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Chapter 1 : Solar Energy Economics | Solar ROI by State | Sunrun

Energy Economics is the premier field journal for energy economics and energy finance. Themes include, but are not limited to, the exploitation, conversion and use of energy, markets for energy commodities and derivatives, regulation and taxation, forecasting, environment and climate, international trade, development, and monetary policy.

Nearly gigawatts GW , or about half of the existing thermal generator fleet i. The default choice for utilities and merchant generators operating in competitive markets to replace retiring generators is construction of new natural gas-fired power plants. Gas-fired generation technology is mature and cost-effective compared to older, retiring generators, especially with the currently low but inherently volatile price of natural gas. Thankfully, new gas plants are not the only option the US has. These cases included two combined-cycle gas turbine CCGT power plants, planned for high-capacity factor operation, and two combustion turbine power plants, planned for peak-hour operation. These power plants are proposed for a wide variety of regions with different resource availability, resource costs, climate- and weather-driven demand needs, and customer bases. In all four cases, RMI found clean energy portfolios to be cost-competitive with proposed gas-fired generation, while meeting all required grid services and supporting system-level reliability. In three of the four cases, optimized, region-specific clean energy portfolios cost 8â€”60 percent less than the proposed gas plant, based on industry-standard cost forecasts and without subsidies. However, further analysis revealed that modest carbon pricing i. Similarly, two more years of anticipated renewable and storage cost reductions would also eliminate the difference in cost between the clean energy portfolio and the gas plant. Net Cost of Clean Energy Portfolios across Four Case Studies, Relative to Proposed Gas-Fired Power Plants Our study also included several conservative assumptions that overestimated the cost and underestimated the benefits of the clean energy portfolios. By using an asset-specific paradigm, the analysis limited the possible savings from economies of scope that are possible with integrated system-level planning. We also assigned zero value to existing incentives e. RMI examined a scenario where more than half of retiring thermal capacity through was replaced by portfolios of resources that can provide the same energy, peak capacity, and flexibility to the grid, using conservative assumptions of both renewable and DER adoption. Market Opportunity for Clean Energy Portfolios in the US, â€” Gas Plants Could Face Profitability Threats In addition to suggesting a clear cost-saving opportunity to reshape investment in the US power sector, the analysis also suggests that existing gas plants, and any built in the future, could face profitability threats in the near term. In other words, within the next 10â€”20 years, it will likely be less expensive to build entirely new clean energy portfolios that can perform the same grid services as a gas plant than it will be to run existing gas plants. The result of this will be fewer operating hours and eroded revenue for owners of gas-fired power plants in the US. Investors in new gas-fired generation should carefully consider this emerging dynamic as they evaluate making multibillion-dollar bets on new projects. Comparison of Combined Cycle Operating Costs vs. Regulators, market operators, utilities, and technology providers all have a role to play in realizing this opportunity: State regulators should carefully consider alternatives to approving cost recovery for new gas generation, taking into account the most up-to-date pricing and capability data for alternatives, including battery energy storage, utility-scale and distributed solar photovoltaics, next-generation demand flexibility technologies , and targeted energy efficiency programs. Market operators and state regulators should align investment incentives with least-cost outcomes. In vertically integrated markets, regulators can adjust the utility business model to remove a bias toward utility-owned assets and enable a competitive market for grid services. The utility planning paradigm has long resulted in large-scale generation investments to meet continually growing demand; now that demand is flat and large-scale generation is no longer the most cost-effective option, there is a clear opportunity to update processes to reflect the new reality. Technology and service providers can offer resource portfolios that meet grid needs, either individually or as part of optimized portfolios, and continue to drive down soft costs that may limit the cost-effectiveness of aggregated resource portfolios. Service providers can also build confidence in nontraditional solutions e. If the opportunity afforded by the current investment cycle is missed, the United States risks locking in costs and carbon emissions for generations to come. Image courtesy of iStock.

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Chapter 2 : Energy Economics | Economics | MIT OpenCourseWare

Energy economics is a broad scientific subject area which includes topics related to supply and use of energy in societies. Due to diversity of issues and methods.

While it is true that renewable energy provides great environmental benefits and may yet prove to be our main hope for decarbonization, it is just as true and often overlooked that renewable energy provides considerable economic and social benefits. Take jobs for example. If you add large hydropower to the mix, you get a conservative estimate of an additional 1. While the bulk of employment is found in a relatively small number of countries, more and more countries are deploying renewable energy and creating jobs. Plummeting prices for renewable energy technologies are also triggering capacity additions and driving more jobs in installation and operation and maintenance. Solar PV is the largest renewable energy employer with 2. In an auction this year, Dubai contracted for the lowest-ever price of electricity from a solar park, without financial support, at less than US 6 cents per kilowatt-hour kWh. Wind is another example where falling costs are creating new jobs. Employment in wind energy passed the 1 million jobs mark, up from , at last count. Onshore wind is now one of the most cost-competitive sources of electricity available with some projects now delivering electricity for as little as US four cents per kWh, again without financial support. The new reality is that the cost of generating power from renewable energy sources has reached parity or dropped below the cost of fossil fuels for many technologies in many parts of the world. Biomass, hydropower, geothermal and onshore wind are all competitive with or cheaper than coal, oil and gas-fired power stations, even without financial support and despite falling oil prices. These low prices are making the business case for renewable energy stronger than ever. Renewable energy is not just about saving the environment any more. It is now also about stimulating the economy, creating jobs, generating new sources for growth, increasing income and improving trade balances. Yes, doubling the share of renewables to 36 percent by could prevent nearly 9 gigatonnes of carbon emissions, contributing significantly to the efforts to stabilize the climate. The technologies are already available to achieve this objective and world leaders have recognized the importance of renewable energy and the phasing out of fossil fuels in keeping global temperature rise below 2 degrees Celsius. But, the real story in this new era of renewables is that doing so is actually cheaper than the alternative when factoring in social and environmental costs. In a world recovering from an economic crisis and stressed by high unemployment rates, this job creation potential is an important consideration for policy-makers. World leaders must develop forward-looking approaches to train and educate people to fill these new job vacancies and policies must be adopted to maximize renewable energy job creation. This entails developing a supportive policy mix that governs deployment, trade, investment, research, education and regional development. For example, the Modi government in India has adopted an ambitious vision for renewable energy development over the next few years. If the right policy mix is enacted and the government reaches its goal of installing GW of solar PV and 60 GW of wind, it will generate more than 1 million much needed jobs by In the US, declining technology costs and enabling policies have already resulted in a 22 per cent and 43 per cent increase in solar and wind power employment respectively over the past year. The economics of renewable energy are now undeniable. It has never been more economically feasible to create jobs, bring modern energy services to the 1.

Chapter 3 : Resource and Energy Economics - Journal - Elsevier

Energy economics is the field that studies human utilization of energy resources and energy commodities and the consequences of that utilization. In physical science terminology.

Overview[edit] Olkiluoto 3 under construction in It is the first EPR design, but problems with workmanship and supervision have created costly delays which led to an inquiry by the Finnish nuclear regulator STUK. Utility-scale solar electricity generation newly contracted by Palo Alto in costs 2. Many countries, including Russia, South Korea, India, and China, have continued to pursue new builds. Globally, 71 nuclear power plants were under construction in 15 countries as of January , according to the IAEA. In the United States, nuclear power faces competition from the low natural gas prices in North America. These reactors are extremely expensive to build. It can sometimes take decades to recoup initial costs. Timothy Stone , businessman and nuclear expert, stated in "It has long been recognised that the only two numbers which matter in [new] nuclear power are the capital cost and the cost of capital. The recent liberalization of the electricity market in many countries has made the economics of nuclear power generation less attractive, [57] [58] and no new nuclear power plants have been built in a liberalized electricity market. Private generating companies now have to accept shorter output contracts and the risks of future lower-cost competition from subsidised energy sources, so they desire a shorter return on investment period. This favours generation plant types with lower capital costs or high subsidies, even if associated fuel costs are higher. Profundo added up investments in eighty companies in over financial relationships with banks in the following sectors: Because a power plant does not earn income and currencies can inflate during construction, longer construction times translate directly into higher finance charges. The NRC has new regulations in place now see Combined Construction and Operating License , and the next plants will have NRC Final Design Approval before the customer buys them, and a Combined Construction and Operating License will be issued before construction starts, guaranteeing that if the plant is built as designed then it will be allowed to operateâ€"thus avoiding lengthy hearings after completion. In Japan and France , construction costs and delays are significantly diminished because of streamlined government licensing and certification procedures. In France, one model of reactor was type-certified, using a safety engineering process similar to the process used to certify aircraft models for safety. That is, rather than licensing individual reactors, the regulatory agency certified a particular design and its construction process to produce safe reactors. In the United Kingdom and the United States cost overruns on nuclear plants contributed to the bankruptcies of several utility companies. In the United States these losses helped usher in energy deregulation in the mids that saw rising electricity rates and power blackouts in California. When the UK began privatizing utilities, its nuclear reactors "were so unprofitable they could not be sold. But the company that took them over, British Energy, had to be bailed out in to the extent of 3. However, nuclear has lower fuel costs but higher operating and maintenance costs. Generally, the fuel used is uranium , although other materials may be used See MOX fuel. This represents a higher level of assured resources than is normal for most minerals. Further exploration and higher prices will certainly, on the basis of present geological knowledge, yield further resources as present ones are used up. Fuel efficiency in conventional reactors has increased over time. Similar efforts have been utilizing weapons-grade plutonium to produce mixed oxide MOX fuel, which is also produced from reprocessing used fuel. Other components of used fuel are currently less commonly utilized, but have a substantial capacity for reuse, especially so in next-generation fast neutron reactors. Radioactive waste All nuclear plants produce radioactive waste. To pay for the cost of storing, transporting and disposing these wastes in a permanent location, in the United States a surcharge of a tenth of a cent per kilowatt-hour is added to electricity bills. Currently, there is no plan for disposing of the waste and plants will be required to keep the waste on the plant premises indefinitely. Long term management is subject to change based on technology and public opinion, but currently largely follows the recommendations for a centralized repository as first extensively outlined in by AECL in It was determined after extensive review that following these recommendations would safely isolate the waste from the biosphere. Very long term monitoring requires less staff since high-level waste is less toxic than naturally occurring uranium ore deposits within a few centuries. Depleted uranium DU waste can also be used as fuel in fast reactors. Waste produced by a fast-neutron reactor and a pyroelectric refiner would consist only of fission products, which are produced at a rate of about one tonne per GWe-year. This entails either dismantling, safe storage or entombment. Vulnerability of nuclear plants to attack A report for the Union of Concerned Scientists stated that "the costs of preventing nuclear proliferation and terrorism should be recognized as negative externalities of civilian nuclear power, thoroughly evaluated, and integrated into economic assessmentsâ€"just as global warming emissions are increasingly identified as a cost in the economics of coal-fired electricity". In when North Korea turned on a "power" reactor, there was uncertainty in defense circles whether it was for power use or plutonium production: Lists of nuclear disasters and radioactive incidents candles in memory of the Chernobyl disaster in , at a commemoration 25 years after the nuclear accident, as well as for the Fukushima nuclear disaster of Nuclear safety and security is a chief goal of the nuclear industry. Great care is taken so that accidents are avoided, and if unpreventable, have limited consequences. Accidents could stem from system failures related to faulty construction or pressure vessel embrittlement due to prolonged radiation exposure. Many more recent reactor designs have been proposed, most of which include passive safety systems. These design considerations serve to significantly mitigate or totally prevent major accidents from occurring, even in the event of a system failure. Still, reactors must be designed, built, and operated properly to minimize accident risks. The report that UNSCEAR presented to the UN General Assembly in states that 29 plant workers and emergency responders died from effects of radiation exposure, two died from causes related to the incident but unrelated to radiation, and one died from coronary thrombosis. It attributed fifteen cases of fatal thyroid cancer to the incident. It said there is no evidence the incident caused an ongoing increase in incidence of solid tumors or blood cancers in Eastern Europe. With 46 deaths in its entire six-decade worldwide history, nuclear power remains the safest-ever way to make electricity, by a very wide margin. Instead, the public faces the prospect of severe losses in the event of any number of potential adverse scenarios, while private investors reap the rewards if nuclear plants are economically successful. Because of the high profiles of the Three Mile Island accident and Chernobyl disaster , relatively few municipalities welcome a new nuclear reactor, processing plant, transportation route, or deep geological repository within their borders, and some have issued local ordinances prohibiting the locating of such facilities there. Nancy Folbre , an economics professor at the University of Massachusetts, has questioned the economic viability of nuclear power following the Japanese nuclear accidents: The proven dangers of nuclear power amplify the economic risks of expanding reliance on it. Indeed, the stronger regulation and improved safety features for nuclear reactors called for in the wake of the Japanese disaster will almost certainly require costly provisions that may price it out of the market. Safety interlocks were turned off. Coolant circulation was turned off. Core temperature rose from the usual degrees Fahrenheit to degrees within 20 seconds. The boiling temperature of the sodium coolant is degrees. Within seven minutes the reactor had shut itself down without action from the operators, without valves, pumps, computers, auxiliary power, or any moving parts. The temperature was below the operating temperature. The reactor was not damaged. The operators were not injured. There was no release of radioactive material. The reactor was restarted with coolant circulation but the steam generator disconnected. The same scenario recurred. Three weeks later, the operators at Chernobyl repeated the latter experiment, ironically in a rush to complete a safety test, using a very different reactor, with tragic consequences. Safety of the Integral Fast Reactor depends on the composition and geometry of the core, not efforts by operators or computer algorithms. The worst case nuclear accident costs are so large that it would be difficult for the private insurance industry to carry the size of the risk, and the premium cost of full insurance would make nuclear energy uneconomic. It is often argued that this potential shortfall in liability represents an external cost not included in the cost of nuclear electricity. However, the problem of insurance costs for worst-case scenarios is not unique to nuclear power: If 15 percent of these funds are expended, prioritization of the remaining amount would be left to a federal district court. If the second tier is depleted, Congress is committed to determine whether additional disaster relief is required. Please update this article to reflect recent events or newly available information. August The cost per unit of electricity produced kWh will vary according to country, depending on costs in the area, the regulatory regime and consequent financial and other risks, and the availability and cost of finance. Costs will also depend on geographic factors such as availability of cooling water, earthquake likelihood, and availability of suitable power grid connections. So it is not possible to accurately estimate costs on a global basis. Commodity prices rose in , and so all types of plants became more expensive than previously calculated. A study by former utility staffperson Craig A. Sovacool , the marginal levelized cost for "a 1,MWe facility built in would be Cost of electricity by source Generally, a nuclear power plant is significantly more expensive to build than an equivalent coal-fueled or gas-fueled plant. If natural gas is plentiful and cheap operating costs of conventional power plants is less. A comparison of the "real" cost of various energy sources is complicated by a number of uncertainties: The cost of climate change through emissions of greenhouse gases is hard to estimate. Carbon taxes may be enacted, or carbon capture and storage may become mandatory. The cost of environmental damage caused by any energy source through land use whether for mining fuels or for power generation , air and water pollution, solid waste production, manufacturing-related damages such as from mining and processing ores or rare earth elements , etc. The cost and political feasibility of disposal of the waste from reprocessed spent nuclear fuel is still not fully resolved. In the United States, the ultimate disposal costs of spent nuclear fuel are assumed by the U. Operating reserve requirements are different for different generation methods. When nuclear units shut down unexpectedly they tend to do so independently, so the "hot spinning reserve" must be at least the size of the largest unit. Over 87 reactors in the United States have been granted extended operating licenses to 60 years of operation by the NRC as of December [update] , and subsequent license renewals could extend that to 80 years. Due to the dominant role of initial construction costs and the multi-year construction time, the interest rate for the capital required as well as the timeline that the plant is completed in has a major impact on the total cost of building a new nuclear plant. In particular it aimed to develop "a robust approach to compare directly the costs of intermittent generation with more dependable sources of generation". Wind power was calculated to be more than twice as expensive as nuclear power. Nuclear figures included estimated decommissioning costs. An overview can be found here Table 2: However, the most important subsidies to the nuclear industry do not involve cash payments. Rather, they shift construction costs and operating risks from investors to taxpayers and ratepayers, burdening them with an array of risks including cost overruns, defaults to accidents, and nuclear waste management.

Chapter 4 : Economics of nuclear power plants - Wikipedia

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The Awesome Economics of Solar Energy Growth by John McGarry on October 21, Renewable energy costs have decreased significantly over the past several years as solar prices dropped dramatically. These cost decreases and the resulting uptick in investment and acceptance are beginning to have a wide-ranging impact on electricity markets, utilities, and regulations. The Cost of Solar Energy Solar energy costs have been declining steadily and meaningfully over the past 25 years. But only recently has the cost reduction and competiveness with other energy sources had a more meaningful impact on planning, regulation, and investment. As a starting point, the chart below shows the decline in solar photovoltaic module cost and the annual installations from to Modules, however, are just one component of total solar energy costs. Utility-scale solar projects larger than 5 MWac [1] in capacity have led capacity additions over the last five years and represent the lowest cost solar energy. See Figure 2 Figure 2. Median Installed Price of Solar by Type [1] https: These long-term purchase agreements capture the cost of installing, operating, and maintaining utility-scale solar projects, as well as the impact of tax credits. See Figure 3 Figure 3: See Figure 4 Figure 4: This follows a record 7. See Figure 5 Figure 5: Share of New US Electric Generating Capacity Q According to the report , utility-scale PV is expected to drive the majority of demand in , accounting for nearly three-fourths of new capacity. More than 10 GWdc of utility PV is slated to come on line this year. At least another 4. So what impact does the fall in prices and resulting increase in installed capacity have on utilities and electricity markets? First, in some markets the competiveness in pricing relative to gas and coal is causing planners to consider solar as the lowest cost option for adding generating capacity to the grid. Across all eight scenarios, the assessment concluded that most capacity additions were solar, totaling from 14, MW to 28, MW. Falling utility-scale PV costs are also driving utilities to invest directly in more solar projects. Utilities are also beginning to grapple with large customers defecting from the grid and the potential for non-utility companies to sell renewable power directly. In August, Apple was granted the authority to sell excess electricity generated by its solar farms into the wholesale market, motivated by cost and reliability , as well as the objective to promote renewable energy. The solar array is expected to produce 6. Challenges and Opportunities The fall in solar costs and the resulting increase in deployment have been remarkable, but significant challenges exist in reaching the solar penetration levels needed to decarbonize our electricity grid. As part of the their Sunshot Initative, in May the Department of Energy released a series of insightful reports detailing the key barriers and opportunities that solar faces in achieving cost parity. Target System Prices for Utility, Commercial and Residential Sectors, , , In summary, the reports highlight the following challenges: The value of solar technologies can only be understood in the context of the generation system as a whole. Increasing the use of grid flexibility options will be critical to increasing solar penetration. High penetrations of distributed solar will require the use of more advanced inverters to efficiently manage distribution voltage. This is independent of further technology cost improvements. Implementing a range of utility-rate reforms could minimize solar value losses at increasing levels of distributed PV penetration. At the heart of this issue is net energy metering NEM. Under NEM, PV owners can sell to a utility the electricity they generate but cannot consume on site, often at full retail rates. This widespread policy has helped drive the rapid growth of distributed PV, but its success has raised concerns about the potential for higher electricity rates and cost-shifting to non-solar customers, reduced utility shareholder profitability, reduced utility earnings opportunities, and inefficient resource allocation. Summary Cost reductions and the resulting increases in installed capacity are enabling solar to become a competitive source of electricity on the US grid. The ITC has contributed significantly to the increase in capacity and allowed cost parity with fossil fuel sources in some markets. Extending the ITC for five years at the end of has given the market near term policy certainty and is expected to contribute to the continued robust pace of solar development. If history is any guide, prices will continue to fall as capacity increases. As the Sunshot studies indicate, cost parity on an unsubsidized basis is achievable by the end of the decade. While the trend of increasing solar installations is positive, the near-term path may be volatile. The somewhat unexpected ITC extension at the end of caused a spike in utility scale projects in as developers rushed projects into construction. The five-year extension may now cause other projects to be delayed. In the residential market, continued growth will be impacted by state and utility level decisions on the value of solar and net metering.

Chapter 5 : Economics of Renewable Energy | Climate Solutions

This course explores the theoretical and empirical perspectives on individual and industrial demand for energy, energy supply, energy markets, and public policies affecting energy markets. It discusses aspects of the oil, natural gas, electricity, and nuclear power sectors and examines energy tax, price regulation, deregulation, energy.

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Chapter 6 : The Awesome Economics of Solar Energy Growth | Climate Solutions

economics, since the characteristics of nuclear energy are quite different from the renewable energy sources discussed here. Nuclear economics hinge in part on the.

Chapter 7 : Energy Economics - Journal - Elsevier

The Energy Outlook makes projections to and beyond, while the Statistical Review provides historic data on world energy markets Statistical Review of World Energy saw record growth in solar capacity, 'OPEC plus' production cuts and *a surge in Chinese gas demand.*

Chapter 8 : Readings | Energy Economics | Economics | MIT OpenCourseWare

The Master of Energy Economics (MEECON) is a month, full-time professional master's program designed to educate future leaders and strategic thinkers in the energy sector.

Chapter 9 : Report Release: The Economics of Clean Energy Portfolios - Rocky Mountain Institute

Yet advances in renewable energy and distributed energy resources (DERs) offer lower rates and emissions-free energy while delivering all the grid reliability services that new power plants can, according to RMI's The Economics of Clean Energy Portfolios report.