have learned much as solar technologies have been deployed at increasing scale both in the U.S. and abroad.” (p iv)

The total monetary value of achieving the SunShot Vision exceeds \$400 billion in present-value terms under the study’s central estimates, which is equivalent to roughly 3.5¢kWh solar. (p 35)

Regarding greenhouse gas emissions: achieving the SunShot Vision reduces power sector life cycle greenhouse gas emissions by 13% in 2030 and 18% in 2050. These reductions could produce global present value benefits of \$259 billion in the form of lower future climate change damages. These potential future benefits build on the 17 million metric tons of CO₂ savings realized annually from the 2014 solar fleet.

Regarding health benefits from lower air pollution, achieving the SunShot Vision reduces emissions of sulfur dioxide (SO₂), nitrogen oxides (NO_x), and fine particulate matter (PM^{2.5}) in the power sector by 14%, 14%, and 13% in 2030 and 15%, 18%, and 13% in 2050. These reductions produce benefits of \$167 billion, derived, in large measure, from reducing premature mortalities by 25,000-59,000 based on methods developed by the EPA. The future benefits of achieving the SunShot Vision provide annual domestic air quality benefits of \$890 million.

Regarding water use reductions, achieving the SunShot Vision reduces power sector water withdrawals by 8% in 2030 and 5% in 2050, while power sector water consumption is reduced by 10% in 2030 and 16% in 2050. Cumulative water impacts from 2015 to 2050 equal 46 trillion gallons of avoided withdrawal and 5 trillion gallons of avoided water consumption. Importantly, drought prone and arid states are among those with the largest reductions in water use.

“Moreover, economic research has found that policies directly targeting the internalization of external costs and correction of market failures are likely to be more cost effective than technology- or sector-specific policy incentives, in part due to possible economy-wide rebound and spillover effects and also because such policies directly target the achievement of public benefits.” (p 35)]

U.S. ENERGY INFORMATION ADMINISTRATION (EIA): Solar, natural gas, wind make up most 2016 generation additions, U.S. Energy Information Administration, Mar 1, 2016.
<http://www.eia.gov/todayinenergy/detail.cfm?id=25172>.

[Electric generating facilities expect to add >26 gigawatts (GW) of utility-scale generating capacity to the power grid in 2016, mostly from solar, natural gas and wind 6.8. “Planned utility-scale solar additions total 9.5 GW in 2016, the most of any single energy source.” This figure does not include additional distributed generation from solar photovoltaic rooftop. (In 2015, nearly 2 GW of solar photovoltaic capacity was added.) Natural gas is expected to add 8 GW of capacity in 2016, and wind 6.8 GW. (In 2015, wind added 6.8 GW.)]

WORLD RESOURCES INSTITUTE: Aden, Nate, The Roads to Decoupling: 21 Countries Are Reducing Carbon Emissions While Growing GDP, World Resources Institute blog, Apr 5, 2016. <http://www.wri.org/our-work/topics/energy>.

[Analysis by Nathaniel Aden, a research fellow at the World Resources Institute, a Washington think tank, shows that, since the start of the 21st century, the United States and 20 other countries have reduced annual carbon emissions while growing their economies. In economic terms, these countries have already fully “decoupled” their economic growth (GDP) from greenhouse gas (GHG) emissions. In these countries, GDP went up since 2000, while carbon pollution went down. In addition, global GHG emission stayed flat in 2014 and 2015.

The US has experienced multiple consecutive years in which economic growth has been decoupled from GHG emissions growth. From 2010 - 2012, energy-related carbon dioxide emissions declined by 6% (eliminating 350,000 million metric tons, while GDP grew by 4% (\$600,000 billion). The US Information Administration analysis of the EPA Clean Power Plan forecasts that moving to a cleaner electricity system after 2020 would bring about a sustained period of GDP-GHG decoupling. Clean Power Plan implementation is expected to reduce total US energy-related CO2 emissions by another 6% and enjoy GDP growth of 13% between 2020 and 2025.

In addition to the US, other country-level decouplings driving the global trend are: Austria; Belgium; Bulgaria; Czech Republic; Denmark; Finland; France; Germany; Hungary; Ireland;

Netherlands; Portugal; Romania; Slovakia; Spain; Sweden; Switzerland; Ukraine; the UK, the US and Uzbekistan.

There is not a single formula, policy or demographic factor driving GDP-GHG decoupling. Sweden, for example, implemented carbon taxes and other ambitious policies. Denmark rapidly scaled up renewable energy.

Given still enormous global carbon dioxide emissions “it’s clear that decoupling needs to be scaled up rapidly to have any chance of limiting average warming.” But the decoupling of GDP and GHG emissions in numerous countries demonstrates the feasibility and prevalence of the transition to cleaner modes of economic activity.]

2015

ALLIANCE FOR A GREEN ECONOMY and NUCLEAR INFORMATION AND RESOURCE SERVICE: Replacing FitzPatrick: How the Closure of a nuclear Reactor can Reduce Greenhouse Gasses and Radioactive Waste, while Creating Jobs and Supporting the Local Community, Alliance for a Green Economy and Nuclear Information and Resource Service joint White Paper, Oct 22, 2015.

[White paper by nonprofit public interest groups compare the cost of taxpayer subsidies to prop up Entergy’s FitzPatrick nuclear plant versus support for clean energy replacement as well as alternatives to economically support area municipalities and plant workers.

The economics for nuclear have always required taxpayer subsidies for construction, accident insurance and radioactive waste. But in recent years, aging nuclear plants have also become increasingly expensive to maintain and operate. The negative economic outlook has led to announcement of several nuclear plants, including Entergy’s Vermont Yankee plant.

Flat electric demand in Central New York and stiff market competition has made Entergy’s FitzPatrick reactor, located near Oswego, NY, uncompetitive and unprofitable. Its economic outlook is unlikely to change.

“The trends are moving against nuclear energy, in favor of cleaner, cheaper, and/or more flexible energy sources.” (p 5) The only way to keep FitzPatrick running is to provide Entergy with a public subsidy or to change the wholesale electricity market rules to favor nuclear power over other energy sources. Either option would cost New Yorkers tens of millions of dollars a year. Key conclusions of the report are:

- FitzPatrick’s full electricity generation could be replaced with energy efficiency and wind at less than the current cost of power from the nuclear reactor.
- Diverting FitzPatrick’s revenue to clean energy would result in greenhouse gas emissions equivalent to a 264 MW coal plant or a 330 MW combined cycle natural gas plant.
- Replacing FitzPatrick with efficiency and wind could create more than 2X the number of jobs.

- New York could support municipalities and workers affected by the nuclear plant's closure through an economic transition at less cost than subsidizing Entergy to keep the plant open.

The analysis shows that providing a subsidy for the nuclear reactor would be costly to ratepayers and the environment. "There are major opportunity costs for allowing FitzPatrick to operate, even without a subsidy. If FitzPatrick were to close and the money currently going to the reactor in the market were instead directed into energy efficiency and wind, the entire output of FitzPatrick could be replaced. Money would be left over to build additional renewable or to lower energy prices." (p 15) An alternative energy and wind scenario proposed in the report is 92% as reliable for meeting peak demand and would result in significant additional greenhouse gas emissions reduction. Pursuing a replacement scenario with a combination of efficiency and wind would create more than twice the number of jobs. The option of NY even simply paying FitzPatrick's workers and protecting local municipalities from tax-revenue losses could be accomplished at substantially lower cost than paying Entergy to continue the plant's operation.]

BBC WORLD NEWS: HardTalk, Stephen Sackur interview of economist Jeremy Rifkin, BBC World News, Aug 26, 2015.

[Andrew Rifkin, an economist and senior lecturer at the Wharton School's Executive Education Program at the University of Pennsylvania, has advised the European Union and Chancellor Angela Merkel of Germany on the potential of creating a new way of organizing economic life in a sustainable, post-carbon economic era.

"We have millions of millions of people now – small businesses, homeowners, consumer coops – that are literally producing their own solar and wind green electricity at near-zero marginal cost. They have to put the technology on, that costs some money. But the moment that solar and wind is out there on your property, the actual marginal cost of the sun and the wind is free. The sun is free. The wind on your property is free. The geothermal heat under your ground is free. So we have millions of people who are actually now bypassing the expensive fossil fuel industry and they are producing their near zero marginal cost energy right now."

"We now have 25% of the electricity of Germany is green energy – solar and wind on the electricity grid. We're having a 35% in 2020 and its being produced at near zero marginal cost. ... The wholesale prices have gone way down because it's really free energy. The retail prices have gone up because the utility companies are passing the feed-in tariff to the ratepayers. But that's a short hump. When they get over that hump: free green electricity."

"We're in a long-term transition from the Second Industrial Revolution energies and technologies to the Third – I'm talking about the very beginning of something that's going to emerge as a new economic system, not the end game."]

BLOOMBERG BUSINESS: Malik, Naureen, Wind Rescues New York Power After Nuclear Plant Shutdown, Bloomberg Business, Dec 15, 2015.

<http://www.bloomberg.com/news/articles/2015-12-15/wind-rescues-new-york-power-prices-after-nuclear-plant-shutdown>.

[Indian Point 3 unexpectedly went offline at 7 pm December 14, 2015, a Monday night, due to an electrical disturbance. Wind turbines in the state “came to the rescue” compensating for the loss of the reactor.

Wind and solar have subdued prices and at times curtailed the need for coal and gas plants. “Meanwhile, Entergy is facing political and economic pressure as Governor Andrew Cuomo seeks to shut the plant while power prices in December head for the lowest monthly average on record.”]

BLOOMBERG NEWS: Xcel CEO: Wind energy cheaper than natural gas, Bloomberg News, Oct 23, 2015. <http://finance-commerce.com/2015/10/xcel-ceo-wind-energy-cheaper-than-natural-gas/>.

[Xcel Energy Inc., the biggest US wind power provider, expects long-term contracts for the technology to beat the cost of natural gas. Xcel, which serves 8 states, plans to add 1,600 MW of wind energy over the next ~15 years and is receiving bids for 20-year power-purchase agreements at about \$25 a MWhr.

While gas prices are close to historic lows, Xcel expects fossil fuel to be closer to \$32 a MWhr over the 20 year period. Ben Fowke, Xcel’s CEO, told Bloomberg News: “When we’re buying wind at \$25, it’s a hedge against natural gas’.” On some of the windiest days, the company’s wind farms supply as much as 60% of the utility’s power. “Wind is becoming pretty close to parity,” he said.]

BLOOMBERG NEW ENERGY FINANCE (BNEF): Wind and Solar Boost Cost-Competitiveness Versus Fossil Fuels, Bloomberg New Energy Finance Press Release, Oct 5, 2015. http://about.bnef.com/content/uploads/sites/4/2015/10/BNEF_PR_20151006_Global-Cost-of-Energy.pdf.

[A detailed analysis by Bloomberg New Energy Finance (BNEF) has determined that onshore wind and solar photovoltaic power – the two most widespread renewable forms of electric power generation – reduced costs in 2015. The report shows offshore wind costs also went down, but not as much as onshore wind.

In contrast to the renewables, fossil fuel (and in the Americas, Europe, Middle East and Africa) nuclear generation costs have risen.

The BNEF report is titled “Levelised Cost of Electricity Update”. Levelised costs take into account the cost of generating a marginal MWh of electricity, the upfront capital and development expense, the cost of equity and debt finance, and operating and maintenance fees.

The report states: “[O]nshore wind and solar PV are both now much more competitive against the established generation technologies than would have seemed possible only five or 10 years ago.”]

ENERGY & ENVIRONMENTAL SCIENCE: Jacobson MZ, Delucchi MA, Bazouin G, Bauer ZAF, Heavey CC, Fisher E, Morris SB, Piekutowski DJY, Vencill TA, and Yeskoo TW, 100% clean and renewable wind, water, and sunlight (WWS) all-sector energy roadmaps for the 50 United States, Energy & Environmental Science (2015); 8: 2093-2117. <http://web.stanford.edu/group/efmh/jacobson/Articles/I/USStatesWWS.pdf>.

[Authors are from the Atmosphere and Energy Program, Department of Civil and Environmental Engineering, Stanford University and the Institute of Transportation Studies, University of California, Berkeley.

Study presents a set of roadmaps for converting the energy infrastructures of each of the 50 US states to 100% wind, water, and sunlight (WWS) by 2050. The study demonstrates significant health and environmental cost savings with creation of jobs, stabilization of energy prices, assays to minimize land requirements. Various factors are quantified.

Energy efficiency measures are also included. Nuclear power, coal (including coal with carbon capture), biofuels, and natural gas are excluded in the scheme.

While many studies focus on changing energy sources in one sector, this study integrates changes among all energy sectors: electricity, transportation, heating, cooling, and industry). The roadmaps envision electricity generation increases, but significant decreases of end use load. Conversion from a combustion to electrified system is calculated to reduce US-averaged end-use load by ~39.3% (A separate companion study provides a grid integration analysis to support the plan.)

Conversions proposed are deemed both technologically and economically feasible with little downside and near elimination of energy-related pollution and greenhouse gas emissions. The study provides rigorous detailed estimates of 2050 state-by-state air pollution damage, climate damage, energy cost, solar rooftop potential, and job calculations, not previously available.

Job analysis – analyzing both production and loss – predicts net creation of ~2 million clean energy operation and maintenance jobs, with a net gain in annual earnings of ~\$85 billion per year. (p 2110)

In the proposed timeline for implementation, by 2020, there would be “no more construction of new coal, nuclear, natural gas, or biomass fired power plants; all new power plants are WWS.” (p 2110)

Based on 2050 energy estimates, remaining all-purpose annually-averaged end-use U.S. load is proposed to be met with 328,000 new onshore 5 MW wind turbines (providing 30.9% of energy); 156,200 off-shore 5 MW wind turbines (19.1%); 46,480 50 MW new utility-scale solar-PV power plants (30.7%); 2,273 100 MW utility-scale CSP power plants (7.3%); 75.2 million 5 kW residential rooftop PV systems (3.98%); 2.75 million 100 kW commercial/government rooftop systems (3.2%); 208 100 MW geothermal plants (1.23%); 36,050 0.75 MW wave

devices (0.37%); 8,800 1 MW tidal turbines (0.14%); and 3 new Alaska hydroelectric power plants. (pp 2114-2115)

The 2013 business costs of hydroelectric, onshore wind, utility-scale solar, and solar thermal collectors for heat are already similar to or less than the costs of natural gas combined cycle. By 2050, the business costs of conventional fuel are expected to rise and the costs of all WWS technologies are expected to drop, most significantly for offshore wind, tidal, wave, rooftop PV, CSP, and utility PV. (p 2115)

The state roadmaps will reduce US air pollution mortality by ~62,000 (19,000-115,000) in current figures and by ~46,000 (12,000-104,000) in 2050, which would avoid ~\$600 billion (\$85 billion to \$2.4 trillion) per year (2013 dollars) in 2050, a sum equivalent to ~3.6% of the 2014 US GDP.

Converting would also eliminate ~\$3.3 trillion per year in 2050 global warming costs due to US emissions.

Recommended first policy steps include: Expanding Renewable Energy Standards and Energy Efficiency Resource Standards; incentivizing conversion to heat pumps and solar thermal hot water heaters; incentivizing efficient lighting in buildings and on streets; promotion of efficiency technologies; revising building codes as new technologies become available; incentivizing landlord investment in efficiency; introduction of a Public Benefit Funds program; increasing Renewable Portfolio Standards (RPS); extending or creating state WWS production tax credits; streamlining small-scale solar and wind installation permitting process and creating common codes, fee structures, and filing procedures across the state; requiring utilities to use demand response grid management; incentivize the growth of clean transit, including rail and shifting of freight from trucks to rail; ease installation of electric charging stations permitting processes; set up time-of-use electric rates; promoting public transit; and increasing safe biking and walking infrastructure.

State planning and incentive structures should “Lock in in-state fossil fuel and nuclear power plants to retire under enforceable commitments. At the same time, streamline the permit approval process for WWS power generators and high-capacity transmission lines.” (p 2114)

States should also work with local and regional governments to manage zoning and permitting issues or pre-approve sites to reduce the cost and uncertainty of projects; create a green building tax credit program for the corporate sector; and create energy performance rating systems with minimum performance requirements to assess energy efficiency levels across the state and pinpoint areas for improvement.

The timeline for a renewable energy transition is: 80% by 2030 and 100% by 2050. For the transition to succeed, conversions to WWS need to occur rapidly. But if followed, implementation in the US – and implementation of similar schemes in other countries – it “will eliminate energy-related global warming; air, soil, and water pollution; and energy insecurity.” (p 2115)

“Based on the scientific results presented, current barriers to implementing the roadmaps are neither technical nor economic. As such, they must be social and political. Such barriers are due partly to the fact that most people are unaware of what changes are possible and how they will benefit from them and partly to the fact that many with a financial interest in the current energy

industry resist change. However, because the benefits of converting (reduced global warming and air pollution; new jobs and stable energy prices) far exceed the costs, converting has little downside.”]

FORTUNE: Korosec, Kirsten, In U.S., there are twice as many solar workers as coal miners, Fortune Magazine, Jan 16, 2015. <http://fortune.com/2015/01/16/solar-jobs-report-2014/>.

[Solar employs 2 X as many people as coal mining in the US and has added 50% more jobs in 2014 than the oil and gas pipeline construction industry and the crude petroleum and natural gas extraction industry did combined, the Solar Foundation reports.]

GUARDIAN: All electricity in Austria’s largest state now produced from renewables, Guardian, Nov 5, 2015. <http://www.theguardian.com/world/2015/nov/06/all-electricity-in-austrias-largest-state-now-produced-from-renewables>.

[Austria’s largest state announced on November 5, 2015 that 100% of its electricity is now generated by renewable energy. Erwin Proell, premier of Lower Austria, said “We have invested heavily to boost energy efficiency and to expand renewable.” The investment has created 38,000 green jobs, which the state aims to increase to 50,000 by 2030. Austria as a whole voted against nuclear power in a referendum and now gets 75% of its power from renewables.]

HEINRICH BÖLL STIFTUNG: Schneider M and Froggatt A, World Nuclear Industry Status Report 2015, Mycle Schneider Consulting Project report for Heinrich Böll Stiftung Foundation; National Resources Defense Council (NRDC); and Schweizerische Energie-Stiftung Foundation Suisse De L’Energie, Jul 2015. www.worldnuclearreport.org/IMG/pdf/201507wnsr2015-v1-hr.pdf

[Primary authors are Mycle Schneider (Paris, France) and Antony Froggatt (London, UK), independent energy consultants. Contributors are Julie Hazemann, Director of EnerWebWatch (Paris, France); Tadahiro Katsuta, Assoc. Professor, School of Law, Meiji University (Tokyo, Japan); M.V. Ramana, Nuclear Futures Laboratory & Program on Science and Global Security, Woodrow Wilson School of Public and International Affairs, Princeton University (US); and Steve Thomas, Professor for Energy Policy, Greenwich University (UK).

Nuclear power continues to decline in energy markets. Most new construction has experienced cost escalation and delays. Five units have been listed as “under construction” for over 30 years. AREVA, the French nuclear giant, is technically bankrupt, downgraded by Standard & poor’s to “junk” status.]

NC CLEAN ENERGY TECHNOLOGY CENTER: Going Solar in America: Ranking Solar's Value to Consumers, Report of the North Carolina Clean Energy Technology Center with the support from the U.S. Department of Energy SunShot Initiative, Jan 2015.

http://nccleantech.ncsu.edu/wp-content/uploads/Going-Solar-in-America-Ranking-Solars-Value-to-Customers_FINAL1.pdf.

[Solar, as of January 2015, could be more economical choice for energy consumers in 42 of America's largest cities. Due to the falling price of solar installations, a fully financed solar PV system would cost average residential consumers less than they would pay for electricity from their current local utility.

New York City and Boston top the list. Washington D.C. is ranked no. 6. number also in Other cities in the top ten are Albuquerque, San Jose, Las Vegas, Washington D.C., Los Angeles, San Diego, Oakland and San Francisco. Existing high local energy costs account for some of the economic benefits of solar.

Some 9.1 million single-family homeowners in the 50 cities investigated live in a location where buying a solar system outright would cost less than their current utility bill over the life of the system. Additionally, 21 million homeowners would paying less if low-cost financing were available via a 100% financed purchase at 5% interest over 25 years, the average life of current solar PV systems.]

NEW YORK TIMES: Reed, Stanley, Clean Energy Dreams in an Increasingly Electrified World, New York Times, Dec 11, 2015.

<http://www.nytimes.com/2015/12/11/business/energy-environment/wood-burning-british-power-plant-is-emblem-of-an-industry-at-a-carbon-crossroads.html>.

[Big, old-line electricity producers like Drax, which runs coal plants in the UK, are scrambling to remain relevant and financially viable.

New forms of power production might render obsolete the whole notion of a big electric utility providers — whether future electricity comes from many smaller-scale wind or solar sources, or from new technologies. (Bill Gates and other philanthropists announced creation of the Breakthrough Energy Coalition at the 2015 Paris Climate Conference.)

“‘If you change the underlying economics of an industry, you change the structure of the companies,’ said Dieter Helm, a professor of energy policy at the University of Oxford. ‘That is why you see the writing on the wall for the big utilities.’”

Some big European energy companies are adapting.

A flagging demand for fossil-fuel energy has led the Italian utility Enel to permanently shut two dozen conventional power plants. Enel now has 600,000 customers generating their own power from solar panels and wind turbines. On sunny or windy days, the customers send power to the grid. When it is dark or calm, Enel provides the electricity. The company no longer views itself as a power plant operator. Instead, Enel's chief, Francesco Starace, said, “‘We are providers of energy.’”

NEW YORK TIMES: Eddy, Melissa, Germany's Approach to Reducing Fossil Fuel Use May Be Global Model, New York Times, Dec 4, 2015.

<http://www.nytimes.com/2015/12/04/world/europe/germany-may-offer-model-for-reining-in-fossil-fuel-use.html>.

[Since 2000, Germany, the world's 4th largest economy, has committed itself to a program known as the Energiewende, or Energy Transition. The program involves developing new clean energy sources, reducing consumption, phasing out nuclear power and investing in a low-carbon future.

Across party lines and with strong public support, German governments have passed laws and set regulations encouraging the production of solar, wind and bioenergy and energy efficiency.

Energiewende has been used as an opportunity for some companies to expand their product markets. For example Schüco, one of Germany's oldest window companies, also designs low-energy doors and facades. Andreas Engelhardt, the company's chief executive, said high-greenhouse gas emitter countries like China and India, which are plagued by air pollution, rank have a growing interest in sustainable, environmentally friendly buildings.

Dirk Messner, a member of the German Advisory Council on Global Change, which advises the government, recalls that when Germany announced the phase-out of all its reactors after Fukushima in 2011, "There were many at the time who considered this a wacko-green idea."

But the German Energiewende – or Energy Transition – has resulted in an unprecedented shift to renewable and energy efficiency. In 2014, Germany reached a milestone by reducing its overall energy consumption while still recording economic growth.

The share of renewables has continued to rise as the use of other fuels falls — all while tempering the concerns of industry about rising costs and maintaining global competitiveness.

"Germany is the first country in the world to show they can uncouple growth from burning of fossil fuels," said Jim Yong Kim, president of the World Bank. "This is the main task of our generation.""]

NEW YORK TIMES: Krauss, Clifford and Diane Cardwell, In Texas, Night Winds Blow In Free Electricity, New York Times, Nov 9, 2015.

<http://www.nytimes.com/2015/11/09/business/energy-environment/a-texas-utility-offers-a-nighttime-special-free-electricity.html>.

[Texas wind farms are generating so much electricity some utilities are giving power away.

TXU Energy is one company at the vanguard of an attempt by utilities to change how people consume energy. TXU's free overnight plan is coupled with slightly higher daytime rates. The simple goal is for customers to use less energy during peak use times when wholesale prices are highest and more when winds blow strongest and prices are lowest.

Texas runs its own electricity grid so the abundance of nightly wind power generated in Texas must be consumed in Texas. By encouraging energy use at night, utilities reduce some of the burdens, and costs, that the oversupply of wind power puts on the power grid.

Omar Siddiqui, Director of Energy Efficiency at the Electric Power Research Institute, an industry group, describes the arrangement as “a proverbial win-win for the utility and the customer.”

Similar market experiments are being conducted elsewhere. In Maryland, Baltimore Gas & Electric gives rebate credits for every kilowatt-hour less customers use during certain high-demand times. Opower, which manages similar programs for a number of utilities, runs program. In Worcester, Mass., National Grid has installed a home energy management system from Ceiva Energy in ~11,000 homes, connecting devices like smart plugs, high-tech thermostats and digital picture frames that display the home’s energy use. In Italy, Enel, a leading utility, provides incentives to customers who keep electricity use below a predetermined level at times of highest demand.

But Texas represents the biggest energy market experiment and “time of use” plans are growing in popularity, according to the Electric Reliability Council of Texas (Ercot), the operator of the Texas power grid.

The Texas experiment is facilitated by recent and nearly universal distribution of residential smart meters that can receive and transmit data on electricity. “Texas is head and shoulders above everybody else with really unique packages for the consumer,” said Soner Kanlier, a retail energy markets expert at DNV GL, a consulting firm based in Oslo, Norway.”

“‘You can be green and make green,’ said Scott Burns, senior director for innovation at Reliant Energy, which has plans to offer incentives to increase night and weekend electricity use.”

“‘The American consumer wants choice,’ said Jim Burke, TXU’s chief executive. ‘Consumer choice, with its impacts and benefits, will drive the future of the power industry.’ But he quickly added a note of caution: ‘I think the pace at which it evolves is the unknown.’”

Some utilities in other markets have resisted market innovation because they have little financial incentive to use new data source capability in creative ways and do not want to lose revenue to renewable energy sources.]

NEW YORK TIMES: Abrams, Rachel, Procter & Gamble to Run Its Factories With Wind Power, New York Times, Oct 20, 2015.

<http://www.nytimes.com/2015/10/20/business/energy-environment/procter-gamble-to-run-its-factories-with-wind-power.html>.

[The global consumer products giant Procter & Gamble is teaming up with EDF Renewable Energy to build a wind farm in Texas that will power all of its North American plants that manufacture home care and fabric products. The move is the latest in “a burst of partnerships between major American corporations and renewable energy companies.”

“More and more, we find a very large number — call it two-thirds of consumers — looking to make some kind of contribution in the space, and hopefully not making trade-offs in value or performance,” said Shailesh Jejurikar, president of P.&G.’s North American fabric care division.”

The wind farm is estimated to produce 370,000 megawatt-hours of electricity a year. P.&G.’s North American fabric and home care facilities use about 300,000 megawatt-hours each year. So the company will net power to the grid.

This year, 81 US companies – including Hewlett-Packard, Kaiser Permanente and Dow Chemical – have announced plans to buy renewable energy.]

SYNAPSE ENERGY ECONOMICS and LABOR NETWORK FOR SUSTAINABILITY (LNS) and 350.ORG: The Clean Energy Future: Protecting the Climate, Creating Jobs and Saving Money, Synapse Energy Economics report for Labor Network for Sustainability and 350.org, Oct 2015. http://www.labor4sustainability.org/wp-content/uploads/2015/10/cleanenergy_10212015_main.pdf. Technical appendix at http://synapse-energy.com/CEF_Appendix.

[The report was prepared by the Labor Network for Sustainability and 350.org, with research conducted by a team led by economist Frank Ackerman of Synapse Energy Economics, a research and consulting firm.

The report presents plan backed by technical and economic data for the US to reduce greenhouse gas emissions by 80% by 2050 and saving Americans \$78 billion in electrical, heating, and transportation costs, while adding 500,000 new jobs a year.

The plan involves transforming the electrical system by 50% elimination of coal-fired power in 2030 and total elimination of coal by 2050, reduction of the use of natural gas far below business-as-usual levels, and no new nuclear build.

The plan uses current trends and does not rely on any new technical breakthroughs.

Analysis shows strong net employment gains – especially in manufacturing and construction – to more than offset losses in extractive fuel industries like mining. Such new jobs tend to have higher wages and better benefits than average. Manufacturing and construction also provide a high proportion of better jobs held by people of color, thus expansion of those sectors will help counter inequality within the American labor market.

The report advocates deliberate policies to create new high quality work pipelines, especially for groups which have been most excluded by the current economy. “Climate protection strategy should be designed to provide the maximum number of good, secure, permanent jobs with education, training, and advancement that provide maximum possible improvement in our job shortage. The deterioration in the quality of jobs is directly related to the reduction in the size and bargaining power of labor unions; reinforcing the right of workers to organize and bargain collectively should be an explicit part of public policy for climate protection.” (p 14)

Authors note that a “Clean Energy Future also opens up a wide range of opportunities for creating a more democratic economy and society. It allows for a less top-down and more

distributed energy system. It provides many opportunities for local economic initiatives, ranging from energy coops to locally –and community-based enterprises of many kinds.” (p 15) The clean energy pathway will challenge the power of the some industries. But the opportunity presented by climate action to reduce the dominance of big energy in the political system should not be squandered.

The report ends with the question: “The Clean Energy Future represents a pathway away from climate destruction that is also far better for workers and consumers than our current pathway based on fossil fuels. Should we let greed and inertia prevent us from taking it?” (p 15)]

UNIVERSITY OF CAMBRIDGE UNIVERSITY and PWC: Financing the Future of Energy: The opportunity for the Gulf’s financial services sector, University of Cambridge and PwC (PricewaterhouseCoopers) report for the National Bank of Abu Dhabi, Mar 2015.
https://www.nbad.com/content/dam/NBAD/documents/Business/FOE_Full_Report.pdf.

[Report presents evidence behind the changing nature of the global energy system, highlighting the growing demand for sustainable energy in the Gulf region, the technologies most likely to supply demand, and the scale of financing needed.

Forward by Alex Thursby, Chief Executive of the National Bank of Abu Dhabi (NBAD), states: “Some of the report’s findings may surprise you, as they did me. For example, renewable energy technologies are far further advanced than many may believe: solar photovoltaic (PV) and on-shore wind have a track record of successful deployment, and costs have fallen dramatically in the past few years. In many parts of the world, indeed, they are now competitive with hydrocarbon energy sources. Already, more than half of the investment in new electricity generation worldwide is in renewable. Potentially, the gains to be made from focusing on energy efficiency are as great as the benefits of increasing generation.” (p 2)

The scale of the opportunity is large. The investment required for power generation, transmission and efficient use of energy is in the order of “hundreds of billions (possibly a trillion) US dollars per year worldwide.” (p 3) In recent years “over 50 per cent of investment in new generation has gone – and continues to go – into renewable. This has amounted to an average of US\$260 billion a year worldwide over the past five years.” (p 13) This trend is projected to increase. For example, China has a target to generate 70,000 mw of solar power by 2017.

Solar photovoltaic (PV) has fallen in cost by 80% in the past 6 years and on-shore wind has fallen by 40%. Solar is on track to achieve grid parity in 80% of countries within 2 years “so cost is no longer a reason not to proceed with renewable.” (pp 6 & 28)

“Wind power is on its way to similar levels of competitiveness.” (p 28) Modern wind turbines produce 15 X more electricity than the typical wind turbine did in 1990.

“The decline in costs of renewable has been so rapid that, in many cases, the finance sector is using outdated perceptions on the relative prices of fossil fuel and renewable energy supplies.” (p 14) Moreover once built, renewable generation has no variable fuel cost.

The historic concern over intermittency is increasingly proving to be less of an issue. Modern grids can manage up to 40% of renewable easily, reducing the need for back-up gas

generation. Developments in storage technologies are progressing rapidly and in the next few years, utility scale solutions will minimize intermittency concerns. Building renewable energy technology supply chains and capacity within the region will also open opportunity to export expertise and deliver solutions elsewhere.

“Governments have a continued contribution to make, from establishing Power Purchase Agreements or procurement frameworks that enable new technologies to be deployed at scale and drive down costs. Plus the key contribution of Governments is to provide the longer term certainty that is a prerequisite for new project development.” (p 5)

The transition to a new energy future that powers a sustainable economy that improves quality of life for citizens will require innovations including renewable and high efficiency. The transition to this new energy future will be gradual. “But making the transition smoothly requires strategic decisions in the short term – over the next five to ten years – to avoid locking the energy system into further investments that will need to be rethought as unavailability of competitively priced conventional fuel sources mounts and environmental sustainability becomes an increasingly important performance criterion.” (p 6)

Part of the potential of solar PV technology is its flexibility and adaptability: suited to decentralized and off grid situations.

“New research in 2014 by scientists at Lawrence Berkeley National Laboratory reported that it costs utilities just US\$ cents 2.1 in total to reduce energy demand by 1kWh. This is less than half the cost of producing the same amount of electricity at a power plant.” (p 36) Moreover, early evidence from US efficiency programs show that every \$1 spent on efficiency programs, delivers \$4 of benefits. (p 36)

Globally, the economic development of the “West-East Corridor” – the super-region that stretches from Africa through the Middle East to Asia – is of particular importance because this is where the largest amount of new demand will come from. The West-East Corridor is characterized by the rise of new megacities, rapid industrialization and increasing middle class expectations. Many of these nations have large populations often living in off-grid situations. These countries are looking for different kinds of solutions and “there is a huge opportunity to leapfrog traditional approaches to developing energy systems, moving immediately to cutting edge technologies, more cost-efficient and decentralized systems, and applying more innovative approaches to finance these developments.” (p 4) “Renewable energy technologies that can realize these opportunities are proven, cost-effective and available today.” (p 4).

Support for renewable energy can also have “significant positive domestic economic, social and environmental benefits.” (p 23)]

WIRES ENERGY AND ENVIRONMENT: Hohmeyer OH and Bohm S, Trends Toward 100% renewable electricity supply in Germany and Europe: a paradigm shift in energy policies, WIREs Energy and Environment (2015); 4 (1): 74-97.
<http://onlinelibrary.wiley.com/doi/10.1002/wene.128/full>

[As industrialized European nations like Germany seek to move away from fossil fuel and nuclear power, the question arises, whether it will be possible to supply 100% of all necessary electricity from renewable energy sources? Authors find that a fast expanding volume of

analyses demonstrate the feasibility and reliability of 100% renewable electricity supply systems. “This fast mounting evidence appears to mark the beginning of a paradigm shift in energy politics The example of the highly publicized study of the German Council of Environmental Advisors shows how a 100% renewable electricity system for Germany, Europe, and North Africa could look in 2050 and how the transition toward such a system could be achieved.” The German Council of Environmental Advisors study (in which the authors had major involvement) is used to show the major aspects of a 100% renewable electricity supply system, including security of supply in every hour of the year, compensation of intermittent sources such as wind and solar PV energy by other renewables and expanded storage, and the extension and upgrade of grid infrastructures.]

2014

ALBANY UNIVERSITY: Perez R, Comparing the World’s Energy Resources: Where Should We Invest for the Long Haul? Slide on webpage Richard Perez, PhD, of the Atmospheric Sciences Research Center, The University at Albany. (accessed from web Apr 2014)

<http://www.asrc.cestm.albany.edu/perez/publications/Other%20Papers%20and%20Applications/parkings.pdf>

[This slide was prepared by Richard Perez, PhD, of the Atmospheric Sciences Research Center, The University at Albany. <http://asrc.albany.edu/people/faculty/perez/>. The diagram shows the enormous enduring energy potential of solar power.]

ARIZONA DAILY INDEPENDENT: Navajo Nation wins \$5 billion settlement in uranium mine case, Arizona Daily Independent, Apr 7, 2014.

<http://www.arizonadailyindependent.com/2014/04/07/navajo-nation-wins-5-billion-settlement-in-uranium-mine-case/>

[Anadarko Petroleum Corp and its former parent Kerr-McGee Corp agree to pay \$5.15 billion for abandoned uranium mine cleanup in the northern and eastern agencies of the Navajo Nation. The Nation is one of several claimants in the case, which also includes the Department of Justice, 22 states, and several environmental response and tort trusts. The Navajo Nation plans to use its percentage of the settlement – about \$1 billion – to help cleanup 49 abandoned uranium mines that were owned by Kerr-McGee. Some 460 other cleanup sites remain unfunded.]

ASSOCIATED PRESS: Fahey, Jonathan, Home electricity use in U.S. falling to 2001 levels, Associated Press, Jan 5, 2014.

http://www.denverpost.com/business/ci_24843691/home-electricity-usage-u-s-falling-2001-levels

[The US Energy Information Administration reports that the average amount of electricity consumed in US homes during 2013 has fallen to levels last seen in 2001. The Energy Department predicts average residential electricity use per customer will fall again in 2014, by 1%.

The reason is use of more energy-efficient housing, appliances and gadgets. In the early 2000s more states adopted or toughened building codes to force builders to build more energy efficient homes. In addition insulated windows and other building technologies have dropped in price. As a result of federal energy standards and developing technology, appliances and systems like air conditioners, refrigerators, dishwashers, water heaters, washing machines and dryers became more efficient.

Lighting efficiency standards have also changed the equation. Compact fluorescent and LED light bulbs use 70 to 80 % less power than the old incandescent bulbs. Some 40" LED televisions use 80 % less power than old TVs, with some using less than a 60 watt incandescent bulb would use.

According to the Energy Department, widespread use of LEDs could save the energy equivalent of 44 large power plants by 2027.

While people use more electric devices, the move to mobile has had the effect of reducing consumption. Laptops, tablets and smartphones use less power than desktop computers.]

BUSINESS INSIDER: Wile, Rob, GOLDMAN: Solar Is On The Way To Dominating The Electricity Market, And The World Has Elon Musk To Thank, Business Insider, Mar 18, 2014. <http://www.businessinsider.com/goldman-on-solar-and-elon-musk-2014-3>.

[Report on Goldman Sachs analysis (with quotes from report). Goldman Sachs estimates residential solar power will become competitive with existing electric power generation across the US relatively soon. Even with some renewable energy stalls, the cost of solar panels continues to fall. Goldman estimates "This puts LOCE at \$0.20 by 2033 which would be at parity with the US grid price" and this could happen even sooner in New York, California, and Hawaii, where electricity is more expensive. In addition, the Goldman report postulates, "decreased reliability from an aging distribution infrastructure, a broadening desire to reduce the carbon footprint and most importantly, the reduction of solar panel and battery costs could also work together to make grid independence a reality for many customers one day." Goldman views the potential market for solar as very large.]

BUSINESSWEEK: Patel, Tara, EDF Curbs Nuclear Generation to Allow for Wind and Solar on Grid, Bloomberg Businessweek, Mar 19, 2014. <http://www.businessweek.com/news/2014-03-19/edf-curbs-nuclear-generation-to-allow-for-wind-and-solar-on-grid>.

[Electricite de France SA (EDF), the world's biggest nuclear operator, is being forced to cut energy generation from its nuclear reactors to avoid overload of the grid. "As European countries add more renewable sources such as wind and solar parks, plants that produce atomic or fossil-fueled power are having to suspend output to avoid overloading the grid."]

CHICAGO TRIBUNE: Wernau, Julie and Alex Richards, As Exelon Threatens to shut nuclear plants, Illinois town fears fallout, Chicago Tribune, Mar 9, 2014.

http://articles.chicagotribune.com/2014-03-09/business/ct-exelon-closing-nuclear-plants-0308-biz-20140309_1_quad-cities-plant-byron-plant-exelon/3.

[A Chicago Tribune analysis found that several nuclear plants operated by Exelon, the nation's largest nuclear plant operator and parent of Commonwealth Edison, haven't made enough money to cover operating and ongoing capital costs since 2008. Exelon stated in Feb 2014 that it will announce plant closings by the end of 2014 if market conditions don't improve. In recent years, a boom in wind power cheap natural gas and have driven down electricity prices, eroding nuclear power's profits.

Travis Miller, director of utilities research at Chicago-based Morningstar, told the Chicago that nuclear has "lost a lot of its cost advantage when you consider the amount of capital investment it requires."

Exelon's Quad Cities and Byron plants "have been hit the hardest by 'negative' price conditions, meaning Exelon paid the operator of the electric grid to take its power. Because nuclear plants have to operate around the clock, they have to continually producing power. In 2012, Quad Cities plant was paying the grid operator to take its power 8% of the time. The Clinton plant is vulnerable because it sells electricity to a market "that's flush with cheap electricity generated by wind turbines."

"Once a wind turbine is constructed, the cost to run it is minimal, regardless of subsidies."

"The real impact of wind energy on electricity markets is that it displaces a more expensive, polluting source of energy with zero-fuel-cost wind energy, driving down electricity prices and saving consumers money," said Michael Goggin, senior electric industry analyst for the American Wind Energy Association."]

CLIMATE PROGRESS: Kroh, Kiley, Germany Sets New Record, Generating 74 Percent Of Power Needs From Renewable Energy, May 13, 2014.

<http://thinkprogress.org/climate/2014/05/13/3436923/germany-energy-records/>.

[In the first quarter of 2014, renewable energy produced 40.2 billion kilowatt hours of electricity in Germany – 27% percent of the country's electricity demand. On one day renewable produced 74% of the nation's electricity.]

CLIMATE PROGRESS: Phillips, Ari, The Toxic Metal Keeping Your Car Running Could Soon Be Recycled To Power Your House, Climate Progress, Aug 21, 2014. Climate Progress, Aug 2014. <http://thinkprogress.org/climate/2014/08/21/3473796/lead-car-batteries-recycled-solar-cells/>.

[Reporting on advances made by MIT researchers and others of developments that could pave the way for economic, large-scale solar cell technology.

A newly-harnessed material called perovskite and a new system proposed by MIT researchers proposes recycling lead from car batteries that would otherwise be discarded to build solar panels. The system is based development of solar cells using crystalline structures called

perovskite. Composed primarily of calcium titanate, perovskite is found in deposits all over the world.

“Once the battery technology evolves, over 200 million lead-acid batteries will potentially be retired in the United States, and that could cause a lot of environmental issues,” said Angela M. Belcher, co-author of the paper which was published in the journal Energy and Environmental Science.”

According to Belcher, the lead perovskite photovoltaic cells have achieved power-conversion efficiency of over 19%, close to that of many commercial silicon-based solar cells. However, making solar cells from perovskite would be cheaper and easier. {*link to demonstration video.*}

The MIT researchers estimate a single car battery could produce enough solar panels to provide electricity to 30 homes. After the panels run through their lifecycle, the material can be recycled into new panels. “Although with solar panel technology accelerating at breakneck speeds, it’s hard to know what panels will be made of 20 or 30 years down the road.”

Perovskite could also be used as a spray-on solar cell, a process recently developed by researchers at the University of Sheffield. The spray is only 11% efficient, but it is cheap to make and could benefit from economies of scale in large-scale panel manufacture.]

CRAIN’S: Geiger, Daniel, Con Ed ups its energy-saving incentives, Crain’s New York Business, Mar 17, 2014.

http://www.crainsnewyork.com/article/20140317/REAL_ESTATE/140319884/con-ed-ups-its-energy-saving-incentives.

[Energy efficiency programs being implemented in advance of the expiration of Indian Point Energy Center’s license in 2016 include major incentives offered to major landlords who cut their electrical consumption during peak hours in the summer. In addition to energy savings incentives, Con Ed is increasing the amount of money given to landlords who invest in energy-efficient building systems that will help them reduce their consumption. Incentives, in part, are encouraging equipment that will shift the energy load to alternate times of the day when consumption is lower.]

DEPARTMENT OF ENERGY: Letter from Peter W. Davidson, Executive Director Office of Loan Programs, Department of Energy, to Earl Long, Assistant Treasurer, Georgia Power Company, Feb 11, 2014. http://www.eenews.net/assets/2014/04/21/document_gw_04.pdf

[Department of Energy letter to Georgia Power Company discussing subsidies for a nuclear site. The letter says DOE “is pleased to provide” Georgia Power with a credit subsidy fee of \$0 in connection the DOE’s \$3.4 billion loan guarantee to the Vogtle nuclear project.]

DW: Fuchs, Richard, Germany boosts wind power at green energy summit, DW, Apr 2, 2014. <http://www.dw.de/germany-boosts-wind-power-at-green-energy-summit/a-17536470>

[German state and federal politicians agreed on reforms to Germany’s Renewable Energy Act at an April 2014 summit in Berlin. Compromise between divergent interests included an agreement

to drop proposed limits on the country's wind power facilities, affirmation of the 2,500 megawatt yearly wind goal and a decision to replace old wind turbines with new, more efficient models.]

DW: Virtual Power Stations – A Boost for the Transition To Renewables? DW broadcast, Mar 25, 2014. <http://www.dw.de/virtual-power-stations-a-boost-for-the-transition-to-renewables/av-17519830>.

[Small scattered renewable energy generation across a region can be combined to form one big networked utility. New technologies like this are playing a significant role in Germany's long-term energy plan.

A refurbished old factory building in Cologne, Germany is the site of a “virtual” power plant. The plant has no generator, no turbines, just computers which serve as a data processing center calculating electricity output.

The output comes from more than 1000 small facilities – including many farms – that have solar roofs, wind turbines, and biogas generators. “Together they are as powerful as a nuclear plant.”

A box at the Cologne factory connects the computer systems at all the mini renewable-generating facilities in the region to a mainframe which adds up the electricity. A box communicates through a modem. The modem receives data from and sends signals to a guidance system, which, in turn controls energy flows.

The virtual power plant in Cologne was the brainchild of two young economists who came up with the idea 5 years ago. They sought a clean energy way to make up for temporary fluctuations in the power grid and realized a lot of separate small renewable energy sources could be networked to even out fluctuations and take over the same output that conventional plants provide. And the idea worked. By 2014 the project resulted in the trade of some 100 million euros worth of electricity and is making a profit.

Biogas makes up an important building block in this much larger complex. Biogas's main advantage is the controllability of power production and storage. But electricity from biogas is the most expensive of the renewable energies. For the German farmers, biogas is made economical because they get access to the energy market and derive compensation. The farms in the area also have solar roofs and wind turbines. A farmer interviewed drives an electric car powered by his farm.]

ENERGY & ENVIRONMENTAL SCIENCE: Chen P-Y, Qi J, Klug MT, Dang X, Hammond PT, and Belcher AM, Environmentally responsible fabrication of efficient perovskite solar cells from recycled car batteries, Energy & Environmental Science (2014); DOI: 10.1039/C4EE00965G. Abstract.
<http://pubs.rsc.org/en/content/articlelanding/2014/ee/c4ee00965g/Unauth#!divAbstract>.

[Researchers from the Massachusetts Institute of Technology report on discovery of a feasible way to recycle acid-lead car batteries to generate large-scale, cost competitive solar power. The process relies upon harness of a crystalline structured material called perovskite.

Organolead halide perovskite solar cells (PSCs) show great promise as a new large-scale and cost-competitive photovoltaic technology. The concern, so far, has related to the over-production of raw lead ore, which has harmful health and ecological effects.

The findings of the MIT group suggest an environmentally responsible and economic process to fabricate efficient PSCs by reusing car batteries to both avoid the disposal of toxic battery materials and provide alternative, practical and readily available lead sources for PSCs through assembly of perovskite films.]

ENVIRONMENT AMERICA RESEARCH & POLICY CENTER: Burr J, Hallock L, and Sargent R, Star Power: The Growing Role of Solar Energy in America, Report of the Environment America Research & Policy Center, Nov 20, 2014.
http://www.environmentamerica.org/sites/environment/files/reports/EA_Star_Power.pdf.

[Authors are analysts from Environment America Research & Policy Center and the Frontier Group.

Based on renewable energy technical potential reported by the National Renewable Energy Laboratory, the US has the potential to produce more than 100 times as much electricity from solar photovoltaic (PV) and concentrating solar power (CSP) installations as the nation consumes every year. Each of the 50 states has the potential to generate far more electricity from the sun than its residents consume. (See Figure 3, p 12.) Tens of millions of residential and commercial rooftops across the nation could host solar panels. (See Figure 4, p 15.)

Nationally, solar PV capacity increased at a rate of 77% per annum from 2010 – 2013. Were solar installations to continue increasing by just 22% from 2013 – 2030, America would be able to generate 10% of its electricity with solar power (see Figure 5, p 16), reducing the nation's global warming pollution by 280 million metric tons in 2030. Obtaining 10% of electricity from solar energy would also dramatically reduce power plant water consumption.

Solar energy creates local clean energy jobs that cannot be outsourced. Growth in the solar industry from November 2012 to November 2013 was 10 times faster than the national average for employment. More than 140,000 Americans worked in the solar energy industry in 2013.]

ENVIRONMENT AMERICA RESEARCH & POLICY CENTER: Burr J, Dutzik T, Schneider, and Sargent R, Shining Cities: At the Forefront of America's Solar Energy Revolution, Report of Environment America Research & Policy Center, Apr 2014.
http://www.environmentamerica.org/sites/environment/files/reports/EA_shining_cities_srn_0.pdf.

[Authors are analysts from Environment America Research & Policy Center and the Frontier Group.

Report (62 pp) details the exponential growth of solar energy, particularly photovoltaic (PV) panels. America's solar energy capacity tripled between 2011 and 2013. In 2013, the US passed the 12 gigawatt (GW) mark for solar capacity, with 4.74 GW being installed in 2013

alone. (p 16) An analysis by researchers with the National Renewable Energy Laboratory estimated that rooftop PV systems could generate more than 20% of the electricity used in the US each year. (p 36, citing Lopez A, *et al*, U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis, Technical analysis for National Renewable Energy Laboratory, Jul 2012.) “Every one of the 50 states has the technical potential – through both utility-scale and rooftop solar energy systems – to generate more electricity from the sun than it uses in the average year.” (p 36)

“Harnessing available rooftop potential is especially important for America’s cities, where millions of empty rooftops could be used to generate clean energy.” (p 36)

Innovations in manufacturing, growing economics of scale and the creation of new financing and business models are making solar increasingly accessible and less costly, with costs continuing to decline.

An example of how public policy can drive solar power expansion is Germany: “The cost per watt of an installed solar energy system in Germany is roughly half that of the United States due to a variety of factors, including larger average system size, but primarily due to lower ‘soft costs’ – cost such as those associated with attracting customers, installing the systems, completing paperwork, and paying taxes and permitting fees.” Reduction of such soft costs in the US can substantially boost solar energy. (15-16)

The report looks at 57 major cities which are leaders in solar PV and they are not necessarily cities that receive the most sunlight. “Cities where homeowners are paid a fair price for the energy they supply to the grid, where installing solar panels is easy and hassle-free, where there are attractive options for solar financing, and where there has been a strong commitment to support solar energy development, are seeing explosive growth in solar power.” (p 24).

There are a wide variety of policy initiatives that can drive the transition to clean power. Local and state governments can lead by example by installing solar power on government buildings and installations; sites which are also usually excellent candidates for PV. Governments can use their negotiating power to influence the investor-owned utilities that serve them. An example is New York City’s partnership with Con Edison. “In 2007, New York City was designated a ‘Solar America City’ by the U.S. Department of Energy (DOE), helping to kick off a collaboration between the City University of New York, Con Edison, The New York City Department of Builders, the New York State Energy Research and Development Authority (NYSERDA) and the DOE’s Solar America Cities program” Installed solar PV capacity in NYC then rose from 1 MW in 2007 to 8.1 MW in mid-2012. (pp 31-32) New York’s “NY-SUN Initiative” has helped place New York City in the top 20 cities for total installed solar PV capacity. (p 35)

Strong solar-specific renewable electricity standards (RES) in New Jersey and Delaware have enabled Newark and Wilmington to be national solar leaders. (p 32)

A powerful example of smart solar policy at work in a smaller city is New Bedford, Mass. Despite high levels of poverty and low average incomes, the city created an Energy Office in 2010 and adopted aggressive policies to promote renewable energy, energy efficiency, and environmental benefits. The city put solar installations on public buildings under a power purchase agreement with Con Edison Solutions, whereby the city buys and Con Edison Solutions owns the solar installations. New Bedford additionally created a “Clean Energy Results” program to promote solar farms on unusable “brownfields” – environmentally contaminated land – thereby creating a sustainable energy source from otherwise unusable

land. New Bedford contracted with Con Edison Solutions and Blue Wave Capital to construct one such solar farm on a brownfield site adjacent to a middle school and high school. The schools, in turn, are developing a clean energy curricula and connecting students to jobs in the solar industry. (p 23)

Energy market and financial management options can spur private investment. A crucial – and low cost – way to promote solar is through streamlining permitting and installation processes. (p 24)

Commercial Property Assessed Clean Energy (PACE) financing is a tool cities can use to make solar affordable. PACE enables property owners to invest in solar installation via financing from a specially created fund for clean energy projects. The loan is repaid through property tax bills over a number of years. This enables the property owner to install solar power with minimal upfront cost, while still assuring repayment of the loan even if the property changes ownership. Other financing mechanisms are Clean Local Energy Available Now (CLEAN) contracts and feed-in tariffs (FiTs), which give energy producers fixed and long-term contracts for solar electricity produced. (p 26) Other options that support solar and encourage distributed generation are net metering and interconnection standards.

These programs provide the additional benefits of reducing pollution, improving public health, saving water, and attracting solar jobs. Los Angeles' "100 MW Feed-in Tariff," for example is expected to create over 2,000 jobs in the city. A study of Colorado showed the state's solar industry created the equivalent of 10,790 full time jobs since 2007. (p 27, citing Solar Foundation, An Assessment of the Economic, Revenue and Societal Impacts of Colorado's Solar Industry, Oct 2013.)

Another option is community solar programs – also called Community Solar Gardens – which give every resident in a utility's service territory a viable option to fund solar. The actual solar projects are sited in areas ideally situated for solar. Customers are not necessarily technically connected to solar power, but they receive credit for the output of the solar project on their utility bills. These programs provide economies of scale and offer ratepayers low upfront costs. They are an attractive alternative for homeowners or renters who cannot site solar on their own properties. (p 30)]

FORBES: McMahon, Jeff, 3 Utilities Most Likely To Fall In Death Spiral, According to Morningstar, Forbes Op-Ed, Mar 27, 2014.

<http://www.forbes.com/sites/jeffmcmahon/2014/03/27/utilities-most-likely-to-fall-in-death-spiral-morningstar/>.

[Jeff McMahon is a Forbes contributor who covers energy, technology and the environment. Here he reports on a Morningstar analysis.

"Utilities that rely on nuclear fleets and speculative coal plants are most vulnerable to the solar-powered 'death spiral' roiling the electric industry, Morningstar analysts conclude in a report to institutional investors." Distributed generation (DG) is also posing a competitive threat to large centralized power forms of generation.

Morningstar's "Utilities Observer" report issued in Mar 2014 begins with the warning to investors that distributed generation (DG) could kill utilities unable to adjust to technologies such as rooftop solar. Century-old centralized networks will not be able to maintain their large-scale

competitive advantage as more and more customers adopt distributed generation. The most vulnerable corporations are Dynegy (coal), Exelon (nuclear), and Pinnacle West (holding company).

However other companies are repositioning themselves to survive and benefit from the opportunities created by distributed generation. These include NRG Energy and Edison International – traditional energy companies that have targeted investment in solar power and distributed generation – and SunPower, a solar module manufacturer and systems installer. States can help utilities transform. For example: “Regulators in Arizona, California, and Colorado have shown willingness to address DG, specifically net metering deficiencies.”]

FORBES: McMahon, Jeff, Steven Chu Solves Utility Companies’ Death Spiral, Forbes, Mar 21, 2014. <http://www.forbes.com/sites/jeffmcmahon/2014/03/21/steven-chu-solves-utility-companies-death-spiral/>.

[Jeff McMahon is a Forbes contributor who covers energy, technology and the environment. Here he reports on a presentation made by Steven Chu, PhD, former Energy Secretary and Nobel Prize winning physicist.

Dr. Chu said utility companies have been seeking regulatory protections and higher connection charges to save them from a “death spiral” spurred by a surge in rooftop solar installations.

The utilities, Chu said are in “a flat to shrinking business,” and as solar and batteries get cheaper and cheaper, they’re going to see their customer base go to solar.

Utilities are in danger of being “FedExed,” Chu said, the way the Post Office got FedExed.

Instead of blocking transformation, Dr. Chu urged utilities to adopt a better business model: “So I’m telling utility companies, this is coming down the line, so let’s think of a new business model where you can profit from this.” Chu advocates utilities invest in rooftop solar modules and batteries, then partner with private rooftop-solar installation firms to do the installation. Utilities could own the solar panels and batteries and sell electricity to the customers for a profit.

Customers would get both lower rates and solar power without having to pay for installation, and would further enjoy battery backup during power outages.

Utility companies would benefit from a reduced need to install new transmission lines. A distributed network of panels and batteries at the end of the distribution system would provide grid stability.

“Chu said he began talking to utilities about this issue in roundtable discussions two years ago. He said he has received three kinds of responses:

1. “Tell us what to do.
2. “Deer in the headlights.
3. “We’re going to fight this.”

“This is not a radical model,’ Chu said, ‘this is the old telephone system model, where the telephone companies owned the phone, they rented you the phone for so long, they maintained it.’”]

Fricke, Thomas, Climate and Competitiveness, Project-Syndicate.org, Mar 24, 2014.
<http://www.project-syndicate.org/commentary/thomas-fricke-argues-that-further-reductions-of-greenhouse-gas-emissions-could-save-european-industry>.

[The author, Thomas Fricke, is Chief Economist of the European Climate Foundation.

Empirical evidence shows that reducing carbon-dioxide emissions might help make industries *more* competitive. Germany, with some of the world's most ambitious climate policies, has doubled its exports since 2000. Even energy-intensive industries have grown, despite energy prices. "The reason is simple: there is more – much more – to competitiveness than energy prices. Indeed, estimates for Germany show that for most of its industrial base, energy costs account for a mere 1.6% of gross value added. Thus, even rapidly rising energy prices imply only a limited additional cost burden for firms."

Competitiveness cannot be understood through simplistic comparison of cost statistics. Factors like highly qualified labor and the benefits of being integrated into well-functioning clusters, likely play a more important role. The new paradigm should focus on finding ways to reduce CO₂ emissions in ways that ultimately help to produce better products at lower cost. This will also help businesses capture new markets in emerging countries.]

GLOBAL COMMISSION ON THE ECONOMY AND CLIMATE: Better Growth, Better Climate: The New Climate Economy Report: The Synthesis Report, Report of the Global Commission on the Economy and Climate, Washington, DC, Sep 2014.
<http://static.newclimateeconomy.report/TheNewClimateEconomyReport.pdf>. Overview at: <http://newclimateeconomy.report/overview/>.

[Report by the Global Commission on The Economy and Climate Change, an expert group appointed by the nations of Colombia, Ethiopia, Indonesia, Norway, South Korea, Sweden and the United Kingdom.

The key finding of the report is that tackling climate change would not be costly.

An ambitious series of measures to limit emissions would cost ~\$4 trillion over the next 15 years, but that is an increase of just ~5% over the amount that would likely be spent anyway on new power plants, transit systems and other infrastructure.

When the secondary benefits of greener policies – like lower fuel costs and improved human health – are taken into account, reducing emissions could save money.

The Commission urges nations to realize the potential of renewable forms of energy, the costs of which have been plunging so fast that most previous analyses of its potential role are out of date: "Renewable energy sources have emerged with stunning and unexpected speed as large-scale, and increasingly economically viable, alternatives to fossil fuels." (p)

The Commission also urges elimination of subsidies to fossil fuels, which amount to some \$600 billion a year. The report emphasizes the problem of economic policies around the world which continue to favor fossil fuels over renewable and energy efficiency and conservation. (In

Venezuela, for example, government subsidization enables gasoline to sell for ~6¢ a gallon, encouraging consumption.) Most notably, current subsidization of fossil fuels is over 6 times that given to renewable energy.

Halting destruction of forests, more efficient land use, and reducing wasteful urban sprawl and traffic congestion are also actions that have manifold benefits.

A concerted worldwide push to scale up ideas which have already proven successful could reduce greenhouse gases by billions of tons per year plus add to the quality of life. The likelihood is that ~\$90 trillion is likely to be spent over the coming 15 years on new infrastructure around the world no matter what. So the big challenge for governments is to adopt rules and send stronger market signals that direct that investment toward low-emission options.]

GREENPEACE: Energy Revolution 2014. A Sustainable USA Energy Outlook, Report by Greenpeace, May 2014.
<http://www.greenpeace.org/usa/Global/usa/planet3/PDFs/Solutions/Energy-Revolution-2014.pdf>.

Hayes, Denis and Scott Denman, As nuclear power dies, solar rises, CNN Op-Ed, Apr 22, 2014. http://www.cnn.com/2014/04/22/opinion/hayes-denman-solar-power/index.html?hpt=op_t1.

[Denis Hayes, an adjunct professor of engineering at Stanford University and former Director of the U.S. National Renewable Energy Laboratory (SERI), heads the Bullitt Foundation and is Chairman of the Board of the Energy Foundation. Scott Denman is the Director of the Independent Council for Safe Energy (Tides foundation/center).

Nuclear is “less and less cost effective”. The nuclear fleet is aging, dangerous and uncompetitive. New reactors are too expensive to build (a reason why 9 nuclear projects were scrapped in 2013). Solar, on the other hand is growing rapidly and adding far more new capacity to the grid.

Data on solar's growth actually underestimate the total contribution to our country's electrical supply from solar because nonutility and small-scale (residential and commercial rooftop) photovoltaic systems don't show up as electric generation in industry statistics. Utilities that compile generation statistics view rooftop solar electricity, used on site, not as power generation but as a reduction in demand.

A six-story green energy design office building {*Bullitt Center*} built in Seattle generated more electricity on its roof last during its first year of operation than it used. “If this can be done in Seattle, the cloudiest major city in the contiguous 48 states, it can be done anywhere.”]

HEINRICH BÖLL STIFTUNG: Morris C and Pehnt M, Energy Transition: The German Energiewende, Report of the Heinrich Böll Stiftung Foundation, Jan 2014 {revision of Nov 2012 report}. http://energytransition.de/wp-content/themes/boell/pdf/en/German-Energy-Transition_en_Key-Findings.pdf

[The share of renewable electricity in Germany rose from 6% to nearly 25% in only 10 years. On sunny and windy days, solar panels and wind turbines supply up to half the country's electricity. Despite skepticism, Germany is on track to attain more than 40% of its power from renewable by 2020. The German Renewable Energy Act guarantees priority grid access to all electricity generated from renewables, and empowers local communities and small and midsize businesses to generate their own renewable energy. "Across Germany, a rural energy revolution is underway." (p 1) Communities are benefiting from new jobs and increasing tax revenues.

"Unlike coal and nuclear power, the costs for renewable are not hidden and passed on to future generations, but transparent and immediate. The government sees its role as setting targets and policies; the market decides how much is invested in renewable and how the price of electricity develops. Consumers are free to choose their power provider so they can buy cheaper electricity or switch to a provider with a 100% renewable portfolio." (p 2)

In 2013, more than half of the investments in renewables came from small investors.

More than 380,000 Germans work in the renewals sector – far more than in the conventional energy sector. Some of these are manufacturing jobs, many others are in installation, maintenance, architecture, etc. The energy transition is not only about switching to clean generation, but about efficiency, construction and design. Germany is a global leader in green architecture.

Wind and solar energy have also driven down wholesale power market prices. "The demand for solar panels, wind turbines, biomass and hydro power plants, battery and storage systems, smart grid equipment, and energy efficiency technologies will continue to rise. Germany wants to gain a first-mover advantage and develop these high-value engineering technologies 'Made in Germany.'" (p 2) German firms will be well positioned to deliver the technology, skills and services for emerging and expanding renewable markets. The German industrial giant Siemens has eliminated nuclear from its global portfolio and is focusing on wind and hydropower.]

JOURNAL NEWS: 'Capacity zone' to zap utility bills, Journal News Editorial, Apr 29, 2014. <http://www.lohud.com/story/opinion/editorials/2014/04/28/energy-capacity-zone-new-york-hudson-valley/8428155/>.

[A New York Independent System Operator (NYISO) plan to create an "energy capacity zone" would allow power companies in the New York City to mid-Hudson region to charge more during peak usage periods. "Local energy generators can charge more for a scarce commodity, compared to suppliers who would transmit cheaper, more plentiful energy from upstate and western New York generators."

The NYISO "is using a simple calculation for a complex problem."

Critics note the problem is not just generation, but transmission. "There's inadequate infrastructure to get the gobs of electricity generated upstate to heavy users downstate." Gov.

Andrew Cuomo's Energy Highway initiative aims to get power downstate where it's needed. The NYISO has not properly considered the impact of transmission improvements.

"The new capacity zone undermines efforts to employ energy production upstate to feed a dearth of energy generation downstate, which could help boost the perpetually struggling upstate economy; it also holds no guarantees that it will spark interest in developing more energy generation downstate."

The new capacity zone, energy experts predict, could drive up utility bills for consumers and business, respectively, by 10% and 18%. The "big winner" would be Entergy, owner of Indian Point, which will be able to charge more "without adding a kilowatt".]

Kanellos, Michael, Folsom Labs: Another Example Why Solar Is The Future, Forbes Op-Ed, Jan 13, 2014. <http://www.forbes.com/sites/michaelkanellos/2014/01/13/folsom-labs-once-again-shows-why-solar-is-the-future/>.

[Author, Michael Kanellos, is a technology writer and Forbes contributor is vice president at Eastwick Communications.

Ultimately economics will drive energy markets and make solar a major delivery leader. "Why does a software tool like this mean solar will become the default choice of energy in the future? Unlike most other energy and cleantech markets, solar is horizontally focused. The industry is growing because companies are driving innovation and lowering costs by focusing on very specific segments of the value chain. Panel prices plummeted in the 2000s because of an intense focus on reducing silicon and boosting performance... inspired companies like Tigo Energy to concentrate on optimizing the electronics that go into arrays. ...Horizontal business models helped drive the computer industry. You see it in LEDs, but it's far less pronounced in markets like wind or fossil fuels. And it's no coincidence that both solar and LEDs have enjoyed steady and steep price declines."]

Kolata, David, Exelon must shoulder financial burden of its nuclear plants: State bailout would insulate utility from cost of its decisions, Chicago Tribune Op-Ed, Mar 30, 2014. http://articles.chicagotribune.com/2014-03-30/business/ct-nuclear-plants-cub-oo-0330-biz-20140330_1_exelon-nuclear-plants-wholesale-power-prices.

[David Kolata is Executive Director of the Citizens Utility Board, which represents the interests of residential utility customers of Illinois, as well as a featured columnist for the Daily Southtown, Chicago's third largest daily newspaper.

Over the last decade, Exelon reaped over \$21 billion in profits, running a fleet of nuclear plants that benefited from high electricity prices. With the fall of wholesale power prices, Exelon's business model is in trouble and the company is demanding Illinois state legislators force consumers to pay more to ensure Exelon profits and minimize its market risk. "A bill that would insulate Exelon from the costs of its business decisions, while obligating consumers to pay the consequences, would be the financial equivalent of nuclear waste. ... Though Exelon asserts the virtues of competitive markets in its rhetoric, its actions suggest that what it really wants is privatized profit and socialized risk — the worst of all worlds for consumers."

The state's power portfolio should prioritize cost-effective clean energy resources. "The clean energy economy — based on energy efficiency, the smart grid and alternative sources like solar — is key if we are to maximize consumer and environmental value."

The state should also demand a full transparent analysis of Exelon's financial situation. "Anything resembling a full-fledged bailout of Exelon's plants would be radioactive for our pocketbooks."]

MCKINSEY: Frankel D, Ostrowski K, and Pinner D, The disruptive potential of solar power: As costs fall, the importance of solar power to senior executives is rising, McKinsey Quarterly, Apr 2014.

http://www.mckinsey.com/insights/energy_resources_materials/the_disruptive_potential_of_solar_power.

[Authors David Frankel and Dickson Pinner are, respectively, an associate principal and principal in McKinsey & Company's San Francisco office. Ken Ostrowski is director of the consulting firm's Atlanta office.

China is investing "serious money" in renewables. Solar adoption rates in the US and Europe have more than quadrupled since 2009. The solar "industry is poised to assume a bigger role in global energy markets; as it evolves, its impact on businesses and consumers will be significant and widespread." While cheap natural gas and a flood of Chinese solar exports have caused short-term financial challenges, the long-term potential for solar is high. Sharply declining costs are the key. Module costs are falling and even larger cost reductions loom in the downstream – or "soft" – costs (like installation, service, and regulatory adherence). Solar per watt peak best-in-class system capacity cost to the consumer was \$7 in 2008 and \$4 or lower in 2013. McKinsey research suggests that figure is poised to fall to \$2.30 by 2015 and \$1.60 by 2020.

Cost reductions will put solar in economic "striking distance" of new build for traditional generation power plants. "Solar's changing economics are already influencing business consumption and investment. In consumption, a number of companies with large physical footprints and high power costs are installing commercial-scale rooftop solar systems, often at less than the current price of buying power from a utility." Examples include Wal-Mart, which has announced its plan to switch to 100% renewable power by 2020; Starwood Hotels and Resorts, which has powered with NRG Solar to begin installation at hotels; and Verizon, which is spending \$100 million on solar and fuel cell technology to power its facility and cell-network infrastructure.

"As for investment, solar's long-term contracts and relative insulation from fuel-price fluctuations are proving increasingly attractive...Accordingly, investors are more and more willing to underwrite long-term debt positions for solar, often at costs of capital lower than those of traditional project finance." Major players are creating advanced financial products for solar. A prime example is NRG Yield. The McKinsey authors expect other companies to unveil similar securities which "pool renewable operating assets into packages for investors."

Solar growth poses a disruptive threat to utilities that continue to use the old business model, which depends upon capture of all new demand to support revenue growth. (In the first 10 months of 2013, over 20% of new US installed capacity was solar.) Solar also alters the demand side of the equation. However US utilities can also seize new opportunities and profit.

Solar involves long-lived assets and power purchase agreements of 15 to 20 years could provide enduring revenue streams.

Solar installations also provide a natural focal point for the provision of many products and services: from, mortgages and data storage to installations of security systems, thermostat and smoke detectors, etc. "As a result, companies in a wide range of industries may benefit from innovative partnerships built on the deep customer relationships that solar players are likely to own. Tesla Motors already has a relationship with SolarCity, for example, to develop better storage coupled with solar. It is easy to imagine future relationships between many other complementary players. These possibilities suggest a broader point: the solar story is no longer just about technology and regulation. Rather, business-model innovation and strong management practices will play an increasingly important role in the sector's evolution and the way it engages with a range of players from other industries."]

MOODY'S INVESTORS SERVICE: Moody's: Low natural gas prices dim prospects for nuclear power generation in US, Moody's Global Credit Research Press Release, Nov 24, 2014. https://www.moodys.com/research/Moodys-Low-natural-gas-prices-dim-prospects-for-nuclear-power--PR_313430. Report at http://www.moodys.com/viewresearchdoc.aspx?docid=PBC_176037.

[Press Release on Moody's report "Global Nuclear Generation Prospects Power Up in Asia But Power Down Elsewhere," issued Nov 24, 2014. The report examines prospects in seven markets and the effect of nuclear generation on the credit quality of the utilities operating within them. In addition to the US, these markets are China, South Korea, Japan, the UK, France and Germany.

Factors affecting potential closures include competition from low natural gas prices as well as high fixed operating costs and large capital-spending requirements to repair and refurbish aging plants. Another reason nuclear generation is likely to decline is the dearth of new nuclear build in the US. Only two new plants are under construction (owned by Georgia Power Company and South Carolina Electric & Gas Company), and construction of both plants has been delayed by up to 3 years, with the units not expected to come on line until at least 2018-2020.]

NATURAL RESOURCES DEFENSE COUNCIL: Cavanagh R and Martinez S, Positive Energy Trends Bode Well for U.S. Security and the Economy: NRDC's Second Annual Energy Review, Oct 2014. <http://www.nrdc.org/energy/energy-environment-report/files/energy-environment-report-2014.pdf>.

[**ADD IN QUOTES** Total energy use in the US peaked in 2007 and then trended downward largely due to significant improvements in energy efficiency technologies like LED bulbs. Improvements in energy efficiency over the last 40 years have done more to meet growth in America's energy needs than the combined contributions of coal, nuclear power, natural gas and oil.

The efficiency trend is most pronounced in the data on electricity consumption. Since 2000, growth in electricity use has dropped well below population growth, this despite the use of consumer electronics and plug-ins.

Oil consumption by vehicles, homes and businesses peaked in 2005 and has gone down more than 12% in the years since.

Significant advancement has been made in the area of renewable energy. More than one-eighth of US electricity supply is now in the renewable category which consists of wind, solar, hydro, and geothermal power. And renewable energy sources are growing and becoming cheaper.

These trends put the country in a strong position to meet the carbon dioxide emissions standards proposed by the EPA for reducing pollution from power plants. The EPA proposal would encourage states to push for energy efficiency improvements across the economy to reduce power plant generation. Because optimizing energy use is cheaper than making more electricity, the E.P.A. projects that electric bills will drop.

The findings of the NRDC report show that clean energy resources in the US can be mobilized to reduce carbon pollution. EPA power plant standards (proposed in June 2014) will keep more than 5.3 billion tons of carbon dioxide out of the atmosphere by 2030. Thus, in just 16 years, the standards will reduce harmful emissions from America's power plants by 30% compared to 2005 levels. And proposed energy efficiency improvements in all sectors of the economy, should yield savings for the average customer.

The findings also demonstrate that progress toward a clean energy economy goes hand-in-hand with economic health, reduction of greenhouse gas emissions, and energy security.]

NATURAL RESOURCES DEFENSE COUNCIL (NRDC): Lashof D and Yeh S, Cleaner and Cheaper: Using the Clean Air Act to Sharply Reduce Carbon Pollution from Existing Power Plants, Delivering Health, Environmental, and Economic Benefits, Issue Brief, Natural Resources Defense Council (NRDC), Mar 2014. <http://www.nrdc.org/air/pollution-standards/files/pollution-standards-IB-update.pdf>.

[Primary authors: Dan Lashof and Starla Yea. Contributing authors: Dale Bryk, Sheryl Carter, David Doniger, Derek Murrow, and Laurie Johnson.

Proposal for EPA to set emission limits for each state, then allow states flexibility to transform their carbon dioxide (CO₂), sulfur (SO₂) and nitrogen oxide (NO_x) pollution output using wide array of policy and technology mechanisms. These include mechanisms like energy saving standards for new construction, investment in wind and solar, and installation of smart grid technologies. If implemented, the authors state, U.S. could eliminate 470 - 700 million tons of CO₂ pollution per year and reduce overall demand by as much as 6% by 2020. Analysis uses updated economic models and developments in energy efficiency technology. Implementation costs: \$0 - \$14.6 billion. Savings: \$28 billion - \$63 billion. The results of analysis conducted by ICF International for NRDC "show that the proposed approach would begin to modernize and clean up America's electricity sector without significantly changing the nation's electricity bill." (p 6)

An innovative feature of the proposal is the inclusion of energy efficiency, which would enable state regulated efficiency programs to earn credits for avoided pollution from reduced consumption. "Energy efficiency is one of the lowest-cost energy resources and emission

reduction options. States could use this provision to slash emissions without costly and lengthy power plant retrofits or new construction, reducing the overall cost of the regulations.” (p 5)

“Improving energy efficiency also cuts costs to consumers and businesses. Switching to more efficient light bulbs, adding weather-stripping or insulation in buildings, or installing more-efficient appliances and equipment reduces electricity bills and creates jobs that can’t be outsourced to other countries.” (p 5) In addition to the direct economic, environmental and health benefits, the approach would stimulate investment in energy efficiency and renewables, giving the energy industry the investment certainty needed to avoid billions of dollars of stranded investment in obsolete power plants. (p 10)]

NATURAL RESOURCES DEFENSE COUNCIL (NRDC): Biogas briefing, accessed Apr 9, 2014. <http://www.nrdc.org/energy/renewables/biogas.asp>.

NEW YORK CITY SOLAR AMERICA CITY PARTNERSHIP: New York City Solar Map, (accessed Apr 17, 2014). <http://nycsolarmap.com/>. [Web map developed and hosted by Sustainable CUNY (City University of New York). The map is a tool which shows existing solar PV and thermal installations in New York City and gives practical information and steps for installation. The map also provides estimates of the solar PV potential of every rooftop in the city’s five boroughs.]

NEW YORK TIMES: Krugman, Paul, Errors And Emissions: Could Fighting Global Warming Be Cheap and Free? New York Times Op-Ed, Sep 19, 2014. <http://www.nytimes.com/2014/09/19/opinion/paul-krugman-could-fighting-global-warming-be-cheap-and-free.html>.

[“This just in: Saving the planet would be cheap; it might even be free.”

Two serious, careful analyses on the economics of fighting climate change conclude that strong measures to limit carbon emissions will barely slow economic growth, and might actually lead to faster growth. One is large study by a blue-ribbon international group, the New Climate Economy Project. The other is a working paper out of the International Monetary Fund.

A key reason for the improved economic picture is that renewable energy technology has made dramatic progress over the past few years. The costs of solar power, in particular, are plunging, down by half since just 2010. Moreover large “co-benefits” — positive effects over and above the reduction in climate risks — would accrue from taking action against the climate threat, and these benefits would come fairly quickly. The I.M.F. paper notes the most important co-benefit would be improved public health. For this reason, carbon pricing is worth doing regardless of whether an international agreement can be reached.

“It’s easier to slash emissions than seemed possible even a few years ago, and reduced emissions would produce large benefits in the short-to-medium run. So saving the planet would be cheap and maybe even come free.”

People who wave away all this analysis and declare that fighting climate change will bring an end to economic growth are often the same people who say free-market economies are endlessly flexible and creative. But with respect to pricing carbon, suddenly insist industry will be completely incapable of adapting to changed incentives.

Others, even hard scientists, often do not understand what economic growth means. “They think of it as a crude, physical thing, a matter simply of producing more stuff, and don’t take into account the many choices — about what to consume, about which technologies to use — that go into producing a dollar’s worth of G.D.P.... The idea that economic growth and climate action are incompatible may sound hardheaded and realistic, but it’s actually a fuzzy-minded misconception. If we ever get past the special interests and ideology that have blocked action to save the planet, we’ll find that it’s cheaper and easier than almost anyone imagines.”]

NEW YORK TIMES: Gillis, Justin, Sun and Wind Alter Global Landscape, Leaving Utilities Behind, New York Times, Sep 14, 2014.
<http://www.nytimes.com/2014/09/14/science/earth/sun-and-wind-alter-german-landscape-leaving-utilities-behind.html>.

NEW YORK TIMES: Cardwell, Diane, NRG Energy Buys Goal Zero, a Start-Up, as Entry to Mobile Solar Business, New York Times, Aug 15, 2014.
<http://dealbook.nytimes.com/2014/08/14/nrg-energy-buys-solar-start-up-goal-zero/>.

[NRG Energy, one of the largest independent American power producers, is entering the mobile solar business.

The purchase is part of the broader strategic vision of David Crane, NRG’s chief executive to reposition the company in a fast moving energy market and the spread of distributed generation, like rooftop solar, and smart appliances.

Toward that goal, NRG is reorganizing into three main units: (1) NRG Business, which will hold the company’s conventional wholesale coal, nuclear and gas power plants; (2) NRG Renew, which will focus on developing renewable energy sources, including large-scale wind and solar farms and microgrids, for commercial and government customers; and (3) NRG Home, which will focus on residential customers, offering solar and home energy products and services.

NRG acquisitions include: Roof Diagnostics, a fast-growing residential solar installation company based in NJ; the retail electricity business of Dominion Resources; and Goal Zero, a start-up which makes solar-charged battery packs that fit in a handbag and mobile generators that can run main home systems.

Energy experts say that the electric market, long dominated by large corporations, is changing rapidly. “‘In this environment, utilities have to change their business model and become more customer-oriented or actually get into distributed generation or microgrids themselves,’ said

Aditya Ranade, who leads green building analysis at Lux Research. ‘Competitors like Duke have so far stayed away because it’s too far out of their comfort zone. That has left that field open to smaller, more nimble competitors like NRG.’”

Other companies moving aggressively to stake a claim in the new market, including information, communications and computing giants like Google, Honeywell, Apple, Comcast, and Time Warner. Strategy Analytics, a research and consulting firm, expects spending on smart home systems/services to reach \$18 billion in the US in 2014 and more than double to \$39 billion in 5 years, with millions of residential customers of security companies like Vivint and ADT driving that growth. Vivint is considering an initial public stock offering for its fast-growing solar installation division.

Most energy companies, however, have remained very tied to their traditional business models, notes Bill Ablondi, who directs the smart home strategies advisory service.]

NEW YORK TIMES: Creswell, Julie and Robert Gebeloff, Traders Profit as Power Grid is Overworked, New York Times, Aug 15, 2014.

<http://www.nytimes.com/2014/08/15/business/energy-environment/traders-profit-as-power-grid-is-overworked.html>.

[Analysis of trading data by the New York Times reveals that energy traders reap huge profits when the electric grid struggles to meet demand in Long Island and New York City. Wholesale electricity prices are higher on LI and NYC City than in upstate NY, because of transmission grid congestion. Prices go up when the grid has to deliver power from distant locations to meet demand. Energy traders benefit financially from the grid strain through complex financial instruments called “congestion contracts.”

The New York Times examined 150,000 congestion contracts that have been auctioned since 2003 by the New York Independent System Operator (NYISO), a nonprofit company which oversees NY’s transmission network. Under deregulation, system operators manage the nation’s transmission lines and run wholesale power markets where utilities like acquire power to sell to their customers.

Deregulation was intended to eliminate old monopolies and create competitive markets. Congestion contracts were intended to protect the electric producers, utilities and industries by enabling them to hedge against sharp price swings caused by competition, weather, plant failures, or equipment problems. The lower costs was also supposed to reduce consumers’ bills.

“But Wall Street banks and other investors stepped in, siphoning off much of the money.” Traders in NY congestion markets made \$639 million in profits in the decade between 2003 and 2013, the New York Times found. And, in most places, electricity bills have been rising.

Frank A. Wolak, a Stanford economics professor who studies commodities, said congestion markets create perverse incentives because profits rise when grid congestion becomes worse. “If traders are making money, then consumers are paying more,” Mr. Wolak said. “The money that these guys are making has to come from somewhere.”

An example of how the energy market is exploited is the money made by DC Energy, a Virginia-based investment company during a heat wave in May 2013. By the hot midafternoon of May 30, 2013, the wholesale price of electricity had jumped nearly 550 percent. Within 48 hours, DC Energy made more than \$1.5 million by cashing in on its congestion contracts. Over the last decade, DC Energy has made about \$180 million from New York State alone.

Some of DC Energy's biggest paydays involved the village of Port Jefferson, Long Island. Margot Garant, mayor of Port Jefferson said: "Why aren't we getting that money?" said Margot Garant, mayor of Port Jefferson. City officials, including the mayor, had not heard of DC Energy before they were told about it by the New York Times.

Federal Energy Regulatory Commission (FERC) officials have grown increasingly concerned about trading schemes being used to manipulate electricity prices. In one case, Louis Dreyfus Energy Services, an energy trading company (then partly owned by a J. P. Morgan hedge fund) was charged with making a quick \$3.3 million in profits in the spring of 2009 by creating non-existent congestion. Louis Dreyfus agreed to pay \$7.4 million to settle FERC allegations of price manipulation. "As is often the case in such settlements, the firm neither admitted nor denied wrongdoing."]

NEW YORK TIMES: Wald, Matthew L, Texas Is Wired for Wind Power, and More Farms Plug In, New York Times, Jul 24, 2014.

<http://www.nytimes.com/2014/07/24/business/energy-environment/texas-is-wired-for-wind-power-and-more-farms-plug-in.html>.

[For years, expansion of wind power has been so hampered by lack of transmission lines that local power surpluses have sometimes forced wind turbines to shut down during heavy wind periods.

Texas is tackling the problem with a large-scale transmission project that links the windy Panhandle and West Texas to the millions of customers in its Dallas-Fort Worth, Austin and Houston areas.

State lawmakers were inspired less by environmentalism than by the prospect of economic stimulus. The state took an "if-you-build-it, they-will-come" approach. "And it is working. 'We've built it and they're marching this way,' said Warren Lasher, the director of system planning at the Electric Reliability Council of Texas, the grid operator, citing plans for new wind farms."

The network will span 3,600 miles handle up to 18,000 megawatts. Work on 7,000 MW of capacity began before the end of 2013, spurred by a federal tax credit available only to projects that broke ground by year end 2013. The \$7 billion cost amounts to about \$300 per person served by the Texas grid. The Texas Public Utility Commission said the typical residential ratepayer is charged about an extra \$6 a month. Proponents say the lines have cut electricity costs by more than the \$6.

The Texas project was spurred by "Cattle graze obliviously among some of the wind towers. Other towers are squeezed into the unused, odd-shaped corners of square fields where farmers have installed circular irrigation systems." Local officials are enthusiastic. In the Panhandle's Carson County, wind energy is income for farmers and for the county itself, said Lewis Powers,

chairman of the county commissioners court. The county's tax base, about \$850 million in 2013, will exceed \$1 billion in 2014, he said.

The decision by the Legislature to build the lines set off a planning process that pushed wind developers to cluster together, into competitive renewable energy zones – or CREZ. Wind developers, now given the assurance of transmission, are building. Together, the Panhandle 1 and Panhandle 2 wind farms will provide 400 MW, and be as powerful as a midsize coal plant.

Energy supply stability is expected to increase as more lines and wind farms go up in diverse locations.]

NEW YORK TIMES: Cardwell, Diane, Buying Into Solar Power, No Roof Access Needed, New York Times, Jun 20, 2014. <http://www.nytimes.com/2014/06/20/business/energy-environment/buying-into-solar-power-no-roof-access-needed.html>.

[Clean Energy Community Gardens and Cooperatives are springing up as arrangements which allow people to buy clean renewable power. Buyers get the opportunity to both contribute to the growth of clean energy and have lower electric bills.

In solar farms, the approach enables customers buy into a solar array constructed elsewhere and receive credit on their electricity bills for the power their panels produce. It is among a number of emerging financing mechanisms that encourage the development of solar power. Others include residential leasing programs to crowdfunding.

For developers, these arrangements create a sizable new market from customers who can't own or lease systems because their properties are physically unsuitable or because they do not own the properties (like renters and apartment building residents).

The concept was largely pioneered in Colorado and is spreading across the country.

Massachusetts passed a state law enabling community renewable energy projects in 2008. One town solar garden began operating in Brewster in 2012 and a leading developer, Clean Energy Collective is building systems that are due to start producing power in the state in June 2014. The company teamed with Next Step Living of Boston, a home energy-efficiency company, which is selling the product to consumers across Massachusetts. California, Minnesota and Washington, DC, have laws to establish their programs. In New York, a bill is working its way through the State Legislature.

Typically, a developer builds a solar farm that can range from a few dozen panels on a rooftop to thousands sitting on more than 100 acres. The electrical output of a set number of panels is sold to each customer, depending on how much solar power they want. Customers then receive a credit for that power, often at a fixed rate per kilowatt-hour, and receive a deduction from their electric bill.

For customers, the approach also offers flexibility, because their interest in the panels is transferable so they can take the output with them if they move or turn it over to someone else.]

NEW YORK TIMES: Gillis, Justin, Fixing climate Change May Add No Costs, Report Says, New York Times, Sep 17, 2014. <http://www.nytimes.com/2014/09/16/science/earth/fixing-climate-change-may-add-no-costs-report-says.html>

NEW YORK TIMES: Gillis, Justin and Michael Wines, In Some States, Emissions Cuts Defy Skeptics, New York Times, June 7, 2014. <http://www.nytimes.com/2014/06/07/science/in-some-states-emissions-cuts-defy-skeptics.html>.

[Emissions cuts of 30 % — the 2030 goal of President Obama’s national plan to cut greenhouse gases — have already been accomplished in at least 10 states between 2005 and 2012, and several other states are well on their way.

Some of the more optimistic assessments of the plan have come from utility executives and state officers tasked with its execution. Some independent energy experts said that electricity prices may rise by a few percentage points in some states, but not necessarily. “I predict this will be far easier and far faster and far cheaper than most people realize,” said Hal Harvey, chief executive of Energy Innovation, a research group.”

According to the Georgetown Climate Center, from 2005 to 2012, Maine, Massachusetts, New Hampshire and New York cut their power-sector emissions by over 40 %. Maryland cut emissions by 39 %. Through cap and trade program, the Northeastern states impose a small price on CO2 emissions from power generation, and plow the proceeds back into energy-efficiency programs like retrofitting homes and businesses, lowering electricity bills. The states also encourage renewable power and less energy waste.

In New England, where some of the greatest reduction in emissions have been achieved, residential electricity bills fell 7 % from 2005 to 2012, adjusted for inflation. And economic growth in the region ran slightly ahead of the national average.

David W. Cash, Commissioner of Environmental Protection in Massachusetts said he saw a direct link between the state’s above-average economic performance in recent years and lower energy bills: “Every dollar they’re not spending on coal that comes from Colombia or natural gas that comes from Pennsylvania is a dollar that stays here in Massachusetts.”]

NEW YORK TIMES: Wald, Matthew L, Experts Queried on Risks Posed by Closed Reactors, New York Times, May 15, 2014. <http://www.nytimes.com/2014/05/15/us/politics/panel-questions-experts-on-closed-reactor-risks.html>.

[Spent fuel sitting at reactor sites will remain “dangerously radioactive for centuries”. Under 1980s legislation the Energy Department, was obligated to start accepting high level nuclear waste in 1998. However the Yucca Mountain program was cancelled and there is no process in place to find a new national waste repository. Collections from nuclear operators to the Nuclear Waste Fund, which began in 1983, ceased as of May 15, 2014.

“Meanwhile, the costs keep rising for a declining industry.”

The cost of taking down Entergy’s Vermont Yankee reactor (closing in 2014), and shipping the low-level waste for burial is estimated to be at least \$1 billion. The expected cost of transferring spent fuel from pool to dry casks at Vermont Yankee is \$150 million to \$175 million, according to Entergy. Entergy is seeking reimbursement from the Energy Department. Entergy wants to take money out of the \$600 million decommissioning fund, but that fund is already too small.

At a May 14, 2014 Senate hearing, Entergy’s vice president for regulatory strategy, T. Michael Twomey, testified that maintaining a full-scale emergency capacity would cost about \$20 million a year, which would also come out of the decommissioning fund. “It’s not a free option,” he said.]

NEW YORK TIMES: De La Merced, Michael, Hoping for Stability, Utility Operator Exelon Agrees to Buy Pepco for \$6.8 Billion, New York Times, May 1, 2014.
<http://dealbook.nytimes.com/2014/04/30/utility-operator-exelon-to-buy-pepco-for-6-8-billion>.

[The utility Exelon is acquiring Pepco in an effort to increase profits via growth “as the industry contends with declining electricity sales and gas prices.”]

NEW YORK TIMES: The Koch Attack on Solar Energy, New York Times Editorial, Apr 27, 2014. <http://www.nytimes.com/2014/04/27/opinion/sunday/the-koch-attack-on-solar-energy.html>.

[The Koch brothers “and other big polluters have been spending heavily to fight incentives for renewable energy, which have been adopted by most states. They particularly dislike state laws that allow homeowners with solar panels to sell power they don’t need back to electric utilities.” The motivation is clear: “They see solar and wind energy as a long-term threat to their businesses.”

“Renewables are good for economic as well as environmental reasons, as most states know.” Over 143,000 Americans now work in the solar industry. In 2013, 29% of newly installed generation capacity came from solar and 43 states have rules which require utilities to buy excess power generated by consumers with rooftop solar panels. Net metering essentially runs electric meters backward for customers when power flows from into the grid. “The utilities hate this requirement, for obvious reasons. A report by the Edison Electric Institute, the lobbying arm of the power industry, says this kind of law will put “a squeeze on profitability,” and warns that if state incentives are not rolled back, “it may be too late to repair the utility business model.”

The Arizona Public Service Company, the state’s largest utility, funneled large sums through a Koch operative to a nonprofit group that put out an ad claiming net metering would hurt older people on fixed incomes by raising electric rates. Another Koch ad proclaims the renewable-energy requirement to “another government mandate we can’t afford,”. That assertion is “deliberately misleading. This campaign is really about the profits of Koch Carbon and the utilities, which to its organizers is much more important than clean air and the consequences of climate change.”]

NEW YORK TIMES: Friedman, Thomas L, Go Ahead, Vladimir, Make My Day, New York Times Op-Ed, Apr 13, 2014.

<http://www.nytimes.com/2014/04/13/opinion/sunday/friedman-go-ahead-vladimir-make-my-day.html>.

[“Clean energy is at an inflection point,” Hal Harvey, CEO of Energy Innovation told New York Times writer Tom Friedman. “The price reductions in the last five years have been nothing less than spectacular: Solar cells, for example, have dropped in cost by more than 80 percent in the last five years. This trend is underway, if a bit less dramatically, for wind, batteries, solid state lighting, new window technologies, vehicle drive trains, grid management, and more. What this means is that clean energy is moving from boutique to mainstream, and that opens up a wealth of opportunities.” In addition, Harvey noted, new houses in California now use one-fourth of the energy they used 25 years ago. Wind in Texas now powers more than 3 million homes. New Jersey generates more solar watts per capita than California.

The company Opower advises utilities and consumers on how to lower electrical use and bills using behavioral economics. The company just went public and recently signed Tokyo Electric Power Company as a client. Opower co-founder Alex Laskey explained the company helps people understand their energy use in simple, clear terms. When people understand where they are wasting energy, many start wasting less.

As consumption falls, utilities can meet customer demand without having to build new power plants to handle peak loads just a few days of the year. Since its founding in 2007, Laskey said, Opower has helped save about 4 terawatt (TW) hours of energy and expects to be soon saving 4 TW each year, a figure tantamount to the annual power produced by the Hoover Dam.]

NEW YORK TIMES, 2014: Woody, Todd, Car Companies Take Expertise in Battery Power Beyond Garage, Mar 26, 2014. <http://www.nytimes.com/2014/03/25/business/car-companies-take-expertise-in-battery-power-beyond-the-garage.html>

[Solar companies and carmakers are converging technologies and goals to create self-sufficient homes, with car battery systems as the linchpin for energy storage. Buildings and transportation account for 44% of US greenhouse gas emissions. The emerging model is for manufacture of electric and hydrogen fuel cell vehicles that are environmentally friendly and also deliver power to homes, buildings and utilities.

Daniel Sperling, Director of the Institute of Transportation Studies at the University of California, Davis is quoted: “It’s a new world in terms of vehicles operating not as isolated artifacts but as being part of a larger energy system, and I think the greatest opportunity for automakers is figuring out how their vehicles become part of that system.”

The Institute of Transportation Studies provided the building site and the heating and lighting technology for a 1,944 sq ft showcase for a Honda Smart Home which uses geothermal energy for heating and a Honda battery pack to store electricity generated from solar panels. A comparable home would consume ~13.3 MW hours of electricity a year while the smart home, according to Honda, could generate an estimated surplus of 2.6 MW hours annually.

The home can also send excess electricity to the grid. So if the utilities become overloaded during summer heat and electrical use – from air conditioners – the local utility can send a signal directing the home to send solar electricity to the grid to help avert blackouts. Steve Center, vice president for American Honda's Environmental Business Development Office, said "We see a lot of things converging," noting, "There will be new business models like home energy sharing and energy storage, using your car's batteries."]

NUCLEAR INFORMATION AND RESOURCE SERVICE: Judson, Tim, Killing the Competition, Report of the Nuclear Information and Resource Service (NIRS), Sep 2014.
<http://www.nirs.org/neconomics/killingthecompetition914.pdf>.

PLATTS: German renewables lead power mix in 2014 with 25.8% share, Platts (London), Dec 29, 2014. <http://www.platts.com/latest-news/electric-power/london/german-renewables-lead-power-mix-for-first-time-21761667>

[Germany's renewable power output has reached a new record in 2014, contributing more than a quarter of the nation's electricity demand and output and topping the power mix.

Renewables provided 25.8% of the nation's power, according to BDEW, the German energy industry's federal lobby group, which has around 1,800 member companies representing about 90% of Germany's power and gas market.

"The continued rise in renewables output again comes at the cost of hard coal and gas-fired power generation, whose combined share dropped to its lowest level since at least 1990."]

PJM INTERCONNECTION: PJM Renewable Integration Study, General Electric Study prepared for PJM Interconnection (Introduction by Ken Schuyler of PJM), Mar 2014.
<http://sustainableferc.org/wp-content/uploads/2014/03/Renewables-Integration-Study-2014.pdf>. {Summary of report at: Moore, John, America's Largest Grid Operator: Massive Renewables Push Won't Be a Problem, NRDC Switchboard blog, Mar 10, 2014.
http://switchboard.nrdc.org/blogs/jmoore/nations_largest_grid_operator.html.}

[PJM Interconnection is the largest US power transmission grid operator with territory covering the Mid-Atlantic region and part of the Midwest. This report (300 pages) was prepared for PJM by General Electric.

Wind and solar power could be integrated to provide ~30% of the electricity needed for the Mid-Atlantic region and part of the Midwest without any significant technological issues by 2026.

The electric grid can handle large amounts of wind, solar, and other forms of renewable power. Some 113,000 MW of installed wind and solar (including distributed generation) could provide enough electricity to power 23.5 million homes annually. **ADD MORE]**

RENEW ECONOMY: Parkinson, Giles, Citigroup says the 'Age of Renewables' has begun, Renew Economy, Mar 27, 2014. <http://reneweconomy.com.au/2014/citigroup-says-the-age-of-renewables-has-begun-69852>.

[Reports that a major new analysis released by Citigroup (Citi) has hailed the start of the “age of renewables.” Even in the US, where gas price is low, solar and wind energy are becoming competitive with natural gas peaking and baseload plants. America has the world’s largest energy market.

The benefits of securing low cost power, fuel diversity and stable cash flows is increasingly drawing decision makers to the economics of solar and wind. “Citi’s report echoes that conclusion. Gas prices, it notes, are rising and becoming more volatile. This has made wind and solar and other renewable energy sources more attractive because they are not sensitive to fuel price volatility.”

For peak, solar is becoming an increasingly attractive option as solar costs continue to fall.

For baseload generation (and fuel diversity), wind, biomass, geothermal, and hydro are becoming more economically attractive.

Both nuclear and coal are structurally disadvantaged because both technologies are uncompetitive on cost.

The aging nuclear fleet in the US is facing plant shutdowns due to the challenging economics. And cost over-runs at the Vogtle plant under construction in Georgia – now slated to run to \$15 billion (way above initial estimates) is pricing nuclear out of the market. Citigroup notes that while financing costs are inexpensive in the current monetary environment, this situation will not last.

Coal, the Citigroup report contends, is basically priced out of the market. Environmental regulations render the LCOE for new coal is around 15.6c/kWh. Coal now only accounts for 2% of the generation projects under development. “We predict that solar, wind, and biomass to continue to gain market share from coal and nuclear into the future,” says the Citigroup report.

The key metric in comparing power sources will be the levelized cost of energy (LCOE). “As solar, wind, biomass, and other power sources gain market share from coal, nuclear, and gas, the LCOE metric increasingly becomes important to the new build power generation decision making,” it says. New “yieldco” financing facilities for solar and wind energy are making these technologies both cheaper and more attractive.

Citigroup says the base case LCOE for solar is 13c/kWh, the near-term upside in 11c/kWh and the long-term upside (2016) is 10c/kWh. (This is despite the fact that some power purchase contracts are being written as low as 4c/kWh or 5c/kWh, but those are helped by various tax rebates). Solar is still early in the growth cycle and in many countries – Germany, Spain, Portugal, Australia, and the American Southwest – residential scale solar already competes with average residential electricity prices.

Wind costs are also declining, but the most interesting development is the reduction in financing costs using the “yieldco” model.]

ROCKY MOUNTAIN INSTITUTE: Lovins AB and Palazzi T, Nuclear power's competitive landscape and climate opportunity cost, slide presentation at Three Mile Island 35th Anniversary Symposium: The Past, Present, and Future of Nuclear Energy Thayer School of Engineering, Dartmouth College, Hanover NH, Mar 28, 2014, as updated Apr 2014. <http://www.beyondnuclear.org/storage/kk-links/LovinsDartmouthSlides-and-notes-15April2014.pdf>.

[Slides used for Author Amory Lovins, PhD, Chairman and chief scientist at the Rocky Mountain Institute (RMI) and Titiaan Palazzi, Special Aide, RMI demonstrating why nuclear power is neither effective nor economically efficient as a means of combating climate change.]

ROCKY MOUNTAIN INSTITUTE, et al, 2014: Bronski P, Creyts J, Guccione L, Madrazo M, Mandel J, Rader B, Seif D, Lilienthal P, Glassmire J, Abromowitz J, Crowdis M, Richardson J, Schmitt E, and Tocco H, The Economics of Grid Defection: When and Where Distributed Solar Generation Plus Storage Competes With Traditional Utility Service, Report of the Rocky Mountain Institute, Homer Energy and Cohnreznick Think Energy, Feb 2014. http://www.rmi.org/PDF_economics_of_grid_defection_full_report.

[Report on the viability of transforming the US electric power system to a clean sustainable model using solar power and distributed generation.]

ROCKY MOUNTAIN INSTITUTE & CITY OF CORT COLLINS: Chan C, Hansen L, Newcomb J, Rucks G, and Agenbroad J, Stepping Up: Benefits and Cost of Accelerating Fort Collins' Energy and Climate Goals, Report of the Rocky Mountain Institute in partnership with Cort Collins Utilities, Jan 2014. (Link and Summary at: http://www.rmi.org/Knowledge-Center/Library/80FortCollinsReport-WEB_2014-02. (See also Energy Efficiency at Fort Collins Utilities: A Role Model for Publicly Owned Utilities, Briefing Paper, Feb 2013. http://www.swenergy.org/publications/documents/EE_at_Fort_Collins_Utilities_Feb_2013.pdf.)

[Fort Collins Colorado is determined to be a clean energy leader, implementing a FortZED zero energy district project, and working to reduce greenhouse gas emissions via a combination of greater efficiency in buildings and transportation and renewable electricity supplied by wind and solar power. Fort Collins is also a high-tech center which has attracted dozens of clean energy companies and has teamed with Colorado State University on projects. The City of Fort Collins Light & Power invited Rocky Mountain Institute to analyze costs and benefits. This joint report is an analysis of the economics of transforming Fort Collins' energy economy on a fast track. The results are based on open-source, peer-reviewed assumptions and methods. The report includes sector-based findings and shows that significant economic benefits can accrue to both residents and businesses.

In the 5 years since Fort Collins established its greenhouse gas emission reduction goal there have been rapid reductions in the cost and expansion of the availability of clean energy efficient technologies (e.g., LED light bulbs). These developments – together with new business and financing models – have dramatically improved conditions for clean energy. The analysis indicates that an accelerated scenario should enable the city to reduce building energy use by 31% , reduce transportation energy use by 48%, and reduce CO2 emissions by 80% by 2030, By 2030 the city could effectively achieve a carbon neutral electricity system.]

Rodin, Judith, New York Times letter, May 15, 2014.

<http://www.nytimes.com/2014/05/16/opinion/electricity-in-new-york.html>.

[Judith Rodin, president of the Rockefeller Foundation and co-chairwoman of the NYS 2100 Commission, writes that modernization of the electric transmission system was a key recommendation made by the NYS 2100 Commission to Gov. Andrew M. Cuomo after Hurricane Sandy. A smart-grid would deliver cleaner energy and increase system resilience.

As recent years have shown, “New York’s electric grid is vulnerable to a range of shocks, including storms, rising tides, heat waves and power outages. Smart-grid technology not only improves efficiency under normal conditions, but can also disconnect and operate as independent islands in the case of grid failure or emergency, which keeps failures from cascading.”]

SECURITIES AND EXCHANGE COMMISSION: Letter of Matt S. McNair, Special Counsel to United States Securities and Exchange Commission letter to Edna M. Chism of Entergy Corporation, Feb 11, 2014. <http://www.sec.gov/divisions/corpfin/cf-noaction/14a-8/2014/nystatecommonentergy021114-14a8.pdf>.

UNIVERSITY OF SHEFFIELD: Scientists develop pioneering new spray-on solar cells, University of Sheffield news release, Aug 1, 2014.

<http://www.sheffield.ac.uk/news/nr/spray-on-solar-cells-1.392919>.

[A team of scientists at the University of Sheffield is the first to fabricate perovskite solar cells using a spray-painting process, a discovery that could help cut the cost of solar electricity.

First demonstrated in 2012, efficient organometal halide perovskite based photovoltaics are a very promising new solar cell technology which combines high efficiency with low materials cost. Spray-painting process wastes very little perovskite and can be scaled to high volume manufacturing, similar to applying paint to cars.

Lead researcher Professor David Lidzey said: “Remarkably, this class of material offers the potential to combine the high performance of mature solar cell technologies with the low embedded energy costs of production of organic photovoltaics’.”

Perovskites additionally require much less energy to manufacture than solar cells manufactured with silicon – the material that dominates the current global solar market. According to professor Lidzey, the best certified efficiencies from organic solar cells are ~10%, whereas perovskite cells have efficiencies of up to 19%, close behind silicon at 25% per cent.”

Solar power continues to grow at a remarkable rate despite the difficult global economic environment.]

UTILITY DIVE: Walton, Robert, New York writes blueprint for brave new utility world, Utility Dive, Sep 17, 2014. <http://www.utilitydive.com/news/new-york-writes-blueprint-for-brave-new-utility-world/308644/>.

[The New York Department of Public Service has proposed a Reforming the Energy Vision (REV) plan aimed at "customer-oriented regulatory reform." The initiative would modernize the energy landscape to provide a broad range of coordinated and distributed energy resources (DER). Energy market incentive structures would be designed to give customers the power to optimize their energy use.

At the heart of the plan is the use of distributed energy resources – termed a "distributed system platform" or DSP – to solve the problems of NY's aging and inefficient transmission infrastructure. The REV plan seeks to harness the potential of renewable distributed generation resources (like wind, solar, hydro) to end-use efficiency, demand response, energy storage and improved transmission grid capability.

DSP providers (DSPP) would initially be the traditional utilities. But the plan envisions creation of an open, competitive marketplace where a diverse group of energy stakeholders could work to create a resilient, user-friendly, and economically beneficial energy system.]

SOLUTIONS PROJECT: <http://thesolutionsproject.org/infographic/#ny>

[Data from Stanford University <http://www.stanford.edu/group/efmh/Jacobson/Articles/I/WW5-50-USState-plans.html> {See 2013 *Energy Policy study*.} Web page of Solutions Project with updated information for a 100% renewable-powered New York by 2050. The plan proposed for New York is estimated to create 224,500 construction jobs and 107,100 operations jobs lasting 40 years or more.]

U~T SAN DIEGO: Lee, Morgan, Plan unveiled to dismantle San Onofre, U~T San Diego Aug 2, 2014. <http://www.utsandiego.com/news/2014/aug/01/decommissioning-san-onofre-moves-forward/2/?#article-copy>.

[Dismantlement of the San Onofre nuclear plant is estimated to cost \$4.4 billion and take 20 years, its operator, Southern California Edison announced in August 2014.

San Onofre reactors shutdown in January 2012 after a small radiation leak was traced to the rapid degradation of brand new steam generators. The plant was permanently closed in June 2013.

As San Onofre's containment domes are cleared out and leveled, heavily radioactive reactor parts will be stored in canisters. Less radioactively contaminated components will be transported to low level waste disposal facilities at Andrews County, Texas, and Clive, Utah. Spent nuclear fuel will remain indefinitely on site, until the US government comes up with a permanent solution for high level nuclear waste storage.

In a conference call with investors and analysts, SC Edison's CEO Ted Craver said San Onofre was fully funded. However, under a proposed settlement agreement being reviewed by the California Public Utilities Commission, utility customers would pay leftover costs of \$3.3 billion.]

WALL STREET JOURNAL: Wastelands: America's forgotten nuclear legacy, 2013-2014.
<http://projects.wsj.com/waste-lands/>.

[Wall Street Journal interactive database shows New York as the state with the largest number of legacy atomic waste.]

WORLD NUCLEAR REPORT: <http://www.worldnuclearreport.org/IMG/pdf/201407msc-worldnuclearreport2014-hr-v1.pdf>. **REVISE below to update**

WORLD NUCLEAR INDUSTRY STATUS REPORT PROJECT: Schneider M and Froggatt A, with contrib.: Hosokawa K, Thomas S, Yamaguchi Y, and Hazemann J, Independent Assessment of Nuclear Developments in the World, Jul 30, 2014.
<http://www.worldnuclearreport.org/IMG/pdf/201407msc-worldnuclearreport2014-hr-v1.pdf>. Aug 2014: <http://www.worldnuclearreport.org/-2014-.html>.

[Lead authors: Mycle Schneider and Antony Froggatt, energy experts and independent consultant based, respectively, in Paris, France and London, UK. Contributors: **Komei Hosokawa**, Professor for Environmental and Social Research at Kyoto Seika University, Japan; **Steve Thomas**, Professor for Energy Policy, Greenwich University, UK; **Yukio Yamaguchi**, Co-Director of the Citizen's Nuclear Information Center (CNIC), Tokyo, Japan; and **Julie Hazemann**, Director of EnerWebWatch, Paris France. The Forward is written by Peter A. Bradford, Esq., an energy policy professor at University of Vermont Law School, and a former Commissioner at the U.S. Nuclear Regulatory Commission (NRC). {Group description and bios at <http://www.worldnuclearreport.org/Who-we-are.html>.}]

Detailed overview of the history, current status and trends of nuclear power programs worldwide. (Length: 166 pages, incl. extensive reference citations.) The edition also includes an update on safety problems (including the issues raised by aging reactor fleets), energy market analyses, and the poor economics of nuclear power. The report concludes the world nuclear industry is facing daunting challenges. Renewable energy investment, installed capacity and generation are reviewed. A key to transitioning to clean energy is energy market reform.]

2013

ASSOCIATED PRESS: Lucey, Catherine, Warren Buffett Is Making A \$1.9 Billion Bet On Wind, May 9, 2013. <http://www.businessinsider.com/buffetts-midamerican-invests-in-wind-2013-5>

[MidAmerican Energy, a subsidiary of Warren Buffett's Berkshire Hathaway, and Iowa's largest energy company announced plans to spend \$1.9 billion to install hundreds of wind turbines. The plan was announced at a Statehouse news conference with Gov. Terry Branstad who noted that

wind energy has been a selling point for high-tech firms looking to invest in Iowa. Branstad said. "As wind energy grows, so does the Iowa economy." When completed, the new turbines will have the capacity to generate as much as 1,050 megawatts of wind power. MidAmerican President William Fehrman said the utility's Iowa customers should also expect to see a slight decrease in their bills. Iowa leads the nation in wind energy production, getting 24.5% of its electricity from wind power in 2012, according to the American Wind Energy Association's Annual Market Report for 2012.]

ATLANTIC: Woody, Todd, Who Will Compete With Energy Companies in the Future? Apple, Comcast, and You: NRG Energy chief David Crane says the day is coming when you will be your own utility, Atlantic, Nov 4, 2013.
<http://www.theatlantic.com/technology/archive/2013/11/who-will-compete-with-energy-companies-in-the-future-apple-comcast-and-you/281109/>.

[The traditional utility revenue model is being challenged by renewables and distributed generation. Customers can increasingly generating their own electricity from rooftop solar arrays, fuel cells, wind farms, and self-contained power systems called microgrids. And climate change, with increasingly severe weather, is casting doubt on the wisdom of relying on a centralized power system.

This Atlantic article is an interview with David Crane, CEO of NRG Energy, one of the largest US independent energy producers. The \$9 billion company is increasingly betting on solar, wind, and distributed generation.

Crane sees an energy landscape undergoing major transition in a manner analogous to the telephone paradigm change. Crane observes: "We're sort of where long-distance, fixed line telephony was in 1985. Right now it's about the time where you can say it's the end of the long-distance fixed-line world. Let's just call it game over, cell phones won. But it took 25 years."

Assuming the pace of change accelerates, Crane believes, there will be a "significant decline" in the need for big power plants in coming decades. Balancing power will be a significantly information technology-based enterprise.

Examples of new products include the "Beacon 10," a 10 kilowatt device for homes which NRG is collaborating on with the inventor Dean Kamen. Beacon 10 can convert natural gas, biogas, and household garbage into electricity, generate heat, and capture electricity generated from solar panels in a battery. The plan is for the energy company to own the machines and lease them to customers. If, for example, 10,000 units were to be leased in the greater New York City area, the effective result would be a 100 MW peak power plant. Crane says: "We see the machine as more as the centerpiece of a series of products and services that we would sell to you as a homeowner and then we would basically manage your own energy supply at your home. And then if you had extra, we would sell it back to into the grid and share any benefit of that with you."

Another new product NRG is planning to market is a solar canopy that can be used as a gazebo, patio cover, or carport. The canopy is a self-standing structure can be oriented to the sun and provides an opportunity multiplier in that it can be used by homes or small businesses not otherwise structurally optimized for solar.

Climate change will be a major driver of energy transformation. Crane reflects: “I actually think we’re in the first stages of adaption to climate change and this extreme weather. The transmission and distribution system that the regulated utilities rely on may have been one of the biggest feats of the 20th century but we’re now in the 21st century. I can’t tell you how quickly the switch to distributed generation will happen, but I’ll tell you that after a couple more Superstorm Sandy’s it’ll happen a hell of lot quicker.”]

BURLINGTON FREE PRESS: Hallenbeck, Terri, Vermont Yankee deal calls for \$25M from Entergy, Burlington Free Press, Dec 24, 2013.

<http://www.burlingtonfreepress.com/article/20131223/NEWS02/312230014/Vermont-Yankee-deal-calls-25M-from-Entergy-lawsuits-dropped>

[The decommissioning cost of Vermont Yankee is estimated to be \$1billion, but only 60% of this sum is in the decommissioning fund set up by the nuclear plant’s owner, Entergy.

In Dec 2013, the State of Vermont and Entergy Corp reached a settlement agreement whereby Vermont would drop legal claims pending in federal court and not oppose plant operation for one more year. Entergy, in turn, promised to decommission the plant more quickly than the 60 years allowed by the NRC. Entergy agreed to move spent fuel to dry cask within 7 years.

“Entergy agreed to start decommissioning the plant as soon as the decommissioning fund is adequate, acknowledging that it’s unknown when that will be. Entergy has agreed to determine by the end of next year how much decommissioning that specific site will cost. When the fund, which now has about \$600 million, grows to that amount, Entergy agrees to start the decommissioning process within 120 days.

Entergy also agreed to set up a \$25 million fund to restore the site along the Connecticut River after plant dismantling. However, no agreement was reached on a specific *definition* of site restoration or establishing which things Entergy could pay for out of the decommissioning fund.

The Connecticut River Watershed Council was critical of the terms of the settlement, because the agreement does not elicit any guarantees from Entergy over discharge of heated water into the river, leaving that to the existing Agency of Natural Resources permitting process.]

BUSINESS WEEK: Martin, Christopher, Tea Party’s Green Faction Fights for Solar in Red States, Bloomberg Businessweek, Nov 12, 2013. <http://www.bloomberg.com/news/2013-11-12/tea-party-s-green-faction-fights-for-solar-in-red-states.html>

[Faction of Tea Party teams up with the Sierra Club in an alliance called the “Green Tea Coalition.” Debbie Dooley, founder of the coalition is for solar and against nuclear power. What’s uniting the groups is the desire to give consumers the option to buy and use cheaper solar power. The Green Tea Coalition is battling utilities which are opposing distributed renewable power because it cuts sharply into utility profits. Barry Goldwater Jr., son of the late senator said: “I’m a conservative Republican and I think people should have a choice.”]

BUSINESS WEEK: Martin, Chris, Mark Chediak, and Ken Wells, Why the U.S. Power Grid's Days Are Numbered, Bloomberg Businessweek, Aug 22, 2013.
<http://www.businessweek.com/articles/2013-08-22/homegrown-green-energy-is-making-power-utilities-irrelevant>.

["There are 3,200 utilities that make up the U.S. electrical grid, the largest machine in the world. These power companies sell \$400 billion worth of electricity a year, mostly derived from burning fossil fuels in centralized stations and distributed over 2.7 million miles of power lines. Regulators set rates; utilities get guaranteed returns; investors get sure-thing dividends. It's a model that hasn't changed much since Thomas Edison invented the light bulb. And it's doomed to obsolescence."

That's the opinion of David Crane, chief executive officer of NRG Energy, a power company which has historically focused on coal and nuclear. A confluence of green energy and computer technology, deregulation, cheap natural gas, and political pressure that, in Crane's words, pose "a mortal threat to the existing utility system." Crane believes that "in about the time it has taken cell phones to supplant land lines in most U.S. homes, the grid will become increasingly irrelevant as customers move toward decentralized homegrown green energy. Rooftop solar, in particular, is turning tens of thousands of businesses and households into power producers. Such distributed generation, to use the industry's term for power produced outside the grid, is certain to grow."

"He's not alone in his assessment, though. An unusually frank January report by the Edison Electric Institute (EEI), the utilities trade group, warned members that distributed generation and companion factors have essentially put them in the same position as airlines and the telecommunications industry in the late 1970s."

In the Northeast, residential solar should be equal in cost to power from a utility within 3 – 10 years. A July 2013 Navigant report says that by the end of 2020, solar photovoltaic-produced power will be competitive with retail electricity prices—without subsidies—"in a significant portion of the world."

"Green-thinking communities such as San Francisco and Boulder, Colo., are starting to bypass local utility monopolies to buy an increasing portion of power from third-party solar and wind providers. Chicago recently doubled the amount of power it buys from downstate wind farms."

"The solar and distributed generation push is being speeded up by a parallel revolution in microgrids. Those are computer-controlled systems that let consumers and corporate customers do on a small scale what only a Consolidated Edison or Pacific Gas & Electric could do before: seamlessly manage disparate power sources without interruption."]

CARBON DISCLOSURE PROJECT: Wealthier, Healthier Cities: How Climate Change Action is Giving Us Wealthier, Healthier Cities, Report of the Carbon Disclosure Project, C40 Cities, 2013. <https://www.cdp.net/CDPResults/CDP-Cities-2013-Global-Report.pdf>.

[The Carbon Disclosure Project is a project of the C40 Cities, a network of the world's megacities which are taking action to reduce greenhouse gas emissions. C40 Chair in 2013 was New York City Mayor Michael R. Bloomberg. This reports the results from a survey. Key

findings are: (1) Climate change action is making cities leaner and richer. Cities report millions in savings per year from tackling climate change. (2) Emissions reduction activities by cities are pro-business. Action leads to economic opportunities and inaction poses risk. (3) Reducing emissions and pollution makes for healthier citizens. Policies that promote walking and cycling also directly and indirectly lead to improved public health. Over the long term, emissions reductions are needed to reduce the serious risk posed by climate change.]

CLEAN TECHNICA: Credit Suisse Projects ~85% Of US Energy Demand Growth Coming From Renewables Through 2025, Dec 20, 2013.

<http://cleantechnica.com/2014/01/01/credit-suisse-projects-85-us-energy-growth-coming-renewables-2025/>.

[On Dec 20, 2013, the financial giant Credit Suisse released a report projecting about 85% of energy demand growth in the US to come from renewable energy. (The title of the report's first section is "Renewables Are Economic and Disruptive to Conventional Markets.") Clean Technica's take is that renewables may take an increasing share of total US power generation, propelled by more competitive costs against conventional electric power plants. "Renewables may meet the vast majority of future power demand growth, weighing on market clearing power prices in competitive power markets, appreciably slowing the rate of demand growth for natural gas from the power sector, and requiring significant investment in new renewables."

This could result in over 100 GW of new renewable capacity additions, with wind and solar market share more than doubling from 2012 to 2025.

Unlike other forms of power – and even ignoring externalities – renewable energy costs are coming down. "Renewable energy costs are primarily based on the cost of the technologies themselves, while fossil fuel costs are largely based on the fuel sources. As renewable energy grows, the technology costs come down. In the case of fossil fuels, increasing demand brings the price of these finite fuels up. Forecasts should take this into account, but they routinely seem to underestimate renewable technology cost drops, and thus also underestimate renewable energy growth. Credit Suisse, Deutsche Bank, and others that are a bit better at these projections are quickly shifting their forecasts to catch up with the renewable energy revolution we've been seeing."]

Cooper, Mark, Declaration In Matter of Proposed Rule: Waste Confidence Continued Storage of Spent Nuclear Fuel 10 C.F.R. Part 51, Nuclear Regulatory Commission Draft Waste Confidence Generic Environmental Impact Statement, Docket No. 2012-0246, Dec 16, 2013. <https://www.nirs.org/radwaste/exhibitd2013-12-16markcooperfinaldeclaration.pdf>.

[Mark Cooper, PhD, Senior Fellow for Economic Analysis at the Institute for Energy and the Environment at Vermont Law School, uses "a 'multi-criteria portfolio analysis' for evaluating and choosing between the available alternatives in the increasingly complex and ambiguous conditions of the electricity market." (p 2)

The costs of nuclear waste management alone – even excluding decommissioning costs – are high enough to significantly affect the cost-benefit evaluation of nuclear power and make it a non-optimal candidate for power compared with energy efficiency and alternative energy sources.

The analysis shows that the costs of managing spent nuclear fuel are likely to be quite large in absolute value, running to hundreds of billions of dollars; conservatively in the range of \$210 billion to \$350 billion.

In addition, there are decommissioning costs which are rising. “For license renewals, there would be an additional question about whether extending the life of a reactor increases the decommissioning costs.” (p 11)

“The economics of old reactors is already fraying and many are already on the economic ‘razor’s edge’... Proper consideration of waste disposal costs could play a part in pushing them over the edge.” (p 20)]

DAILY KOS: NIRSnet, 2013’s Astounding Collapse of the U.S. Nuclear Power Industry: the New Normal, Sep 10, 2013. <http://www.dailykos.com/story/2013/09/10/1237837/-2013-s-Astounding-Collapse-of-the-U-S-Nuclear-Power-Industry-the-New-Normal>.

[Germany is phasing out nuclear power entirely and the nuclear industry is declining in the US. Economist Marc Cooper of the Vermont Law School’s Institute for Energy and the Environment notes: “What we are seeing today is nothing less than the rapid-fire downsizing of nuclear power in the United States. It is important to recognize that the tough times the U.S. nuclear power industry faces today are only going to get worse.” Part of the reason is the availability of gas. Another reason is the growth of renewables. Notably, nuclear is steadily increasing in cost, wind and solar are declining in cost.]

ECONOMIST: Achieving scale in the US: A view from the construction and real estate sectors, Report from the Economist Intelligence Unit, Jun 2013. http://www.economistinsights.com/sites/default/files/legacy/mgthink/downloads/EIU_GBPN_1_US_A4_WEBBr3_0.pdf.

[Study by the Economist Intelligence Unit commissioned by the Global Buildings Performance Network (GBPN) in collaboration with the Institute for Market Transformation (GBPN) and the World Business Council for Sustainable Development (WBCSD)

Energy efficiency is smart business the retrofit sector alone could provide \$1 trillion in energy savings in the US over the next decade. (p 14) In the US, buildings account for 41% of primary energy consumption, according to Department of Energy figures. Many existing buildings, in particular, are energy inefficient. However business leaders will invest in green if presented initiatives and if they can be made to understand the economic benefits.

A key finding of the report is that energy efficiency regulation is fractured, confusing and inconsistent. “The patchwork nature of regulation creates inefficiencies for the private sector. These include higher transaction and compliance costs as well as lessening the ability to

achieve economies of scale.” (p 7) This leads to a suboptimal situation in which the vast majority of companies manage energy at the building level rather than at the portfolio level.

Regulation also tends to disregard the large potential gains of retrofits. Innovative financing can provide opportunities to achieve greater scale. Aggregating projects across and within sectors through green banks and large mortgage financing organizations allows for more efficient allocation of capital and would likely attract large institutional investors. (p 12)

Both the public and private sectors would benefit by the creation of a supply of standardized efficiency and economic data on model programs. Clear strong regulation and building codes would reduce policy uncertainty, a substantial barrier to pursuit of energy efficiency. (p 7)

Co-benefits of energy efficiency retrofits include higher occupancy rates and higher tenant retention. Some are almost immediately tangible for both companies and customers. “A more energy-efficient HVAC system, for example, will offer more comfort and be less likely to fail, thereby increasing occupancy rates and reducing operating costs.” (p 8)

NY State’s “Build Smart” and New York City’s PlaNYC initiatives are positively noted in the report.]

EDISON ELECTRIC INSTITUTE: Kind P, Disruptive Challenges: Financial Implications and Strategic Responses to a Changing Retail Electric Business, Report by Energy Infrastructure Advocates for Edison Electric Institute, Jan 2013.

<http://www.eei.org/ourissues/finance/Documents/disruptivechallenges.pdf>.

[Report prepared by Peter Kind of Energy Infrastructure Advocates for the Edison Electric Institute.

Technological and economic changes are challenging the business model for the electric utility industry. These “disruptive challenges” arise due to a convergence of factors including: “falling costs of distributed generation and other distributed energy resources (DER); an enhanced focus on development of new DER technologies; increasing customer, regulatory, and political interest in demand-side management technologies (DSM); government programs to incentivize selected technologies; the declining price of natural gas; slowing economic growth trends; and rising electricity prices in certain areas of the country.” (p 1). Technological innovation in areas – such as solar photovoltaic – are creating a market paradigm shift. Financial risks for utilities include declining revenues and lower profitability potential over the long term as DER and DSM programs capture market share. Direct metering of DER may adversely impact returns. The paper looks at various strategic responses to these competitive threats.]

ENERGY POLICY: Jacobson MZ, Howarth RW, Delucchi MA, Scobie SR, Barth JM, Dvorak MJ, Klevze M, Katkhuda H, Miranda B, Chowdhury NA, Jones R, Plano L, and Ingraffea AR, Examining the feasibility of converting New York State’s all-purpose energy infrastructure to one using wind, water, and sunlight, Energy Policy (2013); 57: 585-601.

<http://www.stanford.edu/group/efmh/jacobson/Articles/I/NewYorkWWSEnPolicy.pdf>

[Jacobson et al NewYorkWWSEnPolicy.pdf](http://www.stanford.edu/group/efmh/jacobson/Articles/I/NewYorkWWSEnPolicy.pdf) {Updated data at

<http://thesolutionsproject.org/infographic/#ny>}

[Study by scientists from the Atmosphere/Energy Program, Department of Civil and Environmental Engineering at Stanford University; the schools of Civil and Environmental Engineering and of Ecology and Evolutionary Biology at Cornell University; Institute of Transportation Studies at University of California, Davis; PSE Healthy Energy, NY; and Pepacton Institute (all in the U.S.).

The study examines the technical and economic feasibility of converting New York State's energy infrastructure in all sectors from fossil fuels and nuclear power to renewable power.

Authors conclude NY can fully transition to an economy fully powered by wind, water, and sunlight (WWS) by 2030. Conversion would reduce end use ~37% and stabilize energy prices by eliminating fuel cost volatility. (Fuel costs would be ~zero.) The plan would result in net job creation in NY. NY air pollution mortality would decline by ~4,000 (1,200 to 7,600) deaths a year; and associated health costs would decline by ~\$33 billion (\$10 to \$ 76 billion) a year.

NY greenhouse gas emissions decreases would reduce 2050 U.S. climate costs by approximately \$3.2 billion a year.]

ENVIRONMENTAL NEWS SERVICE: Entergy to close Vermont Yankee nuclear plant, Environmental News Service, Aug 27, 2013. <http://ens-newswire.com/2013/08/27/entergy-to-close-vermont-yankee-nuclear-power-plant/>.

[Entergy announced its decision to stop operation of its Vermont Yankee nuclear plant for financial reasons in late 2014. The plant began operation in 1972 and had, in 2011, been granted relicensing by the NRC to operate until 2032.]

ENVIRONMENTAL SCIENCE & TECHNOLOGY: Sovacool BK, Parenteau P, Ramana MV, Valentine SV, Jacobson MZ, Delucchi MA, and Diesendorf M, Comment in response to "Prevented Mortality and Greenhouse Gas Emissions from Historical and Projected Nuclear Power," Environmental Science & Technology (2013); 47 (12): 6715-6717. http://www.its.ucdavis.edu/research/publications/publication-detail/?pub_id=1927.

[Authors are affiliated with Princeton University, Stanford University, University of California Davis, Vermont Law School (all in the US), the University of Tokyo (Japan), and the University of New South Wales (Australia).

Nuclear power plants are less effective at displacing greenhouse gas emissions than energy efficiency initiatives and renewable energy technologies. A comparative study has shown each dollar invested in efficiency displaces nearly 7 X as much CO₂ as a dollar invested in nuclear. And, in a lifecycle equivalent carbon dioxide basis analysis, wind energy has been shown to be 24 X as effective at displacing emissions per kWh, while hydropower is roughly 2 X as effective. When recent marginal capital and levelized costs are factored in for the US, wind energy is 96 X more effective at displacing carbon than nuclear power, and other renewable sources range from about 20 X to 2 X as effective.

Aside from the direct high financial costs of nuclear power are the detriments of serious environmental degradation from uranium mining and milling. Nuclear power also is a highly water use intensive industry and nuclear power plant operability is impaired during water shortages and droughts.

Adding to the problems with nuclear are the security and accident risks. “There is no such catastrophic risk associated with efficiency and renewables.” (p 6715)

Energy efficiency and renewable energy should be “front and center” in any campaign to address environmental pollution and climate change. Given the opportunity costs involved, nuclear power could reduce and retard the climate protection. (p 6716)]

FORBES: McMahon, Jeff, 6 Nuclear Plants That Could Be Next To Shut Down, Nov 7, 2013. <http://www.forbes.com/sites/jeffmcmahon/2013/11/07/6-nuclear-plants-that-may-be-next-to-shut-down/>.

[Coverage of Morningstar’s “Utilities Observer” report for Nov 2013. Operating nuclear plants that Morningstar analysts believe most exposed to the possibility of closure are:

- (1) Indian Point near New York City, owned by Entergy, with licenses expiring and NY State opposition.
- (2) Ginna Nuclear Generating Station, on the south shore of Lake Ontario near Rochester, NY, jointly owned by Exelon and Électricité de France. Like Indian Point, Ginna is facing a political climate hostile to nuclear reactors. Ginna additionally faces competition from wind turbines and falling electric prices. The Morningstar report states: “Upstate New York off-peak power prices have fallen to \$32 per megawatt hour as of mid-2013 from \$55/MWh in 2008”.
- (3) James A. Fitzpatrick Nuclear Power Plant on the south shore of Lake Ontario in NY, owned by Entergy. FitzPatrick faces the same challenges as Ginna and is also an old BWR reactor that may need upgrades. Fitzpatrick’s revenue-sharing agreement with the New York Power Authority expires in Dec 2014, so unfavorable contract renewal negotiations could lead Entergy to shut the plant.
- (4) Three Mile Island, in Western Pennsylvania, owned by Exelon, which faces competition from gas. Several large, high-efficiency gas power plants are planned for the region.
- (5) Davis-Besse Nuclear Power Station, in Ohio near Toledo, owned by FirstEnergy. After Indian Point, it’s the next power plant up for license renewal in 2017. “We expect strong opposition from some parties,” says Morningstar. “It has a tarnished reputation after an extended outage in 2002-04 due to corrosion in the reactor vessel head and several smaller issues since then.”
- (6) Pilgrim Nuclear Generating Station, in Plymouth, Mass, owned by Entergy. Pilgrim survived a contentious license renewal process and was granted relicensing to 2032, but it is an old BWR reactor, expensive to operate, and may be uncompetitive. “Entergy is not obligated to operate it for that long and could exit if power prices sink much further,” Morningstar says.

The analysts’ report excludes disabled plants (e.g., Fort Calhoun in Neb), that are offline and may never reopen or plants scheduled for closure like Oyster Creek (NJ); San Onofre (Calif); Kewaunee (Wis); Crystal River (FL); and Entergy’s Vermont Yankee plant (VT).]

GREEN TECH MEDIA: Trabish, Herman K. FERC Chair Jon Wellinghoff: Solar 'Is Going to Overtake Everything,' GreenTechMedia, Aug 21, 2013.

<http://www.greentechmedia.com/articles/read/ferc-chair-wellinghoff-sees-a-solar-future-and-a-utility-of-the-future>.

[“Solar is growing so fast it is going to overtake everything,” Jon Wellinghoff, Chairman of the Federal Energy Regulatory Commission (FERC) told GreenTechMedia reporter Herman K. Trabish at the [National Clean Energy Summit](#) in Las Vegas. Wellington used the analogy of a single drop of water on the pitcher’s mound at Dodger Stadium being doubled every minute. In an hour, a person chained to the highest seat would be in danger of drowning. “That’s what is happening in solar. It could [double every two years](#),’ he said.” But distributed systems like solar and wind need to get integrated into the wholesale grid and rate structures need to be reformulated to fully recognize the costs and benefits of distributed power. Wellinghoff said more competition needs to be introduced: “I would unbundle utility services. I would do a full analysis of anything not now competitive, like the distribution system, and then try to ensure I could recover costs in a way that adequately reflected all costs and benefits for all users.”

MJ Shiao, a GTM Research senior analyst, estimated that over 2 1/2 years the U.S. will double its entire cumulative capacity of distributed solar – repeating in the span of a few short years what it originally took four decades to deploy. (Reference to article <http://www.greentechmedia.com/articles/read/chart-2-3rds-of-global-solar-pv-has-been-connected-in-the-last-2.5-years>.)]

GREEN TECH MEDIA: Lacey, Stephen, A Solar System Is Installed in the US Every 4 Minutes, GreenTechMedia, Aug 19, 2013.

<http://www.greentechmedia.com/articles/read/america-installs-a-solar-system-every-four-minutes>.

[The US is now installing one solar photovoltaic (PV) system every four minutes. If market growth continues at its current pace, the American solar industry could be installing a system every minute and twenty seconds by 2016.]

INTERNATIONAL ENERGY POLICY: Williams W, Maniam B, and Subramaniam G, U.S. Energy Independence With Lower Emissions, Journal of International Energy Policy (2013): 2 (2): 39-47). <http://journals.cluteonline.com/index.php/JIEP/article/view/8274>.

[Researchers from Sam Houston State University (US) and Universiti Teknologi (Malaysia).

America’s current energy portfolio is not sustainable, but there are many options the US can choose to power the future. Near-term, available “win-win” clean energy solutions involve implementing small scale options. One which minimizes the impact of the generation facility footprint, negative impacts on fishery resources and river ecosystems is small scale hydropower with generation capacities of 30 MW or less. A 2004 US Department of Energy analysis identified nearly 500,000 viable sites for small scale hydropower, capable of providing more than 100,000 MW. (p 43) Another good option is small wind turbines. Small turbines require less wind to operate than large scale utility turbines, and can produce power in more than 50% of the US. They can be installed on premises without the need of transmission lines. (p 43)

A second phase of moving away from fossil fuels towards clean energy in the US would involve a vehicle refueling infrastructure that would combine large scale wind with solar power plants and infrastructure. The final long term phase involves moving completely towards renewables, including wide-scale deployment of personal and public wind, and solar energy and other advanced technologies.

Nuclear fission power plants produce large amounts of hazardous waste. Uranium is a finite resource and uranium mining is costly. These factors make nuclear impractical as a replacement to fossil fuels. (p 44)]

INSTITUTE FOR ENERGY AND THE ENVIRONMENT: Cooper M, Renaissance in Reverse: Competition Pushes Aging U.S. Nuclear Reactors to the Brink of Economic Abandonment, Report of the Institute for Energy and the Environment at Vermont Law School, Jul 2013.

<http://216.30.191.148/071713%20VLS%20Cooper%20at%20risk%20reactor%20report%20FINAL1.pdf>. Also at: <http://will.illinois.edu/nfs/RenaissanceinReverse7.18.2013.pdf>.

[Report by, Mark Cooper, PhD, an economist and Senior Fellow for Economic Analysis at the Institute for Energy and the Environment at Vermont Law School, is a critical analysis of the economic and safety hazards of the nation's fleet of aging nuclear reactors.

Over three dozen reactors in the US are at risk of poorly planned for early retirement due mostly to safety problems and the high costs of retrofitting aging plants to accommodate emerging evidence of risk and age related deterioration.

Cooper uses 11 risk factors identified in analyses by Moody's, UBS, and Credit Suisse. These include competition from lower-cost energy sources, falling demand, safety retrofit expenses, significant repair costs, and rising operating costs.

New York's Indian Point, Fitzpatrick and Nine Mile Point nuclear plants are among the reactors Cooper singles out as facing "particularly intense" challenges. (p. vi) *{Entergy is the operator at both Indian Point and Fitzpatrick; Constellation Energy Nuclear Group operates Nine Mile Point.}*

The report also flags Entergy's Palisades (MI), Pilgrim (MA) and Vt. Yankee (VT) plants as being at especially high risk of abandonment.

(The other plants in the top dozen at-risk list are: Clinton; Davis-Besse; Ft. Calhoun; Ginna; Millstone; and Oyster Creek, which is already set to retire early.)

The report notes the poor performance of nuclear reactors resulting in early retirements in 2012 and 2013 has existed throughout the history of the commercial nuclear sector in the U.S. and the problems are endemic to the technology and the sector. Economic performance evaluation must include outages. Since the start of the commercial industry, over one quarter of US reactors have had outages of over a year. The average cost of such outages (in 2005 dollars) was over \$1.5 billion, with the highest topping \$11 billion (pp. 27 & 29)

The principal underlying economic stresses of the escalating costs needed to maintain an aging fleet plus the availability of lower cost alternatives are likely to continue for the next couple of decades.

Market conditions are making aging nuclear plants increasingly uneconomic. For example, in May 2013, as a result of price competition, Dominion announced the closure of its Kewaunee nuclear plant in Wisconsin, despite the fact it had just been granted a 20 year license extension. The difficulties faced by the industry in executing major capital improvements and repairs is evidenced by operator decisions to abandon Crystal River in Florida and San Onofre in California after repairs went very badly. The experience with major uprates since 2009 exhibits exactly the same problems that have plagued nuclear construction projects throughout the history of the commercial sector: abandonments, cancellations and large cost overruns.

Cooper concludes: “The lesson for policy makers in the economics of old reactors is clear and it reinforces the lesson of the past decade in the economics of building new reactors. Nuclear reactors are simply not competitive. They have never been competitive at the beginning of their life cycle, when the build/cancel decision is made, and they are not competitive at the end of their life cycles, when the repair/retire decision is made. They are not competitive because the U.S. has the technical ability and a rich, diverse resource base to meet the need for electricity with lower cost, less risky alternatives. Policy efforts to resist fundamental economic reality of nuclear power will be costly, ineffective and counterproductive.” (pp. 39-40)]

INSTITUTE FOR ENERGY AND THE ENVIRONMENT: Cooper M, Public Risk Private Profit: Ratepayer Cost, Utility Imprudence: Advanced Cost Recovery for Reactor Construction Creates Another Nuclear Fiasco, Not a Renaissance, Report of the Institute for Energy and the Environment at Vermont Law School, Mar 2013.

http://www.vermontlaw.edu/Documents/PublicRiskPrivateProfit_Cooper.pdf.

[Author, Mark Cooper, is an economist and Senior Fellow for Economic Analysis at the Institute for Energy and the Environment at Vermont Law School. Report is an exposition of ratepayer advance subsidies of nuclear plants not yet built.]

NEW YORK TIMES: Foderaro, Lisa W, Cleaning Up Radiation In Park May Take Years, New York Times, Nov 26, 2013. <http://www.nytimes.com/2013/11/26/nyregion/radiation-cleanup-at-staten-island-park-to-take-years.html>.

[In Nov 2013, officials said that the level of radioactive contamination is more extensive than previously thought. Cleanup likely to take years. Garbage with trace amounts of radium was dumped into the wetlands at Great Kills Park on Staten Island in the 1940s and 1950s. Contamination was first detected in 2005 when a police flyover of New York City detected a positive reading for radioactive material. In the years since, investigations by the city’s Department of Health and Mental Hygiene, the EPA and the United States Army Corps of Engineers turned up more hot spots and a more disturbing picture.

“As we’re getting through this tough job, we’re finding that the contamination is not only in these discrete pockets, but is dispersed in the soil and also at the surface,” said Kathleen Cuzzolino,

an environmental protection specialist for the Park Service. In late 2013, after another flyover and years of excavations, “the Park Service acknowledged that the contamination was more extensive than had originally been believed. Indeed, more than half of the park has shown some degree of radioactivity — virtually the entire area containing the historic fill.”

Park officials have fenced off 260 acres and started the lengthy process of mapping the contamination and devising a cleanup plan. “[T]he National Park Service, with help from the Army Corps of Engineers, is now surveying every square foot of the 260 acres. Radiation technicians have so far scanned three-fourths of the park with detectors, a painstaking job that entailed clearing vegetation in the survey area so that the detectors could come within six inches of the ground...the Park Service will remove at least 30 hot spots with the highest levels of radiation in the coming months. ...The federal government will also undertake a ‘human health and ecological risk assessment,’ in which soil and ground water samples will be analyzed. Then comes the eventual cleanup, which will involve a feasibility study and a public comment period. ‘It’s going to be several years,’ [the Park Service’s Kathleen] Cuzzolino said. ‘It’s not going to be an easy task to remediate contamination across 260 acres.’”]

NUCLEAR STREET NEWS: Entergy Details Company-Wide Job Cuts, Nuclear Street News, Jul 31, 2013.

https://nuclearstreet.com/nuclear_power_industry_news/b/nuclear_power_news/archive/2013/07/31/entergy-details-company_2d00_wide-job-cuts-073102.aspx#.UjnZKJ3D8gE.

[Entergy cited disappointing earnings as reason for the decision to cut 800 positions across its organization. The New Orleans Times-Picayune reported the company will trim 240 positions in Louisiana, 165 in Arkansas, 115 in Texas, 80 in Mississippi and the remainder in New York, Massachusetts, Michigan, and Vermont. “The effects of cost cutting are likely to be felt across the organization’s nuclear fleet, which provides about a third of Entergy’s electrical generation. It is made up of 11 reactors at Arkansas Nuclear One, Grand Gulf, River Bend, Waterford, Palisades, Indian Point, Fitzpatrick, Pilgrim and the Vermont Yankee.” Entergy “cited higher tax, operation, maintenance and depreciation expenses in its justification for a company-wide reorganization expected to save between \$200 million and \$250 million over the next few years.” Also Entergy has filed suit against contractor companies at Arkansas Nuclear One, where a crane accident took the life of a worker in 2013.]

NYSERDA: Greater Binghamton Airport, NYSERDA Announce Geothermal Project to Reduce Greenhouse Gas Emissions, New York State Energy Research and Development Authority News Release, Oct 29, 2013.

<https://www.nyserdera.ny.gov/About/Newsroom/2013-Announcements/2013-10-29-Greater-Binghamton-Airport-NYSERDA-Announce-Geothermal-Project.aspx>.

[New York State Energy Research and Development Authority (NYSERDA) announcement of groundbreaking of pioneering geothermal plan. Greater Binghamton Airport will be the first airport in the country to use a geothermal system to heat an aircraft parking ramp. Geothermal systems use the relatively constant temperature of the Earth to provide energy efficient heating and cooling.

The project sprung from a 2009 submission by Binghamton University students in connection with a National FAA Design Competition for Universities. That submission led to a joint Greater Binghamton Airport and Binghamton University proposal to design and construct a prototype snow melting system, which was submitted in 2010 to the FAA. Ultimately a further improved version of the plan won support by NYSEDA through Governor Andrew M. Cuomo's Regional Council Initiative. The airport will have an educational energy display for visitors to see how the building is performing.

“Projects that stimulate economic development in the region are essential to the Southern Tier's long-term economic security and the Greater Binghamton Airport project is a perfect example of what regional, community-based partnerships can accomplish,” said REDC Co-Chairs Harvey Stenger, President of Binghamton University and Tom Tranter, President and CEO of Corning Enterprises. “This investment will help lay the groundwork for a cleaner, more energy efficient New York State.” The \$1.25 million project is expected to result in the avoidance of 103 tons of greenhouse gas.

“The geothermal project at the Greater Binghamton Airport is an innovative measure that brings more of the technology of the 21st Century to Broome County,” said Broome County Executive Debbie Preston. “As energy continues to evolve, Broome County is on the cutting edge of technologies that bring first-rate services and substantial savings to our taxpayers. Just as the Greater Binghamton Airport is a leader in aviation, Broome County will continue to be a leader in the energy initiatives.”]

PHYS.org: World Bank says no money for nuclear power, Phys.orgm, Nov 27, 2014.
<http://phys.org/news/2013-11-world-bank-money-nuclear-power.html>.

[World Bank president Jim Yong Kim said, “We don’t do nuclear energy,” as he and UN leader Ban Ki-moon announced an effort to ensure all people have access to electricity by 2030. “The World Bank Group does not engage in providing support for nuclear power.” The focus of the World bank instead will be on hydro, geothermal, solar and wind.]

REUTERS: Entergy Michigan Palisades reactor may have to shut by 2017, Reuters, Mar 8, 2013. <http://www.reuters.com/article/2013/03/08/utilities-entergy-palisades-idUSL1N0C0B0520130308>.

[Entergy's Palisades reactor in Michigan may have to shut by 2017 due to NRC findings that the metal in the aging reactor vessel could reach the regulatory limit for handling pressurized thermal shock as a result of decades of radiation, temperature and pressure stresses. NRC spokeswoman Viktoria Mityng told Reuters: that, as a reactor vessel ages the metal becomes less ductile – it tends to bend less and becomes more brittle – as it is bombarded by neutrons and other forces. An example of the kind of accident in which a pressurized thermal shock could occur is if a large pipe breaks, forcing the operator to fill the vessel with emergency water supplies from cold lake water. Palisades began operation in 1971 and is located on the shore of Lake Michigan. In 2007, the NRC gave Entergy a 20 year license renewal, allowing operation to 2031.]

ROCKY MOUNTAIN INSTITUTE: Lovins, Amory, *Reinventing Fire: Bold Business Solutions for the New Energy Era*, Chelsea Green (2013).

[Author Amory Lovins, PhD, Chairman and chief scientist at the Rocky Mountain Institute (RMI), is a Harvard and Oxford-trained experimental physicist and internationally renowned expert on energy. RMI is a research center that has provided energy efficiency guidance to many major corporations and governmental bodies globally. Lovins is a prominent advocate for renewables and efficiency technologies and has urged transition away from nuclear power and coal.

Reinventing Fire envisions analyzes four potential scenarios of the future electricity sector and describes how widespread energy efficiency adoption has flattened demand growth. Demand response and energy storage technologies allow expanding use of variable renewable generators. Spurred by environmental imperatives, a truly competitive energy market would enable distributed and grid-scale renewables to constitute meet the vast majority of the nation's electric power needs by mid-century.

The book looks at four patterns of how electricity could be generated, delivered, and consumed in the next 40 years: Maintain, Migrate, Renew, and Transform. Performance of each alternative is evaluated in five areas: technical feasibility, affordability, reliability, environmental responsibility, and public acceptability.

Renew explores a future US electricity system in which renewables—mostly at utility scale—could provide at least 80% of electricity by 2050. This would involve widespread adoption of energy efficiency and participation in demand response programs. Improved energy efficiency would flatten electricity demand growth, probably leading many regulators and utilities to change the current business to accommodate new value propositions. Demand response programs would be valued for their ability to complement generation from variable renewable sources

In the Transform case, aggressive energy efficiency adoption flattens and then reverses demand growth. Renewables' installed capacity grows substantially, including a large capacity of distributed resources such as rooftop solar, combined heat and power (CHP), fuel cells, and small-scale wind. The grid exploits renewables' geographic and technological diversity to improve load-following and reduce system costs. Unlike Renew with its more centralized renewables, this scenario would site most generation resources at or near customers. With more distributed generation and deployment of smart grid technology, the grid could be clustered in interlinked microgrids that could stand alone when necessary and improve grid resilience against power failures.]

SCIENTIFIC AMERICAN: Mulkern, Anne C and ClimateWire, *A Solar Boom So Successful, It's Been Halted*, Dec 20, 2013. <http://www.scientificamerican.com/article/a-solar-boom-so-successfull-its-been-halted/>.

[Photovoltaics proved so successful in Hawaii that the local utility, Hawaiian Electric Co.(HECO), in Sep 2013, instituted policies to limit further solar power expansion. The utility claimed the grid could not accommodate the vast amount of solar energy. Others view the action as pushback from an industry worried about loss of profits.

Charles Wang, of the Hawaii ECO Project, at a Dec 2013 conference in San Diego warned that similar utility industry opposition to solar will occur in other states. "'I am from the future,' Wang told a room of industry and environmental representatives. 'The utility is that 800-pound gorilla. If you push it to the corner of the room, it's going to fight back. That's what's happening right now.'"]

WALL STREET JOURNAL: Denning, Liam, Utilities' Lights Flicker, Wall Street Journal, Dec 23, 2013.
<http://online.wsj.com/news/articles/SB20001424052702304773104579270362739732266>.

[Wall Street Journal article by Liam Denning states that there is increasing talk on Wall Street of a looming "death spiral" for traditional utilities, with solar power being the culprit.

"Subsidies and falling technology costs are making distributed solar power—panels on roofs, essentially—cost-competitive with retail electricity prices in places like the southwestern U.S. As more people switch to solar, utilities sell less electricity to those customers. The result: Utilities must spread their high fixed costs for things like repairing the grid over fewer kilowatt-hours, making solar power even more competitive and pushing more people to adopt it in a vicious circle."

"As a rival power source, solar takes market share from traditional generators. And once panels are installed, the sun's energy is free, so it will displace more expensive sources such as gas-fired plants.

"David Crane, chief executive of merchant generator calls the spread of distributed energy the biggest change to hit the industry since the grid was built many decades ago. To adapt, NRG is investing in solar and other distributed sources, essentially taking cash generated today by its traditional business and redeploying it into growth opportunities."

Gas also, while not free like sunlight, is cheap and available day or night. "And besides power stations, it can fuel generation equipment that fits in a basement. Stirling engines, for instance, burn gas to make power and also capture useful heat. Such machines potentially can be used alongside solar panels, allowing owners to switch between different sources. At that point, connection to the grid really can become optional."

Distributed electric grid power will keep eating away at the traditional utilities' share of an electricity market. And the need for more electricity is not increasing. US electricity consumption in 2013 is below the peak of 2007. "Efficiency efforts keep eroding electricity requirements." Julien Dumoulin-Smith of UBS states, 'Essentially, we do not see the recent slowdown in electric load growth as cyclical anymore; it is a new and permanent feature of modern life.'"]

WALL STREET JOURNAL: Emshwiller, John R, Wasteland: One Town's Atomic Legacy: A \$500 Million Cleanup, Wall Street Journal Nov 22, 2013.
<http://online.wsj.com/news/articles/SB10001424052702304868404579194231922830904>.

[Estimate of the cleanup costs of radioactive contamination at a long-defunct nuclear weapons site is as high as \$500 million. Federal regulators originally said the waste could safely stay

buried in the field. Subsequently the Army Corps of Engineers authorities found unexpected amounts of “complex material,” mandating increased security at the site. “In a 2007 report, the Corps, taking a different stance from the NRC’s prior assessment of the site, said ‘concentrations of radionuclides in the buried wastes are high enough to present a potential future risk to human health’ and need to be removed.”]

WALL STREET JOURNAL: Emshwiller, John R and Jeremy Singer-Vine, A Nuclear Cleanup Effort Leaves Questions Linger at Scores of Old Sites, Wall Street Journal, Oct 30, 2013.

<http://online.wsj.com/news/articles/SB10001424127887323342404579079483154040874#printMode>.

WORLD NUCLEAR INDUSTRY STATUS REPORT PROJECT: Schneider M, Froggatt A, Hosokawa K, Thomas S, Yamaguchi Y, and Hazemann J, Independent Assessment of Nuclear Developments in the World, Jul 30, 2013.

<http://www.worldnuclearreport.org/World-Nuclear-Report-2013.html>.

[Lead authors: Mycle Schneider and Antony Froggatt, energy experts and independent consultant based, respectively, in Paris, France and London, UK. Contributors: Komei Hosokawa, Professor for Environmental and Social Research at Kyoto Seika University, Japan; Steve Thomas, Professor for Energy Policy, Greenwich University, UK; Yukio Yamaguchi, Co-Director of the Citizen’s Nuclear Information Center (CNIC), Tokyo, Japan; and Julie Hazemann, Director of EnerWebWatch, Paris France. The Forward is written by Peter A. Bradford, Esq., an energy policy professor at University of Vermont Law School, and a former Commissioner at the U.S. Nuclear Regulatory Commission (NRC). {Group description and bios at <http://www.worldnuclearreport.org/Who-we-are.html>.}]

Detailed overview of the history, current status and trends of nuclear power programs worldwide. (Length: 166 pages, incl. extensive reference citations.) The edition also includes an update on safety problems (including the issues raised by aging reactor fleets), energy market analyses, and the poor economics of nuclear power. The report concludes the world nuclear industry is facing daunting challenges. Renewable energy investment, installed capacity and generation are reviewed. A key to transitioning to clean energy is energy market reform.]

2012

BUSINESSWEEK: Funk, Josh, Nebraska nuclear plant not restarting soon, Bloomberg Businessweek News (report from AP), Jul 18, 2012.

<http://www.businessweek.com/ap/2012-07-18/nebraska-nuclear-plant-not-restarting-soon>.

[The Fort Calhoun nuclear power plant in Nebraska was shut down for more than a year due to safety problems. Fort Calhoun was initially shut down in April 2011 for routine refueling maintenance, but flooding along the Missouri River and the safety violations regulators identified forced it to remain offline. Problems included a small electrical fire in June 2011 and deficiencies in flood planning (discovered before extended flooding along the Missouri River). In May 2012, workers found a crack in the steel shield surrounding one of the heaters that help maintain the

temperature of the water used to generate steam. A key electrical part had also failed during a 2010 test.]

CONGRESSIONAL RESEARCH SERVICE: Werner, JD, U.S. Spent Nuclear Fuel Storage, Report of the Congressional Research Service, 7-5700; R42513, May 24, 2012.
<https://www.fas.org/sqp/crs/misc/R42513.pdf>.

[As of Dec 2011 more than 67,000 metric tons of spent fuel in more than 174,000 assemblies is stored at 77 sites (including 4 DOE facilities) in 35 states, increasing at the rate of about 2,000 metric tons per year. About 73% (67,450 metric tons) of spent fuel continues to be in spent fuel pools, which are becoming filled to capacity. At 27 sites there is no current dry cask storage capability. (Summary.) The 5 states with the largest total amount of spent nuclear fuel measured by metric tons of heavy metal content are: New York; Illinois; Pennsylvania; South Carolina; and North Carolina. The top five states with the largest amount of spent nuclear fuel in pools are: New York; Illinois; Pennsylvania; North Carolina; and Alabama. (p 24)

“In fact, virtually every site that has ever hosted a commercial nuclear reactor is currently also a storage site for SNF.” (p 17) Approximately 80% of commercial spent nuclear fuel, measured by mass, is stored east of the Mississippi River. (p 23)

“Notwithstanding the mandate in the Nuclear Waste Policy Act (NWPA) and various contracts that DOE begin accepting SNF for disposal in 1998, no disposal repository has been completed or licensed.” Even if the Yucca Mountain program – terminated in 2009 – were to be resumed quickly, the time required to ship nuclear waste would require an extended period of storage, with interim storage being needed until at least 2056. The current quantity of nuclear waste in the nation (at commercial and government sites) exceeds the legal capacity of the proposed Yucca Mountain repository. (p 5)

A survey of spent fuel storage in 10 nations with significant nuclear operations found that all store substantial amounts of spent fuel in pools or dry casks. France (with 13,500 metric tons of spent fuel and 2,229 cm of vitrified high level waste as of 2007) has not yet selected a disposal site for high level waste. Finland (with 4 nuclear reactors) is the only country where a commercial nuclear waste repository site has been selected with local government acquiescence. (p 7)

The U.S. federal government has already paid out about \$1 billion in claims and faces significant and growing liability arising from contracts DOE signed in 1983 and the 1987 Nuclear Waste Policy Act whereby the government was supposed to assume nuclear waste from commercial nuclear utilities. “The future estimated costs for storage of commercial SNF are approximately \$500 million per year.” (pp 7-8)

The Department of Energy took possession of the spent fuel and debris from the 1979 Three Mile Island plant accident. (p 25)

“In the 1970s a relatively small amount (248.7 MTU of commercial SNF was shipped from commercial reactors, including utilities in Michigan and New York, to the West Valley site in New York, which reprocessed SNF for about six years (1966 to 1972). The resulting high-level waste and contaminated facilities remain at the site. DOE has estimated that decommissioning and

environmental remediation of the contamination at the West Valley site will continue until at least 2020, cost \$3.7 billion, and require indefinite long-term stewardship thereafter.” (pp 25-26)

In addition to the releases of tritium contamination from spent fuel pools and other structures to groundwater at 38 commercial nuclear sites, “tritium contamination was found in groundwater from spent fuel storage pools at DOE sites, including the Brookhaven National Laboratory in New York, Hanford in Washington State, and the Savannah River Site in South Carolina....Tritium is inherently difficult to remediate, once released, because it is simply a radioactive form of hydrogen that substitutes freely with hydrogen in water and decays at a rate of about 5% per year (12.32 year half life). (p 34)

The inherent hazards of spent nuclear fuel can result in a variety of risks. “A variety of forces or ‘threats’ acting on spent fuel could result in containment being breached, resulting in potential exposures and risks, generally: (1) loss of power for water supply, circulation, or cooling, which can have significant consequences for SNF in wet pool storage; (2) external threats, like hydrogen explosions from adjacent reactors, or an airplane crashing into an SNF storage facility; (3) long-term degradation of SNF through chronic corrosion of cladding (e.g., hydride corrosion); and (4) leakage of contaminated water from wet pools to groundwater.” (p 30) In contrast to the US, “Germany explicitly requires protection against risks, including ‘external events’ such as an attack on SNF storage, and this has resulted in construction of hardened storage buildings for dry cask storage of SNF.” (p 32)

“Another potential threat to SNF storage safety is degradation of the cladding and fuel elements.” The potential for degradation of SNF cladding has been well known for decades. (p 33) “Zirconium has a high affinity for hydrogen. Absorption of hydrogen leads to hydrogen embrittlement, which can lead to failure of the zirconium tubing used as cladding for nuclear fuel. In addition, zirconium also reacts with oxygen, which can lead to corrosion.” (p 33, fn 142, quoting Kok, Kenneth D, *Nuclear Engineering Handbook*, CRC press, 2009, at p 287)]

Cooper, Mark, Nuclear Safety and Nuclear Economics, Fukushima Reignites the Never-Ending Debate: Nuclear Safety at an Affordable Cost, Can We Have Both? Is Nuclear Power Not Worth the Risk at Any Price? Paper presented at Symposium on the Future of Nuclear Power, University of Pittsburgh, Mar 27-28, 2012.
<http://www.vermontlaw.edu/Documents/NuclearSafetyandNuclearEconomicssUMMARY.pdf>.

[Paper by economist Mark Cooper, PhD, Senior Fellow for Economic Analysis, Institute for Energy and the Environment at Vermont Law School.

Overview of historic unfavorable economics of nuclear power. As Forbes noted in a 1985 cover story: “The failure of the U.S. nuclear power program ranks as the largest managerial disaster in business history, a disaster on a monumental scale. The utility industry has already invested \$125 billion in nuclear power, with an additional \$140 billion to come before the decade is out, and only the blind, or the biased, can now think that most of the money has been well spent. It is a defeat for the U.S. consumer and for the competitiveness of U.S. industry, it’s the utilities that undertook the program and for the private enterprise system that make it possible.” {*Original quote from Nuclear Follies, Forbes, Feb 14, 1985.*}

From its inception to the present, reactor cost overruns have been endemic. Analysis of reasons for large number of early retirements indicates that, while equipment failures, system deterioration, and repeated accidents, etc. tend to be precipitating events for closure, the most frequent proximate cause is economics. Many plants have also experienced long costly outages. (E,g, Exhibit V-10: Significantly Early Retirements And Reactors with Outages Exceeding 5 Years, p 53)

Notably, cost reductions which the industry hoped would flow from increasing economies of scale and learning curve processes over the decades has never come to pass.

Resource investment in the electricity sector must also deal with risk. In the case of nuclear power – as Fukushima demonstrated – involves the possibility of so-called “low probability, high consequence” events. Nuclear power involves an extraordinarily complex technology that can be catastrophically dangerous and is subject to human error and natural disaster (not to mention security risk).

If a market standard is used, nuclear power is neither affordable nor worth the risk at any cost.

Indeed, the markets have always decided that nuclear power is not worth the risk. Nuclear power has been enabled only because of large public subsidization and externalization of risk.

A prime example is the Price-Anderson Nuclear Industries Indemnity Act of 1957. Price Anderson was enacted for a simple reason: Private companies simply would not build reactors if they were exposed to the full liability of a nuclear accident. The challenge of safety continues to be so severe that the industry would never be viable without shifting risk away from itself onto the public. Price Anderson – which is only one of many subsidies that the nuclear industry has received – creates an unfair market distortion. Competitors – unlike nuclear – need to obtain their own insurance.

More dangerously, Price Anderson takes away the normal market incentive for safety-related investments. “Needless to say, in a market economy where risk is supposed to determine reward, the socialization of risk sends a strong signal about the nature of the investment and the incentives for behavior that affect attention to safety.” (p 10)

The nuclear accident risk imposed upon the public is of potentially very high magnitude. The cost of the 1986 Chernobyl accident is approaching \$700 billion. (p 25) Current estimates of the cost of the 2011 Fukushima disaster are up to a quarter of a trillion. (p 56) The cost of a large accident at a US reactor would likely be about 30 times higher than the current \$12.5 billion cap. (p 26) The impacts of a severe accident at a nuclear power plant in close to proximity to a large population center like Indian Point would be very serious and deserve a great deal of attention.

Post-accident reviews underscore the severe problem that nuclear power suffers when it comes to low probability, very-high impact events. “They are highly uncertain and not well understood. The severe impacts can be imposed on large areas and populations that are not prepared. These problems affect nuclear power at all times. (pp 56-57; *citing 1993 US Office of Technology Assessment of aging reactors.*)

“With a technology as complex and dangerous as nuclear reactors, safety concerns continuously evolve and the technology never stabilizes. Operating experience, aging reactors and beyond design events continually challenge the safety regime in place.” (p 57)]

DENVER BUSINESS JOURNAL: Brown, Steven EF, Renewable Energy Passes Nuclear as U.S. Power Source, Denver Business Journal, Jan 10, 2012.

<http://www.bizjournals.com/denver/news/2012/01/10/renewable-energy-passes-nuclear-as.html?page=all>.

[The U.S. Energy Information Administration report on energy sources and usage in the US, which covered the 9 months of 2011 ending in Sep, showed that renewable energy sources passed nuclear power generation as a share of power. The Energy Information report showed 6.944 quadrillion BTUs – or quads – of energy were generated from renewable sources, compared with 6.173 quads from nuclear. The EIA counts renewable sources as wind, solar, hydroelectric, geothermal, and biofuels.]

ENERGY: Dittmar M, Nuclear energy: Status and future limitations, Energy (2012); 37 (1): 35-40. <http://www.sciencedirect.com/science/article/pii/S0360544211003653>. {See also

paper at

http://www.societalmetabolism.org/aes2010/Proceeds/DIGITAL%20PROCEEDINGS_files/PAPERS/O_118_Michael_Dittmar.pdf.}

[Nuclear energy is plagued by a long list of unsolved problems. Without solution, despite decades of research, is the problem of final safe storage of already accumulated highly radioactive nuclear waste.

A less known problem is that nuclear power plants cannot provide power according to need. Because they must be continuously operated, nuclear power plants cannot power down during times of less demand.

Nuclear power plants also need large contributions of water resources. And uranium is a limited non-renewable fuel.

Finally, the focus on nuclear power has wasted resources urgently needed to move down the path of a low energy future. Thus, nuclear energy is not a solution to our energy worries but part of the problem.]

FORBES: McMahon, Jeff, Exelon's 'Nuclear Guy': No New Nukes, Forbes, Mar 29, 2012.

<http://www.forbes.com/sites/jeffmcmahon/2012/03/29/exelons-nuclear-guy-no-new-nukes/>.

[A few weeks following his retirement as CEO of Exelon, the largest American nuclear power producer, John Rowe Nuclear stated that nuclear power is no longer an economically viable source of new energy in the U.S.

Rowe made his statement during a presentation at the University of Chicago, Harris School of Public Policy on Mar 28, 2012. “Let me state unequivocally that I’ve never met a nuclear plant I didn’t like,” Rowe said. “Having said that, let me also state unequivocally that new ones don’t

make any sense right now.” He added, “It just isn’t economic, and it’s not economic within a foreseeable time frame.”]

Hart EK, Stoutenburg ED, and Jacobson MZ, The Potential of Intermittent Renewables to Meet Electric Power Demand: Current Methods and Emerging Analytical Techniques, Paper published in the Proceedings of the IEEE (2012); 2: 322-334.
<http://www.stanford.edu/group/efmh/jacobson/Articles//CombiningRenew/HartIEEE2012.pdf>.

[Paper describing how large-scale integration into the grid can enable renewable energy sources to supply a large fraction of electric power demand and overcome the intermittency challenges of renewables like wind and solar and the seasonal cycles of renewables like small hydropower, river current and ocean currents. The paper describes a framework for classifying grid integration analyses and looks at the assumptions and modeling considerations various analysts have employed. The authors then propose a new analytical method for including the effects of intermittency, incorporating the results of both low and high penetration analyses, to enable large-scale deployment of renewable. Mitigation of intermittency must address both variability and uncertainty. Variable, but predictable resources can be managed with careful day-ahead scheduling. Uncertainty introduces the need for additional reserves that supply the load in the case of unpredictable reductions in generation or increases in load. (p 232) The authors additionally argue for demand response and energy storage technology as part of a realistic carbon emission reduction strategy.

Reducing carbon requires “reducing technological and institutional barriers to high penetration grid integration of renewable, including transmission infrastructure planning, the development of new interconnection regulations and protocols, and the development of new communications and controls that simultaneously support system reliability and increasing penetrations of renewable energy technologies.” (p 331)]

MICROGRID HORIZONS: Roach M, Hurricane Sandy & the Emperor’s New Clothes: Microgrids as a Risk Mitigation Strategy for Extreme Weather Events, White Paper, Dec 13, 2012.
http://nyes.org/pmwiki/uploads/EnergyLiteracyLibrary/2012_Roach_HurricaneSandyandtheEmperorsNewClothes_wRefs.pdf

[White Paper by Michael Roach, CEO of MicroGrid Horizons, provides analysis of feasibility and emphasizes the urgency of transformation to microgrids.

Hurricane Sandy and other severe storms have exposed the fact the 20th Century electricity transmission systems and utility modes of operation are inadequate to cope with extreme weather events we can anticipate in the 21st Century. For 100 years, the model has been to wait for a storm to blow over, then sequentially respond to customer complaints and calls about loss of power, then send line crews out to repair the system. However, as Sandy, Katrina, etc has showed, when the scale of the damage is vast, utility companies are overwhelmed and contingency plans fail. After Sandy, over 8 million people lost power for from days to weeks. Right after the storm, 85% of Long Island went dark. New York City’s 14th Street Con Edison substation blew up and knocked out power for most of lower Manhattan below 34th Street. The

A smart grid can help, but even a smart grid cannot forecast where exactly a storm will hit or the degree of human and property consequences. The system as a whole needs to be made more secure and resilient and a microgrid structure is a primary means of accomplishing those goals.

At the generation level, while the grid has been reliable, nuclear accidents like Three Mile Island and Fukushima exposed extreme disruptions not included in scenario risk analyses. (p 8) At the transmission level, the US grid system is supposedly designed to prevent cascading failures, but reality has proved otherwise. Major collapses caused by cascading failures include the 2003 Blackout that knocked out power to 60 million people in the Northeast and the Sep 2011 Blackout that shut down power to a large segment of southern California. The grid is particularly vulnerable at the distribution level where winds fell trees, poles, and electric wires.

Reliability is also strained by an outmoded business model and the regulatory framework that continues to enable it. The model where a handful of corporations generate and distribute power is undergoing “extreme stress,” internally from unstable customer markets, financial pressures and often highly volatile energy supply commodity markets, and externally from new technology competitors. “Most utility companies resist structural change and continually fall back on their vestigial monopoly position to fight competition.” (p 8) But Hurricane Sandy exposed “the reckless and extreme level of risk” involved in maintaining the old model.

Entrenched business models resist change, especially if vast forces of vested interest are involved. However history shows that transformation from one dominant business model/technology to another is possible, and sometimes very quickly. Examples include: whale oil to petroleum; Pony Express to telegraph lines; Ma Bell landlines to wireless communications; horse-drawn carriages to automobiles; sailboats to steamships; steamships to airplanes; mainframe computers to distributed computing; express mail to fax machines; fax machines to email. There are also many examples of the military changing technologies. A classic and dramatic example was the fight Gen. Billy Mitchell waged within the US military for heavy investment in air power following WWI. Gen Mitchell felt it was more economically efficient to build and maintain a fleet of one thousand airplanes than to build one battleship to defend the Eastern coast of the US. He also believed the supremacy of battleships in war was over. His efforts led his court-martial for insubordination in 1925. Later in the century he was honored for having the courage and foresight to prepare America for WWII. He is now regarded as the father of the modern American Air Force. (pp 8-9)

“Some utility companies may fight just as tenaciously as the old Generals and Admirals did in denying the importance of a new world-changing energy technology on their business model.” (p 13) But others are slowly embracing the scheme and the forces of technology and economics add strong impetus.

Strategic alternatives to massive power outages from extreme weather events have been proposed. “The New York State Energy Research and Development Authority (NYSERDA) has devoted large resources to ‘studying’ distributed generation and microgrids in particular.” NYSERDA has issued numerous high quality reports. But action remains to be taken. (p 10)

The Consortium for Electricity Reliability Technology Solutions (CERTS), a group of universities, government research laboratories and corporate partners, have conducted studies that show the US continues to experience intermittent but catastrophic blackouts. “Whether nature-made (e.g., hurricanes, lightning, snowstorms, fires, etc.) or man-made (operator errors, equipment malfunction, etc.), the results of an outage were the same for electricity customers – no grid electricity for extended periods of time and no backup.” (p 10) CERTS determined that a priority

is to qualitatively improve grid reliability by integrating distributed energy resources (DER). CERTS analyses showed that grid vulnerabilities could be greatly reduced or eliminated entirely if DER and load management systems were integrated at the facility level. (p 11)
Microgrids – small scale electrical systems – could resolve seemingly intractable technical problems. (*Details on eliminating microgrid technical challenges* pp 11-13)

Integration of renewable resources and distributed systems, with the use of microgrids and cogeneration are a viable and desirable means of hardening the electric system.]

NEW YORK TIMES: Witkin, Jim, Cities Enticed by Pay-if-You-Save Energy Deals, New York Times, Oct 24, 2012. <http://www.nytimes.com/2012/10/24/business/energy-environment/energy-service-contracts-a-boon-for-public-agencies.html>.

[Allocating the funds to pay for energy savings programs is a challenge faced by cities nationwide. A form of financing that has become common among government agencies at all levels: an energy savings performance contract. This model requires no upfront costs and allows the city to pay for the project over time using the savings on utility bills.

The city of Brea, Calif, used the model to rapidly add efficiency in cooperation with an energy service contract with Chevron Energy Solutions, a unit of the Chevron Corp. Chevron performed all the work and provided all the new equipment. The company's contract with the city guarantees a certain level of energy cost savings, and is expected to save the city 40% on energy costs and millions of dollars. From the savings, the city will pay off two bonds issued to finance the project over a period of 20 years.

The energy savings performance contract model is growing in appeal. Dozens of large energy service companies offer contracts with guaranteed savings as their core business model, according to the National Association of Energy Service Companies, a trade association. Some 80 – 90% of energy service company revenues come from projects with municipalities, public universities and schools, hospitals and government agencies. “Most public facilities in most parts of the country are starved for any kind of investment for improvements,” said Don Gilligan, the trade association president. He estimated many aging buildings are wasting 25-35% of what they pay on their energy bills. A performance contract allows them to redirect the money they spend on wasted energy to pay for the capital cost of improvements with no tax increase. “That is a very big payment stream and a very attractive driver for public institutions.”

The Federal Energy Management Program reports that, since 1998, federal government agencies have used performance contracts on about 580 projects, saving \$13.4 billion and enough energy to power a city of 900,000 for a year.

Charles H. Goldman, a senior scientist at Lawrence Berkeley National Laboratory in Berkeley, Calif., who has studied the market since 2000, says the energy service company market gets bipartisan support. “This ‘is an example of a successful private sector industry that is relatively self-sustaining and doesn’t rely on a lot of incentives or subsidies outside the basic economics of these projects’ he said.” Contracts can also be designed so that jobs created are local.]

NEW YORK TIMES: Nagano, Yuriko, Geothermal Power Tests Tradition in Japan, New York Times, Oct 1, 2012. <http://www.nytimes.com/2012/10/02/business/energy-environment/geothermal-power-tests-tradition-in-japan.html>.

[Japan has significant thermal energy potential. Keiichi Sakaguchi, of Japan's National Institute of Advanced Industrial Science and Technology is quoted as stating that geothermal has potential to serve as a base load for energy production in Japan. A major obstacle is that geothermal resources are in areas occupied by hot spring resorts.]

NEW YORK TIMES: Gardiner, Beth, Marine Energy Projects Pick Up Momentum, New York Times, Oct 1, 2012. <http://www.nytimes.com/2012/10/02/business/energy-environment/marine-energy-projects-pick-up-momentum.html>.

[Discussion of potential for harnessing the power of the waves and tides to create power. This is a technology still under development, but the US Department of Energy believes wave and tidal power could meet 15% of US electricity needs by 2030.]

NUCLEAR INFORMATION AND RESEARCH SERVICE: Damveld H and Bannick D, Management of Spent Fuel and Radioactive Waste: State of affairs – A worldwide overview, NIRS Nuclear Monitor, 746/747/748, May 2, 2012. http://www.nirs.org/mononline/nm746_48.pdf.

NYSERDA: Michael, Karl, New York State Energy Efficiency and Renewable Energy Potential Study, Presentation of Karl Michael, Program Manager, NYSERDA, to New York State Energy Planning Board, Jul 9, 2012.

[The NYSERDA study objective was to develop a quantitative assessment of the long-term technical, economic, and achievable potentials for (1) Improvements in end-use energy efficiency and conservation in the residential, commercial, industrial and government sectors, and (2) renewable energy, including grid-level electricity generation and customer-sited production of electricity and thermal energy.

Key efficiency findings: “Significant efficiency potential exists across all sectors and fuel types.” The commercial sector holds the largest efficiency potential across all fuel types. “Electricity efficiency shows the greatest potential to reduce primary energy use.” (p 3)

Key renewable findings: “Substantial potential exists for increases in hydropower, bioenergy, wind power, and solar energy.” “Wind and solar provide the greatest potential for growth.” (p 8)]

ROCKY MOUNTAIN INSTITUTE: Vaughn, Kelly, Empire State Building Retrofit Surpasses Energy Savings Expectations, Article on RMI Outlet, Rocky Mountain Institute May 31, 2012. http://blog.rmi.org/blog_empire_state_retrofit_surpasses_energy_savings_expectations

[The Empire State Building presents a strong case for building retrofit programs. The Empire State Building retrofit is estimated to reduce the building's energy use by 38%, saving some \$4.4 million annually. The retrofit has exceeded the energy efficiency goal by 5%. Over 15 years, the project should cut carbon use by 105,000 metric tons. A joint report produced by Johnson Controls, Jones Lang LaSalle, and W&H Properties identified the following efficiency measures responsible for a total first year savings: (1) radiator insulation and steam trap savings; (2) windows retrofit; (3) direct digital controls and demand control ventilation; (4) chiller plant retrofit; (5) tenant energy management; (6) tenant daylighting and plugs; and (7) VAV Air.]

STANFORD UNIVERSITY WIND STUDY: Dvorak MJ, Corcoran BA, Ten Hoeve JE, McIntyre NG, and Jacobson MZ., US East Coast offshore wind energy resources and their relationship to peak-time electricity demand, Wind Energy (2012); Wiley Online Library (wileyonlinelibrary.com) DOI: 10.1002/we.1524.
<http://www.stanford.edu/group/efmh/jacobson/Articles//Offshore/12DvorakEastCoastWindEn.pdf>.

[Study by scientists from the Atmosphere/Energy Program, Department of Civil and Environmental Engineering, at Stanford University (CA, US).

Authors note that offshore wind energy located near large and dense coastal electricity demand centers has the potential to provide large amounts of carbon-free power. In the US, a majority of the population lives near oceans or the Great Lakes, and 23 of the 25 most densely populated counties are coastal. Moreover, the 28 states that have coastal boundaries use 78% of the nation's electricity.

The major finding of this Stanford University study is that the strong winds off the East Coast alone could power all of the annual coastal electricity demand from Florida to Maine, about one third of US electric demand. In addition, with the exception of summer, all peak-time demand from Virginia to Maine could be satisfied by offshore wind energy from the waters off those states.

The East Coast of the United States is "an ideal location" for large offshore wind farms because its characteristics of exceptional levels of offshore wind, low severe-hurricane risk, and shallow water combined with the factors of a large coastal population, an aging and congested land-based grid, and high electricity prices.

The calculations were made via analysis of the annual mean offshore wind energy resource along the East Coast using 5 years of high-resolution mesoscale model (Weather Research and Forecasting—Advanced Research Weather Research and Forecasting) results at 90 m height. Model output was validated by evaluation against 23 buoys and nine offshore towers.

Peak-time electric demand was analyzed to determine if offshore wind resources were coincident with the increased grid load. The most suitable locations for large-scale development of offshore wind energy were ascertained on the basis of the wind resource, bathymetry, hurricane risk and peak-time generation potential.

The researchers emphasize the importance of demographics. The density of the population in the East Coast enables new electrical generation to serve a large number of people in a limited spatial area with limited investment in transmission. States like New York, Massachusetts, Connecticut, Maine and Pennsylvania with high population densities and high demand for new

transmission often also have the highest siting difficulties. This can be a limiting factor for land-based wind farms. But this problem is greatly reduced for offshore wind turbines where transmission cables are underwater.

Cost analysis must account for transmission congestion, because that adds measurably to the expense of electrical provision. Offshore wind can ease transmission congestion by putting large amounts of generation online adjacent to areas with high demand.

Another determination which must be made when considering the extent to which hourly demand for electricity can be met by renewable supply is reliability of output. "It is known that aggregating wind power generation with transmission lines from multiple, geographically dispersed wind farms reduces the number of hours with no output and makes the total wind energy output probability density function more Gaussian than Weibull." Other researchers have explored the utility of connecting offshore wind farms along the East Coast by using buoy and reanalysis data, finding that wind farms connected ~1000 km apart and aligned with the prevailing frontal movements reduced ramp rates and lowered the number of no or full-power events.

In addition to wind and weather factors, underwater geography is a factor. The continental shelf of the East Coast extends out especially far in the regions off Massachusetts, New Jersey, Delaware and Virginia, with depths of ~50 m being found as far out as 80 km.

Technically, the resource from Florida to Maine out to 200 m depth, with the use of turbine capacity factor cutoffs of 45% and 40%, was found to be 965 to 1372 TWh - a 110–157 gigawatts average.

The study group found the region span from Virginia to Maine has the most exceptional offshore resource. Annual turbine capacity factors in this area range between 40% and 50%. The waters are shallow. And the climatology is favorable. The best summer resource during peak time, in water of ~50 m depth, is between Long Island, New York and Cape Cod, Massachusetts, due in part to regional upwelling which strengthens the sea breeze.

Thus the Stanford scientists concluded that hundreds of gigawatts of high-voltage direct current (HVDC) could be transmitted through a proposed seabed transmission line from New York to Virginia called the Atlantic Wind Connection. An alternative offshore proposed grid location could take advantage of sea breezes, spanning from Long Island, New York to the Georges Bank. In either event, a substantial amount of electricity demand could be met by interconnected offshore wind farms along the East Coast.]

TIMES-PICAYUNE: Galofaro, Claire, City Council grills Entergy on response to Hurricane Isaac, Times-Picayune / NOLA.com, Sep 4, 2012.
http://www.nola.com/hurricane/index.ssf/2012/09/city_council_grills_entergy_on.html.

[The New Orleans City Council unanimously passed a resolution launching an inquiry into how Entergy New Orleans prepared for and responded to Hurricane Isaac, which hit the city on Aug 28, 2012 and sat above the city for over 50 hours. The City Council hammered Entergy "on several topics -- its poor communication with the thousands left in the dark, whether it had neglected rotten poles and encroaching trees and what it could have done better to steel its infrastructure to weather such storms." The council focused on Entergy's failure to communicate their process with the public. "People were left in the dark, deciding whether to stick it out or find

somewhere else to go with no information about when they might expect their power to be restored. Entergy's web site, often inaccurate, the company admitted, was also no good to most without power or Internet access.” Cynthia Hedge-Morrell, Chair of the council's Utility Committee said, “We've got to have one-time, real-time information so people can make life or death decisions.”

Widespread flooding and heavy winds stalled thousands of crews coming into the city from states as far away as New Jersey, he said. Across the state, more than 700,000 lost power and thousands remained without power for over a week. Council President Stacy Head expressed concern that Entergy had not adequately maintained the transmission system, pointing to the high number of rotten poles that toppled in the storm. “Head, and the other council members, asked what system maintenance the company had done since it received \$200 million in federal recovery funds after declaring bankruptcy in the wake of Hurricane Katrina. ‘I think we need to investigate the investment in infrastructure versus the profit by the big boys at Entergy,’ said Council Vice President Jackie Clarkson.”

About an hour after the meeting wrapped up, and the council voted unanimously to launch an inquiry, 11,000 more lost power in downtown New Orleans because of a substation problem.]

2011

BROOKINGS INSTITUTION: Muro M, Rothwell J, and Saha D, with Battelle Technology Partnership Practice, Sizing the Clean Economy: A National and Regional Green Jobs Assessment, Report of the Brookings Institution Metropolitan Policy Program, Jul 13, 2011. <http://www.brookings.edu/research/reports/2011/07/13-clean-economy>.

[Brookings is a non-profit Washington, DC-based research and analysis institution. This report reviews the need for rapid transformation to a clean, sustainable economy in a globe burdened by pollution, climate change, and population growth. An already stressed planet will be further strained in coming decades. Water is a particular concern. A major driver of clean economy growth is better regulation of polluters and reformation of energy market structures.]

ENERGY & CAPITAL: O'Donnell, Cori, Siemens Leaving Nuclear Power Business for Good, Energy & Capital, Sep 20, 2011. <http://www.energyandcapital.com/articles/siemens-leaving-nuclear-power-business-for-good/1786>.

[The Siemens corporation announced it will no longer build or finance nuclear power plants anywhere in the world, but will instead focus on developments with renewable energies, smart grid and water technologies.]

Gordon M, Wiegman L, Fields M, and Oringel H, Mid-Hudson Energy Solutions Roadmap, Issue Brief for Northern Westchester County (NWEAC) (2011); 1. As updated in <http://www.nweac.org/2011/10/26/the-mid-hudson-regional-energy-solutions-road-map/>.

["Operational or mechanical inefficiencies exist in every sector of commerce. Therefore, each sector has significant energy saving opportunities. Energy solutions have powerful cross-cutting benefits for economic development and can often be funded out of net savings realized – making available operating capital for staff and business reinvestment." Brief outlines a "roadmap" of five cohesive energy solution pathways for New York's Mid-Hudson Valley. Solutions 1-3 address the demand side of the energy grid, and focus on efficiency, demand response and microgrids. Solutions 4-5 address supply side energy, focusing on renewable sources and energy storage.

Mid-Hudson region businesses spend as much as \$1.6 billion a year on utilities per year. Energy efficiency alone could make \$80 million or more a year available in the commercial sector. Mid-Hudson region households spend \$2.4 billion on utilities per annum. If just 5% savings were achieved through common energy upgrades, the residential sector alone would save \$119 a year.

"In short, energy efficiency alone could make available \$220 million per year or more in private capital for job retention and creation in our seven counties."]

GOVERNMENT ACCOUNTABILITY OFFICE: Commercial Nuclear Waste: Effects of a Termination of the Yucca Mountain Repository Program and Lessons Learned, Report of the Government Accountability Office, Apr 2011, GAO-11-229.
<http://www.gao.gov/assets/320/317627.pdf>.

["Spent nuclear fuel – considered very hazardous – is accumulating at commercial reactor sites in 33 states." The Nuclear Waste Policy Act of 1982 put the responsibility for creating a waste depository on the government. But DOE determined the Yucca Mountain repository program is not a workable option. Resolving the issue of what to do with spent commercial nuclear fuel "will likely be a decades-long, costly, and complex endeavor, which can be disrupted by changing views and unpredictable funding".

Some funding mechanism is needed to support development and implementation of a disposal solution the nation's spent nuclear fuel. However, "there is no guarantee" that an acceptable less costly than Yucca Mountain alternative will be identified. Finding another permanent solution may be a costly and time-consuming process which will likely take decades and will likely prolong the need for interim storage of spent nuclear fuel at reactor sites, which would have financial and other impacts. The federal government bears part of the nuclear waste storage costs. Industry lawsuits over DOE's failure to take custody of commercial spent nuclear fuel in 1998, "exceed \$15.4 billion and could grow by an additional \$500 million a year after 2020."]

Lovins, Amory B and Rocky Mountain Institute, *Reinventing Fire: Bold Business Solutions for the New Energy Era*, Chelsea Green Publishing, VT (2011). [Amory Lovins, a recognized international expert on energy and its connection to the economy and security, has advised the U.S. energy and defence department and governments worldwide. Rocky Mountain Institute is a think tank that specializes in entrepreneurial-driven ideas for efficient and restorative use of energy and natural resources. Forewords to the book were written by Marvin Odum, President of Shell Oil Company, and John W. Rowe, Chairman and EO of Excelon Corporation. The book provides a roadmap for navigating the U.S. economy through the end of the fossil fuel era by transforming design, promoting innovation, and the vast expansion of

energy efficiency technologies and renewable energy. The ideal driving the work is articulated in the preface:

“Imagine fuel without fear. No climate change. No oil spills, dead coal miners, dirty air, devastated lands, lost wildlife. No energy poverty. No oil-fed wars, tyrannies, or terrorists. Nothing to run out. Nothing to cut off. Nothing to worry about. Just energy abundance, benign and affordable, for all, for ever.” (p. XI)]

NEW YORK TIMES: Dempsey, Judy, Siemens Abandoning Nuclear Power Business, New York Times, Sep 18, 2011. <http://www.nytimes.com/2011/09/19/business/global/19iht-siemens19.html>.

[Siemens, the largest engineering conglomerate in Europe announced it will stop building nuclear power plants and commit to the rapidly growing renewable energy sector. Siemens' CEO Peter Löscher called Germany's plans to end nuclear power and execute its ambitious plan to generate 35% of its electricity from renewable sources by 2020, “the project of the century” and one which was “achievable.” Siemens has more than 400,000 employees worldwide, manufactures turbines, high-speed trains, and a diverse set of other sophisticated equipment and products. It is now one of the world's largest providers of environmental technologies, which in 2010 generated €28 billion of revenue. In 2010 Siemens reported that its renewable energy unit had the strongest growth of all its lines of business.]

NEW YORK TIMES: Navarro, Mireya, Mapping Sun's Potential to Power New York, New York Times, Jun 16, 2011. <http://www.nytimes.com/2011/06/16/science/earth/16solar.html>.

[Two-thirds (66.4%) of the rooftops of New York City's one-million plus buildings are suitable for solar panels. The solar potential could generate enough power to meet nearly half (49.7%) of the city's demand for electricity at peak periods and about 14% of the city's annual electrical demand. This striking solar potential, amounting to some 5,847 megawatts, is detailed in an interactive map on the web site of the City University of New York City (CUNY) <http://nycsolarmap.com/>. The map was created using an aerial laser system known as Lidar, which collected data on the locations, shapes, sizes, angles, and degree of sun exposure of City roofs.]

NON-GOVERNMENTAL ORGANIZATIONS (NGOs): Costs, Risks, and Myths of Nuclear Power: NGO WORLD-Wide Study on the Implications of the Catastrophe at the Fukushima Dai-ichi Nuclear Power Station, Study coordinated by Reaching Critical Will, a project of the Women's International League for Peace and Freedom, 2011. <http://www.nirs.org/international/reachingcriticalwillreport.pdf>.

[Authors are 32 global experts from United Nations NGO's and other non-profit groups. The monograph is a compilation of papers (119 pp). Papers argue the feasibility of and need for the world to transition to renewable. (pp 35-45)]

Sovacool, Benjamin K, *Contesting the Future of Nuclear Power: A Critical Global Assessment of Atomic Energy*, World Scientific Publishing Co (Singapore, Hackensack, London), 2011.

[Benjamin K Sovacool, is Adjunct Assistant Professor in the Government and International Affairs Program at Virginia Polytechnic Institute. He investigated the social impediments to renewable energy systems for the NSF Electric Power Networks Efficiency and Security Program and has worked in advisory and research capacities at Oak Ridge National Laboratory, the New York State Energy Research and Development Authority, the Virginia Center for Coal and Energy Research, and the US Department of Energy's Climate Change Technology Program. In this book, he provides a broad multidisciplinary assessment of why nuclear power is a poor economic, environmental, and sociopolitical energy choice.

Nuclear power depends upon large subsidization to survive and externalizes risk. Renewables and efficiency technologies can provide less polluting energy and reduce carbon emissions without the host of technical, safety, environmental and sociopolitical problems imposed upon society by nuclear power.

Notably, the full nuclear fuel cycle involves mining, drilling, leeching, enrichment, transporting, and nuclear waste storage. Within a few decades, the carbon footprint of nuclear power plants will worsen to the equivalent of some fossil fuel-based sources of electricity. Per unit of net contributing carbon dioxide, nuclear incurs higher costs than competing, readily available, clean alternatives. Nuclear power plants problematically must also operate continuously and thus cannot accommodate to different load needs. Thus investment in renewables and energy efficiency technologies is a better economic bargain than nuclear.]

SYNAPSE ENERGY ECONOMICS: Woolf T, Wittenstein M, and Fagan B, Indian Point Energy Center Nuclear Plant Retirement Analysis, Oct 17, 2011. <http://www.synapse-energy.com/Downloads/SynapseReport.2011-10.NRDC.Indian-Point-Analysis.11-041.pdf>.

[Report by Synapse Energy Economics, a research firm specializing in energy, economic and environmental topics, prepared for the Natural Resources Defense Council, Inc and Riverkeeper, Inc. The report details the replacement options for Indian Point and considers both reliability issues and economic effects. Findings include:

If Indian Point is retired, there is likely to be no need for new capacity to meet reserve margin requirements until 2020 and a large amount of energy efficiency and renewable resources are available to replace Indian Point.

Off-shore and land-based wind and solar in NY can help provide carbon free replacement power. There is a large potential for rooftop solar and off-shore wind resources, most of which could be located within regions near Indian Point and close to high energy load centers.

Energy efficiency is the lowest-cost replacement resource available. Energy efficiency resources, beyond the ones planned, could provide 1,570 MW of capacity savings in the Indian Point region and additional savings are available in the rest of the state.

New transmission lines could play a significant role in ensuring reliability and eliminating congestion between the Indian Point region and the rest of New York State

Reactive power requirements do not pose a constraint on whether or when to retire Indian Point, nor are the costs of installation of capacitors (which would provide transmission operators with significant flexibility in addressing reactive power needs) likely to be significant if Indian Point retires.

To whatever extent efficiency and renewables are not fully utilized to replace Indian Point, natural gas and transmission expansion could make up any difference.

“New York’s goal of generating 30 percent of sales from renewable resources by 2015 is entirely achievable.” (p 18) “If Indian Point is retired, it would likely increase the opportunities for developers of new generation in the region to participate in the wholesale capacity market. Our analysis of the resources currently available in the NYISO queue is conservative in that it does not reflect the extent to which the queue may expand in response to Indian Point retirement.” (p 19)]

UNION OF CONCERNED SCIENTISTS: Koplow D, Nuclear Power: Still Not Viable without Subsidies, Report of the Union of Concerned Scientists, Feb 2011.

http://www.ucsusa.org/assets/documents/nuclear_power/nuclear_subsidies_report.pdf.

Summary at: <http://www.psr.org/nuclear-bailout/resources/nuclear-power-still-not.pdf>.

[Report (136 pp) for the Union of Concerned Scientists written by Doug Koplow, founder of Earth Track, Inc., an economic analysis firm which specializes in evaluation of energy market subsidies.

This report is the first comprehensive analysis of the many market-distorting subsidies provided to nuclear power throughout all stages of the nuclear fuel cycle. Such information is critical for an understanding of the economics of nuclear power and for comparing nuclear to emerging energy options.

“The findings are striking: since its inception more than 50 years ago, the nuclear power industry has benefited – and continues to benefit – from a vast array of preferential government subsidies. Indeed... subsidies to the nuclear fuel cycle have often exceeded the value of the power produced. This means that buying power on the open market and giving it away for free would have been less costly than subsidizing the construction and operation of nuclear power plants.” (p 1)

“In total, we estimate the value of legacy subsidies to nuclear power were at least 7.5 ¢/kWh – equivalent to nearly 140 percent or more of the value of the power produced from 1960 to 2008. In other words, the value of government subsidies to the first generation of nuclear reactors actually exceeded the value of the power produced by those plants.” (p 104) Ongoing subsidies to existing reactors have a broad range, but even the lowest estimate for ongoing subsidies at 2011 power prices would erode nearly 80% of the production cost advantage of nuclear relative to coal. High-end estimates indicate subsidies to existing reactors of roughly 4-6 ¢/kWh, or 70 to nearly 100% of the value of the power produced. “Given that these values *exclude* the massive legacy subsidies to the plants, their magnitude is impressive.” (p 104)

Notably missing from evaluations have been the costs to the taxpayer of nuclear waste and the shifting of long-term safety and security risks to the public. Nuclear plant security concerns have increased significantly since 9/11, and proliferation risks affect the US and the globe. “The complexity and lack of data in these areas make it impossible to quantify the magnitude of

security subsidies for this analysis. But it is clear that as the magnitude of the threat increases, taxpayers will be forced to bear a greater share of the risk.” (p 7)

Environmental damage done by nuclear plants is also a large hidden cost. When existing plants were sited, little consideration was given to the economic or ecological impacts of massive withdrawals of cooling water. Nuclear power reactors are the most intense water users per kilowatt hour of electricity produced. (pp 72-77, 105) As pressure on resources grows, nuclear plants consumptive withdrawals put increasing pressure on waterways.]

WALL STREET JOURNAL: Maremont, Mark, Nuclear Waste Piles Up—in Budget Deficit, Wall Street Journal, Aug 9, 2011.
<http://online.wsj.com/article/SB10001424053111904292504576484133479927502.html>.

[Spent nuclear fuel stranded nuclear sites across the US is not just a potential public health hazard, but a growing burden on federal finances. The federal government's assumption of responsibility for nuclear waste disposal three decades ago has become another unfunded liability, starting with a \$25 billion Nuclear Waste Fund gone astray. Congress spent the fund money on other things, so it is little more than an IOU. In addition, the Department of Energy will owe an estimated \$16.2 billion in legal judgments to nuclear utilities for the cost of holding nuclear waste by 2020; and \$500 million a year after that.

The costs of the ultimate disposal project also are sure to rise, with no plan in sight. (The DOE in 2008 estimated that building the Yucca Mountain facility and then transferring waste to it would cost \$83 billion in 2007 dollars on top of \$13.5 billion already spent.) Taxpayers are on the hook for the cost.]

2010

ASSOCIATED PRESS: More than one quarter of U.S. nuclear plants have leaked tritium, Associated Press interactive diagram, 2010.
http://hosted.ap.org/specials/interactives/national/leaking_nukes/index.html?SITE=AP.

[The diagram identifies nuclear sites which have leaked tritium with red dots and shows the vast majority to be located in the Northeast/East coast.]

CERES: Leurig S, The Ripple Effect, Water Risk in the Municipal Bond Market, Ceres Report with Analysis by Water Asset Management, Oct 2010.
<http://www.ceres.org/resources/reports/water-bonds>.

[In the context of financial assessment of the municipal bond market, this study warns the nation's water supply and water management systems are at risk, particularly from water shortages. Both quality and quantities of supply are at risk. These effects can impact bonds with investment in nuclear power plants which rely on access to water supply for cooling. Water shortages and droughts will especially impact water demand and supply.]

EPA: http://www.epa.gov/agstar/documents/2010_digester_update.pdf

[Showing the utility of agricultural digesters.]

HEINRICH BÖLL STIFTUNG: Froggat A and Schneider M, Systems for Change: Nuclear Power vs. Energy Efficiency + Renewables? Paper prepared for the Heinrich Böll Foundation, Mar 2010, updated Aug 2010. General page:
<http://www.boell.org/web/139.html>.

[Authors Mycle Schneider and Antony Froggatt are energy experts and independent consultants based, respectively, in Paris, France and London, UK. The Heinrich Böll Foundation is a German-based global non-profit which focuses on promotion of democracy and energy and environmental policies beneficial for human welfare.

Nuclear power globally is marred by poor economics. Historically and currently no private energy corporation will risk building a nuclear power plant without substantial government subsidies and guarantees. In addition, billions in government funds is devoted to nuclear waste. Costs for new plants is exploding. The danger of nuclear weapons proliferation where commercial nuclear power exists is growing, with Iran being one recent example.

Expansion of nuclear would act as a massive brake on the development of renewable energy. Nuclear especially limits the growth potential of wind. (Focus is on Europe, especially Germany.)]

HEINRICH BÖLL STIFTUNG: Thomas, Steve, The Economics of Nuclear Power: An Update, Report of the Heinrich Böll Foundation, Mar 2010.
http://boell.org/downloads/Thomas_UK_-_web.pdf.

[Steve Thomas is a professor of energy policy at the University of Greenwich (UK) and an international expert on energy economics and nuclear power policy.
<http://www.gre.ac.uk/schools/business/about-us/departments/ibe/staff/>. Previously he was a senior research fellow at the Energy Policy Programme at the Science and Technology Policy Research program at the University of Sussex and served on a panel of advisory nuclear power experts for the government of South African government. He is co-editor of the book *International Perspectives on Energy Policy and the Role of Nuclear Power* (2009).

The report (68 pp) outlines the poor economics of nuclear energy from an international perspective. Costs of nuclear power are exploding and that does not even take into account the unsolved problems of waste disposal and the susceptibility of the technology to failure. No privately run energy conglomerate will risk its own capital anywhere in the world without government subsidies and guarantee. Massive government subsidies to nuclear power have created a noncompetitive electric energy market.

The belief that nuclear power can be a major way to cut emissions of greenhouse is a “blatantly misguided view” that fails to take into account the realities of economics, waste, and uranium resources. (p 54)

Critically, the extension of the life span of nuclear power plants and the construction of new plants “would act as a massive brake on the development of renewable energies.” (p 5) The real loss of nuclear power is “the opportunity cost” of not pursuing more cost-effective clean energy and efficiency technology options. (p 54) The cost-curve for nuclear power has always been upwards. Instead of getting cheaper over time due to learning, scale economies and technical progress effects as have renewable technologies, nuclear costs have steadily increased. “If some of the resources being poured into another fruitless attempt to revive nuclear power were devoted to these sources, the economic gap between energy efficiency/renewables and nuclear would be highly likely to grow even wider.” (p 54)]

INSTITUTE FOR ENERGY AND ENVIRONMENTAL RESEARCH (IEER): Makhijani, Arjun, *Carbon-Free and Nuclear-Free*, Joint Project of the Nuclear Policy Research Institute and the Institute for Energy and Environmental Research, IEER Press, Takoma Park, Maryland (2010) update of 2007 treatise. <http://ieer.org/projects/carbon-free-nuclear-free/>

[Lead author Arjun Makhijani, PhD, is President of the Institute for Energy and Environmental Research (IEER). Makhijani received his doctorate in engineering from the University of California at Berkeley, where he specialized in nuclear fusion. He was principal author of the first technical assessment (1971) of the energy efficiency potential of the US economy. He served on the EPA’s advisory panel on high-level radioactive waste repository regulations in the 1980s. In 2007, he was awarded a prestigious fellowship in the American Physical Society. IEER is a non-profit public interest scientific research and consulting firm.

This treatise lays out a detailed roadmap for America’s transition away from coal and nuclear power to a clean energy-based economy using currently available technology. A key focus is on efficiency.]

JOURNAL NEWS: Clary, Greg, PSc takes heat over tree-cutting, Entergy spin off, Journal News, Mar 5, 2010. <http://archive.ohod.com/article/20100305/COLUMNIST18/3050345/PSC-takes-heat-over-tree-cutting-Entergy-spin-off>.

[The office of the NY Attorney General is opposing the attempt of Entergy to spin-off its nuclear holdings into a company called Enexus Energy Corp. The AG submission states: “Entergy seeks to spin off several aging nuclear power plants to a new and debt-laded corporation whose only assets would be the plants themselves. Not only would this new corporation be heavily indebted, it would be unique; no other corporation is exclusively built around aging nuclear reactors that operate in a ‘merchant’ (i.e., non-utility) power system.”]

NEW YORK TIMES: Rosenthal, Elisabeth, With Peels and Pig Innards, a Swedish City Forgoes Coal and Oil, New York Times, December 11, 2010. <http://query.nytimes.com/gst/fullpage.html>.

[A decade after determining to get off fossil fuels, the Swedish city of Kristianstad – population 80,000 – was able to virtually eliminated the use of coal, oil, and gas by harnessing biogas. The

move was part of a region-wide energy transition policy in southern Sweden. “It’s a much more secure energy supply — we didn’t want to buy oil anymore from the Middle East or Norway,” said Lennart Erfors, the engineer who is overseeing the transition in Kristianstad, ‘And it has created jobs in the energy sector.’”

Unlike natural gas, which must be pumped from deep underground, biogas is a renewable energy source. Biogas can be captured from landfills, food processing plants and farms. With biogas systems, the methane released through biological decomposition is captured for energy use, rather than just allowed to be released into the atmosphere. “Instead of steaming in landfills, it can heat and electrify homes.”

“Another benefit is that biogas plants can devour vast quantities of manure and sewage that would otherwise pollute the air and potentially contaminate water supplies.”

In the US, however, there is a lack of governmental support which could provide the architecture for commercialization and reduce up-front implementation costs. “The U.S. lacks a supply network for moving organic waste from farms and gas from water treatment plants into a purified biogas that could feed into natural-gas pipelines.”

In Sweden, government grants have supported construction of centralized biomass heating systems, but the payback has been significant. The cost of heating municipal buildings has been reduced by millions of dollars a year and Kristianstad fuels its municipal vehicles with biogas fuel, avoiding the need to purchase nearly half a million gallons of diesel or gas each year.]

NEW YORK TIMES: Barringer, Felicity, In California, Carports That Can Generate Electricity, New York Times Nov 25, 2010.

http://www.nytimes.com/2010/11/26/science/earth/26parking.html?_r=0.

[Schools and community college campuses colleges in California are making parking areas into mini energy generation sites. Some are designed as a broad fan of panels slanting slightly upward and supported by a single pole. Others are designed as solar carports, with PV panels installed on parking roofs. The solar initiative enables school districts to get cheap electricity for their buildings for decades – saving millions – and promotes a philosophy of green thinking among the young.]

POLICY REVIEW: Sokolski H, The High and Hidden Costs of Nuclear Power, Policy Review (Aug & Sep 2010); 162: 53-68. <http://www.psr.org/nuclear-bailout/resources/the-high-and-hidden-costs-of.pdf>.

[The author, Henry Sokolski, a former US Department of Defense deputy and former member of the Central Intelligence Agency’s Senior Advisory Group, is Executive Director of the Nonproliferation Policy Education Center. *Policy Review* is a publication of the Hoover Institution at Stanford University.

Paper discusses the significant negatives of nuclear power, both from an economics and proliferation danger perspective. Despite strong government support in the mid 20th Century, “market forces – coupled with adverse nuclear power plant operating experience – pushed back. As nuclear power plant operations went awry (e.g., fuel cladding failures, cracking pipes, fires, and ultimately Three Mile Island), spiraling nuclear construction costs and delays, as well as the disastrous accident at Chernobyl, killed the dream.” More than half the nuclear plant orders in the US and nearly 90% of the projected plants globally were cancelled. (p 54)

Vast taxpayer subsidies over decades have been bestowed upon the commercial nuclear power industry, but it continues to press for billions more (noting a nuclear power lobby request for an additional than \$100 billion). Certainly, if nuclear power were cheap, could assure security, or economically eliminate greenhouse gas emissions, private capital would be clamoring to invest. But so far, private investors have been unwilling to risk their own capital. The reason is nuclear’s economic record.

Safety is also a concern. The public subsidization of accident risk via Price Anderson creates a disincentive to improve operational and design safety that would otherwise exist if plant operators had to get accident liability insurance through the private sector. The argument for Price-Anderson is that it is unreasonable to ask the nuclear industry to assume the full costs of insuring against nuclear accidents and nuclear terrorism because these risks are too large. Originally, in 1957, when the industry first got Congress to cap liability for damages suffered by third parties, the industry claimed it only needed liability protection until 1967, when it could prove how safe it was. “A half century later, though, industry officials pleaded with Congress that without another 20-year extension, commercial nuclear power would die. They also insisted that they were still unwilling to export U.S. nuclear goods to foreign states that have not yet explicitly absolved nuclear vendors from liability for damages parties located off-site might suffer in the case of an accident.” (pp 61-62)

Hidden costs of nuclear power also include the costs inherent in the full fuel cycle, including nuclear waste.]

WORLD AFFAIRS JOURNAL: Woolsey, R James, Rachel Kleinfeld and Chelsea Sexton, No Strings Attached: The Case for a Distributed Grid and a Low-Oil Future, World Affairs Journal, Sep-Oct 2010. <http://www.worldaffairsjournal.org/article/no-strings-attached-case-distributed-grid-and-low-oil-future>.

[World Affairs is a highly regarded foreign policy and international affairs journal. R. James Woolsey, a former CIA Director, is chair of Woolsey Partners. Rachel Kleinfeld is co-founder and CEO of the Truman National Security Project. Chelsea Sexton is the founder of the Lightning Rod Foundation.

Energy policy affects a wide range of issues, from national security to international corruption to economics to climate change pollution and public health – and all must all be taken into account. The demand for new energy solutions worldwide is vast and will create a huge market. The challenge is to find available and scalable solutions that resolve complicated problems in interconnected systems without causing inadvertent side effects. “Therefore, we believe it is necessary to find answers that at best alleviate multiple problems, and, at worst, don’t exacerbate one problem while curing another.”

Energy decisions should take into account security threats, environmental and health quality-of-life issues, and environmental justice, as these are all often interdependent. Environmental stresses can cause security problems and environmental degradation can make life worse for the poor. The need is not to search for a single solution, but for a portfolio of options that together meet these key concerns; as well as solutions that can begin working immediately.

“With regard to electricity, our investigation has led us to conclude that distributed generation—including a disaggregated grid that produces electricity close to where it is consumed and that can ‘island’ to support small communities while securing itself from cascading grid failure—is key to solving the complex mix of energy problems we face. Such distributed generation would rely more heavily on local facilities producing energy from renewables such as solar, wind, and geothermal power, with a significant role for natural gas as a baseload that could ‘firm’ or supplement the other, intermittent sources.”

America operates from two almost completely disconnected energy systems: a transportation network fueled by oil and largely coal-based electrical grid. “We suggest a shift toward plug-in vehicles complemented by efficiency improvements to remaining internal combustion engines.” Advanced biofuels and moving trucks and fleet vehicles to natural gas where electrification is less efficient are additional changes which are relatively simple to make within existing infrastructure without major technological breakthroughs.

The US electrical grid “is the security equivalent of a house left with the door unlocked, the windows open, and millions of dollars of jewelry and home entertainment equipment strewn about for the taking. If anyone wished to launch a national blackout, they could coordinate attacks in a few rural grassy fields, where major transformers are located. If enemies didn’t want to bother with the travel, our grid is laughably open to cyber attack.” An attack could take down water, sewage, phone, medical and transportation systems.

A priority should be to make the grid much more resilient, able to “island” into microgrids in the event of an outage, preventing a single failure from cascading into a catastrophe.

“The vast majority of homes and businesses would stay connected to the grid, but would harness solar, wind, geothermal, and other local renewable energy sources for an important share of their power needs. New policies would force utilities to allow a power payback system (i.e., a feed-in tariff), enabling individuals and commercial enterprises to sell the electricity they generate in excess of their own needs back to the grid and earn money on their investment. We would still have a national grid transferring bulk electric power over transmission lines on steel towers and via large transformers. We would simply build into our existing distribution grid the capability to island and separate when need be. (If the transmission lines are analogous to freeways, the distribution lines on telephones are the on- and off-ramps and local streets and roads.) Neighborhoods or towns would have the ability to cut themselves off from the rest of the grid if a major share of it were taken down by anything from a terrorist attack to falling tree branches. Micro-grids could provide many households, schools, and businesses with enough power to function during even a long-term emergency, rather than forcing populations to face the cascading total failure of lighting, plumbing, refrigeration, heating, and other infrastructure that an attack would cause today. By building resilience into our current grid, we could have both the benefits of a national grid system and the flexibility of distributed, independent generating capacity.”

Neither nuclear power nor coal are desirable as backup baseload sources of power. Nuclear power generates nuclear waste and presents proliferation threat. Nuclear fuel is just a few cycles from weapons-grade fissile material. "In a number of countries, domestic producers of nuclear power plants are certain to try to export this technology." Burning coal produces large quantities of CO₂ emissions, noxious chemicals, and mercury, as well as mining and mountaintop destruction. Consequently "natural gas is definitely the least of multiple evils when it comes to the required source of baseload power for a distributed generation future."

Renewable energy expansion as rapidly as possible could enable the minimal amount of gas extraction. This would involve not just large solar plants and wind farms, but rapid expansion of small and medium-sized commercial renewable power facilities with capabilities of less than 20 MW. "To be commercially viable and create a market, utilities would need to allow entrepreneurs who install renewable energy platforms at a small commercial scale to sell their electricity back to the grid." This change requires small infrastructure adjustments and rules that enable power payback, like feed-in tariffs, which enable businesses, farms, and homes to benefit from the electricity they produce and feed into the grid. Germany and 40 other countries have made this financing system work well.

Investment in energy conservation technologies is also crucial. Simple changes to building codes could, with today's technology, significantly reduce building energy use. Another priority is research and development of improved energy storage systems like batteries and compressed air energy storage (CAES) systems. Batteries are uniquely suited for microgrid support.

Decentralized grids and distributed energy are beneficial for advanced and developing countries. They can also reduce the leverage of dictatorships (which otherwise can cut off electricity to any region that defies them).

Worldwide there are a multitude of distributed generation initiatives underway, from Kenya (where solar photovoltaic use in rural areas outpaces new grid connections and unsubsidized photovoltaics compose dominate the solar market) to inner Mongolia (where herdsmen can draw power from small wind turbines carried along with their portable yurt dwellings). More pilot projects need to be designed to enable a broad solution. However the promise is the call of the market. The world's poor, collectively, have significant purchasing power and represent a huge future entrepreneurial opportunity: the worldwide energy market for the poor is estimated to be worth some \$230 billion.

National security concerns argue for moving away from energy technologies that subsidize hostile nations. America should also move away from ties to vulnerable supply lines that, if breached, could destroy our economy. As the security expert Anne Korin has observed, until the end of the 19th Century, salt was the only means of preserving meat. "Nations depended on it, and militaries marched for it. Countries that controlled salt mines wielded power and fought wars to control these strategic commodities." Then innovations like electricity and refrigeration broke salt's strategic importance, and it became a commodity like any other.

The same kind of transformation can be accomplish today via the strategy of electrifying a significant number of American household vehicles as in plug-in hybrids (PHEVs) and extended-range electric vehicles (EREVs). Where electrification is impractical, advanced biofuels and (reluctantly) natural gas could play a role.

Democracy is enhanced by distributed widely-available energy. Commodities that command huge amounts of economic rent tend to solidify concentrations of power. “Autocratic governments that need not depend on taxes for revenue have no need to enrich or serve their people. It’s no surprise that of the top nine oil-exporting countries, only Norway is a democracy.”

Whether the goals are security, the environment, or helping the poor, the shift to a new renewable and distributed energy model makes sense. “To power our electrical grid, combining renewables with the least harmful option of natural gas improves both security and environmental and health concerns. Retrofitting our grid to emphasize micro-grids and islanding will help reduce the brittleness of the current system. Cars should be electrified when practical, or fitted with greater efficiency improvements and fueled through drop-in advanced biofuels. These changes can all begin now, without the need to wait for major infrastructure overhauls or technological breakthroughs to get started.”

“Distributed generation of fuels for both electricity and transportation offers America and the developing world a path toward self-reliance, transforming consumers into owners empowered with the means of production. A new energy posture could break the monopoly of oil-based autocracies and corrupt governments, diminish vulnerability to malevolent threats, and reduce the climate change, pollution, and health concerns that harm the quality of life worldwide.”]

2009

ARCHITECTURE MAGAZINE: Perez, Richard, Renewable Energies: Our Solar Future, Daylight and Architecture Magazine (2009) 12: 2-8.
http://www.asrc.cestm.albany.edu/perez/2010/DA12_perez.pdf.

[Richard Perez, PhD, of the Atmospheric Sciences Research Center, The University at Albany, writes: “Every day, the Earth receives 1,500 times as much energy from the sun as mankind consumes.” Renewables such as wind and biomass can assist in the transition to a clean energy future. But, ultimately, the greatest promise lies in a combination of large-scale solar power plants and small-scale, building-integrated solar energy uses.

Reducing demand-side energy need can be achieved by increasing efficiencies – e.g., better engines, higher efficiency lighting, better insulations and avoiding unnecessary waste. The concept can be summed up in a few words: “smarter better and smaller.” As noted by a McKinsey report on climate change, over 40% of the consumption of major consumers like the United States could be met economically by smart conservation and efficiency alone. (p 3)

Infrastructure which allows decentralized production is also critical. “The main attraction of this decentralized deployment model is that it would result in indigenous, highly-secure, and robust energy pathways. Because of the decentralization of production, demand management, and storage operation, the failure of any one decentralized unit, with built-in minimal stand-alone operation capability, would be insignificant.” (p 5)

A fast-track growth and turnover to a renewable-based energy scheme within 50 years is affordable, especially given the fact that both apparent and real costs of conventional forms of energy escalate. “In the end, what will matter is the value proposition offered by solar and renewable, not the cost. If value exceeds cost, then there is no question that renewable will be the way to go, and many indicators point in that direction. The price we pay in our energy bills

today simply does not include all the costs incurred by society: two major costs that are not yet included, as they should be, are the costs associated with the degradation of the environment (chiefly global warming) and the depletion of finite energy resources.” (pp 5-6)

Energy bills further do not account for the costs society pays in the form of taxes, insurance premiums, military budgets, and borrowing heavily from future generations. (p 6) Exploitive forms of power like fossil fuels and nuclear impose global environmental and security costs. Both are also finite, depending upon depleting reserves. With respect to nuclear – short of fusion becoming feasible – even the most speculative uranium reserves scenario and optimistic deployment of advanced reactors and fuel recycling puts the total nuclear potential well below even the one year solar energy potential. (p 3)

Other large real costs not accounted for in energy bills, more site-specific in nature, include power grid reliability and security, as well as the lost value opportunities of job creation and economic growth associated with the advent of renewables. (pp 5-6) Indicators suggest that the value of transitioning to renewables, exceeds the cost.

Energy payback is an accepted fundamental physical metric for long-term economic viability of investments. The financial return of even a worst-case scenario for PV installation in the northeastern US (i.e., with no subsidization, no allowance for falling costs, disregard of environmental degradation, etc), is 2-3% per year, an attractive long-term investment rate. The real return to society is far higher. (p 8)

“In essence, the long term economic soundness of a solar future can be simply expressed in this one fundamental reality: all direct and indirect solar technologies have an energy payback of 3-5 years today and are constantly improving, i.e., when operated under average conditions these technologies produce more energy in a few years than is used to construct and install them. With operational lifetimes far exceeding their energy pay-back period, these technologies are, in effect, energy breeders capable of powering themselves into growth.” (p 7)

Cities and suburbs in 2050 may look very much as they do today, but they can be cleaner and quieter. Many buildings can become net energy producers due to both higher operational efficiencies and the use of available solar energy-harvesting surfaces, as well as energy management/storage hubs at the nodes of smart electrical grids. Load management and storage facilities needed to manage the flow of renewables can be largely embedded in the framework of residential, commercial and industrial districts:, including commuting and transportation. ... “picture a highly efficient, daylight, two-storey, two-apartment residential building with a footprint of 100 m² in....Its roof space will produce more electrical energy than needed by the occupants for all uses.” (p 8)]

ASSOCIATED PRESS: Not enough money to dismantle old nuclear plants, Associated Press interactive diagram, 2009.

http://hosted.ap.org/specials/interactives/national/nuclear_decommission/index.html?SITE=AP.

[The AP diagram features links to 2008 data on the amounts in decommissioning funds for nuclear plants compared to the 2008 estimates of decommissioning cost. At Indian Point 2 & 3 (no data is provided for the defunct reactor no 1), the decommissioning funds are indicated to

be short \$114,430,000. At Calvert Cliffs, the funds are indicated to be short \$417,308,000. At Limerick, the funds are indicated to be short \$716,200,000.]

ASSOCIATED PRESS: Gram, Dave and Frank Bass, Nuclear reactor owners not saving enough to shut down, clean up, Associated Press, Jun 17, 2009.
<http://www.wibw.com/home/headlines/48181512.html>.

[The companies that own almost half the nation's nuclear reactors do not have adequate funds set aside for dismantlement and cleanup. Reactors may sit idle for decades and radioactive waste could leak from abandoned plants into ground water or be released into the air. Spent nuclear fuel poses security risks. In Jun 2009, British officials reported on a 2007 leak in a cooling tank at the decommissioned Sizewell-A nuclear plant. "If the leak had not been promptly discovered, officials said, nuclear fuel rods could have caught fire and sent airborne radioactive waste along the English coast, harming plant operators or the public."

Decommissioning cost estimates have risen by more than \$4.6 billion over two years, while the investment funds that are supposed to pay for shutdown have lost \$4.4 billion

NRC rules do not require nuclear plant owners to set aside money to store old nuclear fuel, demolish buildings, or return the plant sites to pristine states. Some states require a full site restoration, but the federal government does not. "No one at the NRC wants to acknowledge what is absolutely obvious to us, that the funds are inadequate and that the industry has bare assets," said Arnold Gundersen, a retired nuclear engineer and decommissioning expert."

Luminant Corp, the owner of two nuclear plants near Glen Rose, Texas, has about \$385 million set aside to close the reactors expected to shut down in 2030 and 2033. The estimated decommissioning cost is \$824 million.

Entergy, owner of the Vermont Yankee plant along the banks of the Connecticut River, has \$384 million set aside for shut down. The estimated decommissioning cost is \$932 million.]

INSTITUTE FOR ENERGY AND THE ENVIRONMENT, VERMONT LAW SCHOOL: Cooper M, All Risk, No Reward for Taxpayers and Ratepayers: The Economics of Subsidizing the 'Nuclear Renaissance' with Loan Guarantees and Construction Work in Progress, Report, Institute for Energy and the Environment at Vermont Law School, Nov 2009.
http://www.vermontlaw.edu/Documents/PublicRiskPrivateProfit_Cooper.pdf.

[Report by Mark Cooper, Senior Fellow for Economic Analysis at the Institute for Energy and the Environment at Vermont Law School.]

SCIENTIFIC AMERICAN: Jacobson, Mark Z and Mark A. Delucchi, A Plan for a Sustainable Future, How to get all energy from wind, water and solar power by 2030, Scientific American, Nov 2009.
<http://web.stanford.edu/group/efmh/jacobson/Articles//sad1109Jaco5p.indd.pdf>

2008

ENERGY POLICY: Sovacool, BK, Valuing the greenhouse gas emissions from nuclear power: A critical survey, Energy Policy (2008); 36 (8): 2950-2963.

<http://www.sciencedirect.com/science/article/pii/S0301421508001997>.

[Study screens 103 lifecycle studies of greenhouse gas-equivalent emissions for nuclear power plants to identify a subset of the most current, original, and transparent studies.

The range of emissions for nuclear energy over the lifetime of a plant, reported from qualified studies examined ranges from 1.4 g of carbon dioxide equivalent per kWh (g CO₂e/kWh) to 288 g CO₂e/kWh, with the mean value is 66 g CO₂e/kWh. Lifecycle greenhouse gas emissions occur through plant construction, operation, uranium mining and milling, and plant decommissioning.]

NEW YORK TIMES: Hakim, Danny, Nuclear Operator Seeks to End Revenue Deal With State, New York Times, Jul 21, 2008.

<http://www.nytimes.com/2008/07/21/nyregion/21indian.html>.

[Entergy Nuclear, the owner of the two Indian Point plants in Westchester County and the FitzPatrick plant in Oswego County is trying to get out of a revenue sharing agreement with New York. Under the agreement, Entergy is supposed to pay the New York State Power Authority up to \$72 million annually – a total of \$432 million – through 2014.

Entergy's strategy was revealed in a securities filing which outlined a plan to spin off its nuclear plant holdings into a new company called Enexus. In one clause Entergy claims that Enexus would not have to live up to a revenue sharing agreement between Entergy and New York. While the terms of the revenue sharing deal would hold if the plants were transferred to an Entergy affiliate, company officials said that they would not be creating a new affiliate but rather a new independent company.

The Federal Energy Regulatory Commission (FERC) approved the spinoff. Alex J. Schott, an Entergy spokesman, said the spinoff “optimizes the value for all our stakeholders.”

NY State officials are concerned about both the loss of state funds and the potential loss of operator funding needed for decommissioning the Indian Point and FitzPatrick plants.]

NEW YORK TIMES: Wald, Matthew L, As Nuclear Waste Languishes, Expense to U.S. Rises, New York Times, Feb 17, 2008.

http://www.nytimes.com/2008/02/17/us/17nuke.html?_r=0.

[With waste sitting at reactor sites with no long term repository, the federal government may need to pay damages that could reach \$35 billion. “The payments come from an obscure and poorly understood government account that requires no new Congressional appropriations, and

will balloon in size....” The money comes out of the Treasury, not the Energy Department from a fund called the “Judgment Fund.”

The government is also running up extra expenses on its own nuclear waste. Some of the waste that is supposed to go to Yucca, left over from nuclear weapons production, is sitting in storage expensive to maintain.”]

Perez, Richard and Thomas Thompson, Solar Energy: A New York perspective, 2008.
<http://www.asrc.cestm.albany.edu/perez/publications/Other%20Papers%20and%20Applications/2008-solar-energy-a-new-york-perspective.pdf>.

[Paper by Richard Perez, PhD, of the Atmospheric Sciences Research Center, The University at Albany, and Thomas Thompson, Chair of the New York State Solar Energy Industries Association and Executive Vice President of the Atlantis Corporation.

New York has surprisingly strong solar resources. Thus, contrary to common misconception, the state has substantial affordable solar power potential. “In fact, from Buffalo to Broadway and from the St. Lawrence Seaway to Montauk Point, solar electric PV power can lower the cost of energy in NYS, eliminate blackouts, strengthen the electric grid, clean the air and jump start NY’s economic might with good, 21st century jobs.” (p 1)

Approximately 0.45% of New York States’ surface is sufficient to generate all the current electrical energy used in NY. By comparison, nearly 3% of the states’ surface is covered by buildings, parking lots, exclusion zones and roadways. A “substantial fraction of this space could be used to harvest solar energy without modifying (and sometimes even enhancing) its primary use (e.g., parking lot PV canopies) the large scale deployment of PV in the state would require little use of new open spaces.” (p 10)

Most critically, solar could significantly reduce the amount of power needed during hot summer, high demand (high air conditioning use) periods. The state has some 6,000 MW of high value “peak shaving” potential PV solar power (~20% of the state’s generating capacity) which could be deployed to serve this high value/local generation/grid decongestion objective. “It must be stressed that New York, because of its electrical demand profile, is probably one of the best places in the country and the world to take advantage of this capability.” (p 11)

Sound government policy can leverage private sector investment to make New York one of the world’s leading manufacturers of and markets for solar energy in all of its forms – especially PV, but also including commercial and industrial building heating, hot water production, passive solar, and concentrating solar power (CSP). Grid parity is key to fostering the advancement of new technologies like solar. Pillars of market development are: (1) Interconnection Rules, (2) Net Metering Laws; (3) Money, i.e., financial incentives; and (4) Solar Power Mandates on New Building and Major Renovations. This is also known as a Green Building Law. The significant benefit is that the cost of incorporating PV and solar thermal is lowest at the time of new construction. (pp 18-19; strategies are detailed further pp 19-24)]

ROCKY MOUNTAIN INSTITUTE: Lovins AB and Sheikh I, The Nuclear Illusion, Rocky Mountain Institute Report (2008). http://www.rmi.org/Knowledge-Center/Library/E08-01_NuclearIllusion. www.citizenscampaign.org/PDFs/lt_RETf_Report.pdf

TAXPAYERS FOR COMMON SENSE: Nuclear Subsidies Past and Present, Taxpayers for Common Sense Fact Sheet, Dec 12, 2008. <http://www.taxpayer.net/library/article/nuclear-subsidies-past-and-present>.

[As of 2008, more than \$85,870,000,000 in direct federal subsidies, tax breaks and loan guarantees was given to the nuclear industry. (All valuations are in 2007 dollars.)

Table 1 shows a summary of historical subsidies to the nuclear industry (excluding the Price-Anderson Act), with data sourced from the Office of Management and Budget, "Public Budget Database", <http://www.whitehouse.gov/omb/budget/fy2009/db.html>; Nuclear Energy Research Initiative, FY2007 annual report; Congressional Research Service Issue Brief, Energy Efficiency: Budget, Oil Conservation, and Electricity Conservation Issues.

Yet, despite these sums, the nuclear power industry continues to demand subsidies and is "unable to stand on its own two feet in the marketplace."

In addition to the specified subsidies, Congress has significantly limited the liability of individual nuclear plant operators and the industry as a whole for more than half-a-century. This has been done via the Price-Anderson Act, a 1959 law that has been repeatedly extended. Thus the cost of an accident is a liability which would be primarily borne by American taxpayers. (One analysis, for example, has estimated one nuclear reactor accident could result in 143,000 cancer deaths and \$599 billion in property damage.)

Table 2 shows the projected impacts of 2005-2015 subsidies, tax breaks and loan guarantees (primarily from the Energy Policy Act of 2005) to amount to more than \$24,000,000,000. This estimate excludes awards for research and development. The data is compiled from the Joint Committee on Taxation, "Estimated budget effects of the conference agreement for Title XIII of H.R. 6, the "energy tax incentives act of 2005"", July 2005; Public Law 109-58, "Energy Policy Act of 2005", August 2005; Department of Energy Loan Guarantee Program, "Title XVII 2008 Omnibus Report Language."

High level nuclear waste deposition is also a cost. The estimated cost from 2007 through permanent closure and decommissioning of the Yucca Mountain repository is \$83 billion. "The potential risk the US government bears with nuclear power is a cost well beyond any other federal subsidy."

The US has also invested far more funds in Research and Development for nuclear than for any other energy source.

The paper concludes: "For decades the nuclear industry has heavily benefited from subsidies provided by U.S. taxpayers and they continue to ask for billions more. With a growing economic crisis and federal deficits and debt mounting, taxpayers, now more than ever, cannot afford to shoulder the burden of nuclear subsidies. It is time to end handouts to a mature energy industry that has already received billions from taxpayers."]

THINK PROGRESS: Romm, Joe, How Much of a Subsidy is the Price-Anderson Nuclear Industry Indemnity Act?, ThinkProgress, Aug 7, 2008,

<http://thinkprogress.org/romm/2008/08/07/202962/how-much-of-a-subsidy-is-the-price-anderson-nuclear-industry-indemnity-act/>.

[The author Joseph Romm, PhD, is a physicist who received his doctorate from MIT, a Fellow of the American Association for the Advancement of Science and a former acting assistant secretary at the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy. This article is based on testimony he gave to Congress.

Dr. Romm points out "the obvious — that nuclear is a mature source of power that has benefited disproportionately from government support." Subsidies to the nuclear industry have been provided in many direct and indirect forms such as R&D, tax credits and loan guarantees.

The commercial nuclear industry has enjoyed massive taxpayer subsidy from the Price-Anderson Nuclear Industries Indemnity Act alone. Based on figures from a 1992 U.S. Energy Information Administration analysis, [Federal Energy Subsidies: Direct and Indirect Interventions in Energy Markets](#), Dr. Romm calculated that, by 2008, the Price-Anderson subsidy to the commercial nuclear industry exceeded \$100 billion.

Price-Anderson caps both operator and nuclear industry liability for claims arising from nuclear incidents. It reduces the insurance nuclear power plants need to buy and requires taxpayers to cover all claims in excess of the cap. At the time the Act was originally enacted, in 1957, it was deemed necessary because investors and insurers were unwilling to accept the then unquantified risk. The extension of the act through 2025 is hard to justify. "If investors aren't willing to accept the risks of nuclear energy now, without taxpayers liable for any major catastrophe, perhaps the technology no longer deserves government support."]

UWUA LOCAL: EntergyPayWatch.org, a service of UWUA Local 369, accessed from the web Jun 10, 2008. {See also iteration of UWUA Local 369 statement on "excessive" executive compensation following Katrina in Entergy Corporation 2008 proxy statement: <http://www.sec.gov/Archives/edgar/data/65984/000006598408000081/a00808.htm>}

[UWUA Local 369 statement.

Following the devastation caused by Hurricane Katrina in 2005, Entergy successfully lobbied for \$200 million in taxpayer-funded relief to help repair the damage to Entergy New Orleans.

"During 2006 and 2007, Entergy's Board of Directors awarded the equivalent of nearly 35% of the entire federal bailout for Entergy New Orleans as *compensation packages for only five employees* over this two-year period."

"In Entergy's 2008 proxy statement, our Board cited this \$200 million in federal funds as one of the reasons directors approved these executive pay levels."]

2007

ALBANY UNIVERSITY: Perez R, Is There Really Enough Sun in the Empire State? Presentation by Richard Perez, PhD, of the Atmospheric Sciences Research Center, The University at Albany, 2007.

<http://asrc.albany.edu/people/faculty/perez/publications/Other%20Papers%20and%20Applications/Is%20there%20really%20enough%20sun-07.pdf>.

[Demonstrates viability of NY state transition to solar power.]

NEW YORK TIMES: Wald, Matthew L, A U.S. Alliance to Update the Light Bulb, New York Times, Mar 14, 2007. <http://www.nytimes.com/2007/03/14/business/14light.html>.

[A phase-out of the outmoded incandescent bulb would save \$18 billion a year in electricity, and save the amount of power that would be produced by 30 nuclear reactors or as many as 80 coal plants. It would also eliminate substantial mercury emissions from the coal plants, a coalition between major bulb manufacturers and the Natural Resources Defense Council announced.]

OXFORD RESEARCH GROUP: Barnaby F and Kemp J, Too Hot to Handle? The Future of Civil Nuclear Power, Report of Oxford Research Group, Jul 2007.

<http://www.hindu.com/nic/toohottohandle.pdf>.

[Frank Barnaby, PhD, a nuclear physicist, is Nuclear Issues Consultant to the global consulting firm Oxford Research Group. Dr. Barnaby formerly worked at the Atomic Weapons Research Establishment, Aldermaston. James Kemp is a nuclear terrorism expert and research analyst at Oxford Research Group's Secure Energy Project.

If the percentage of world nuclear capacity remains at the 2007 level, by 2050, nuclear power would generate as much carbon dioxide per kWh as comparable gas-fired power plants. The full nuclear fuel cycle generates more greenhouse gases as the grade of available uranium ore decreases.]

OXFORD RESEARCH GROUP: Barnaby F and Kemp J, Secure Energy? Civil Nuclear Power, Security, and Global Warming, Report of Oxford Research Group, Mar 1, 2007.

<http://www.oxfordresearchgroup.org.uk/sites/default/files/secureenergy.pdf>. Summary: http://www.oxfordresearchgroup.org.uk/publications/briefing_papers/secure_energy_civil_nuclear_power_security_and_global_warming/.

[Frank Barnaby, PhD, a nuclear physicist, is Nuclear Issues Consultant to the global consulting firm Oxford Research Group. Dr. Barnaby formerly worked at the Atomic Weapons Research Establishment, Aldermaston. James Kemp is a nuclear terrorism expert and research analyst at Oxford Research Group's Secure Energy Project.

Nuclear power presents a global security threat and is also not a means of combating global warming when consideration of the full nuclear fuel cycle is taken into account.]

2006

ALBANY UNIVERSITY: Root L and Perez R, Photovoltaic Covered Parking Lots: A Survey of Deployable Space In the Hudson River Valley, New York City, and Long Island, New York, Report of the Atmospheric Sciences Research Center, The University at Albany, 2006.

<http://www.asrc.cestm.albany.edu/perez/publications/Other%20Papers%20and%20Applications/parkings.pdf>.

[Professors/researchers Lucas Root and Richard Perez, PhD, of the Atmospheric Sciences Research Center, The University at Albany.

Study finds 9,823 acres of sun-exposed parking lots in NYC, Long Island and the Hudson River Valley, NY have potential to generate 2,947 MW of electric power using PV deployment.

Other areas not evaluated include building rooftops, facades and exclusion zones. Solar power would be a hugely beneficial way of reducing the need for other forms of generation during hot summer “peak load” periods and would complement demand side response programs.]

BAYOU BUZZ: Tidmore, Chrisopher, Is Entergy New Orleans Out of Power? Bayou Buzz, Mar 23, 2006. <http://www.bayoubuzz.com/articles.aspx?aid=6576>.

[Entergy reported to threaten walking away from its New Orleans subsidiary if multi hundred million dollar federal bailout money not provided to help rebuild utility systems damaged by Katrina.]

CORP WATCH: King, Rita, Entergy Holds New Orleans for Ransom, Special to Corp Watch, May 10, 2006. <http://www.corpwatch.org/article.php?id=13569>.

[Following Katrina, Entergy threatened to leave New Orleans “quite literally in the dark” unless the federal government granted Entergy \$718 million to help maintain and rebuild its storm-damaged infrastructure.

While the parent corporation Entergy Corp had prior year revenues of \$10 billion and holds \$29 billion in collective assets – which could comfortably cover storm losses and repairs – Entergy’s subsidiary Entergy New Orleans LLC filed for bankruptcy weeks after the storm to protect its assets.

“According to a May 2004 report from the United States General Accounting Office (GAO), limited liability companies such as Entergy Corp resulted from the deregulation of the electricity industry in the 1990s. ‘Like a partnership,’ the report said, ‘the profits are passed through and taxable to the owners ... like a corporation, it is a separate and distinct legal entity and the owners are insulated from personal liability for its debts and liabilities.’”

Entergy estimated its Katrina losses as over \$1 billion and determined that its first duty was to protect its shareholders, not the population of New Orleans. Entergy spokesman {Morgan} “Stewart explained that each subsidiary is a ‘separate business,’ and that each company is ‘protected from the burden’ of picking up unexpected costs from the others.”]

INSTITUTE FOR ENERGY AND ENVIRONMENTAL RESEARCH (IEER): Smith, Brice, **Insurmountable Risks: The Dangers of Using Nuclear Power to Combat Global Climate Change**, Report of the Institute for Energy and Environmental Research, IEER Press (Takoma Park, Maryland) and RDR Books (Muskegon, Mich / Berkely, Calif), 2006. Link to full report (429 pages) at: <http://ieer.org/resource/books/insurmountable-risks-dangers-nuclear/#download>.

[Author Brice Smith, PhD, is a security and energy expert.

Climate change, catastrophic nuclear reactor accidents (or attacks), and nuclear war are the most serious vulnerabilities associated with the world's current energy system. The frequency and magnitude of many extreme climate events interact with the technological risks of nuclear (especially aging reactors), making nuclear power especially risky. See Executive Summary at: <http://ieer.org/wp/wp-content/uploads/2006/05/InsurmountableRisksSummary.pdf>.]

NUCLEAR REGULATORY COMMISSION: NRC Leak Task Force Report, 2006: NRC Liquid Radioactive Release Lessons Learned Task Force, Sep 1, 2006.
<http://pbadupws.nrc.gov/docs/ML0626/ML062650312.pdf>.