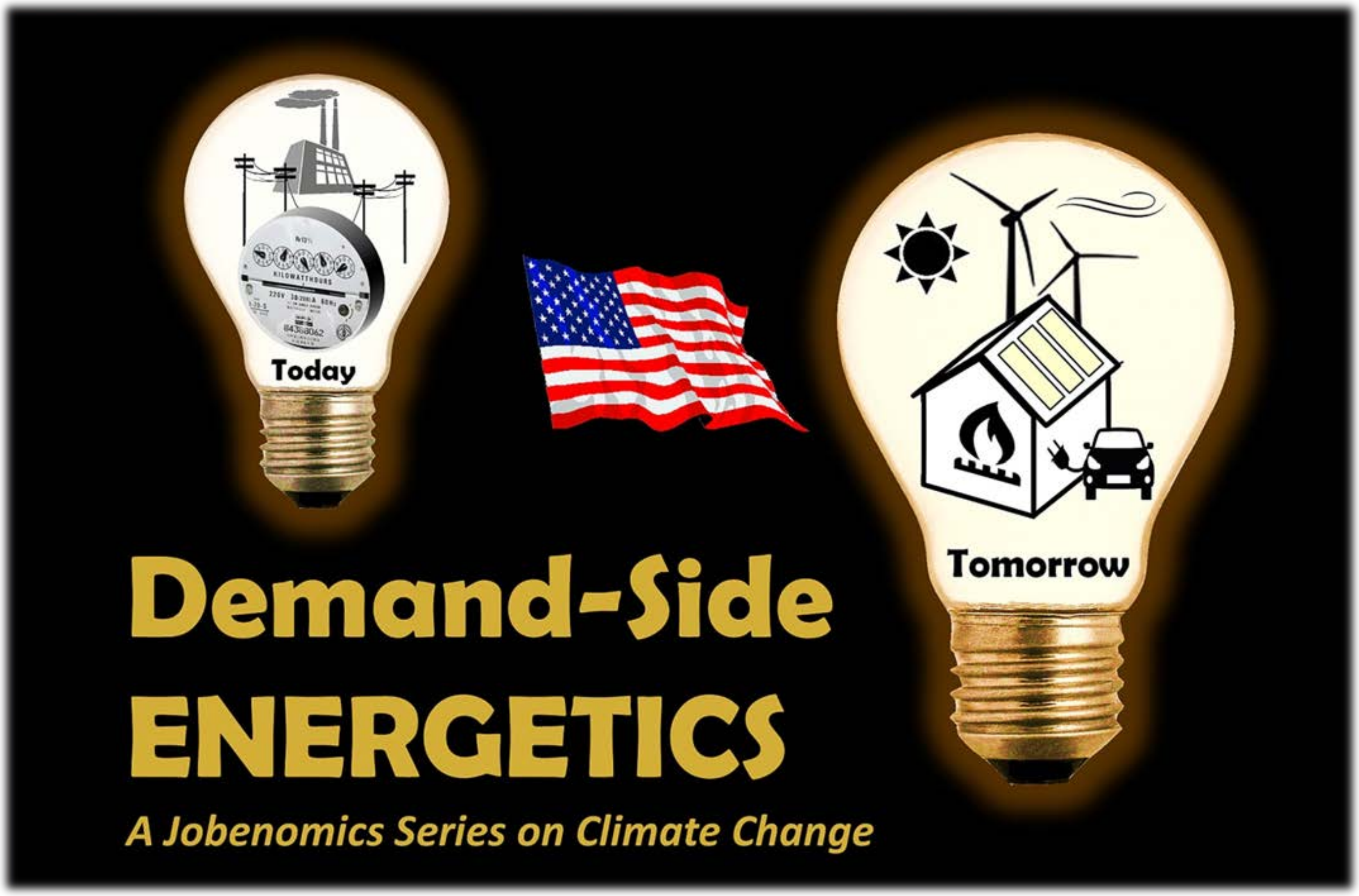
JOBENOMICS™



By: Chuck Vollmer

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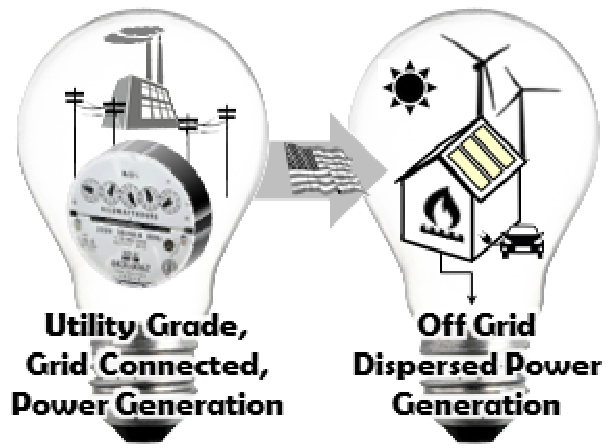
Energetics (also called energy economics) is the study of energy conversion or energy transformation. Examples of energy conversion include the transformation of electricity-to-light, fuel-to-kinetic energy, water power-to-mechanical power, and biomass-to-heat. For millennia, the focus of energy conversion has been on the supply-side of the energy ledger—the side closest to the producer or supplier. The future is on the demand-side—the side closest to the consumer or point-of-consumption.

There are three energetics architectures: (1) large-scale, centralized, **utility generation** designs engaged in selling electric energy to the public, (2) grid-connected **distributed generation** designs intended to offset retail sales, and (3) small-scale, off-grid **dispersed generation** designs.



Utility-scale and distributed generation designs are supply-side oriented, whereas dispersed generation focuses on demand-side energetics at the point-of-consumption. Today, dispersed off-grid generation is usually considered an anomaly best used for remote applications where grid-connected electricity is cost-prohibitive. Jobenomics disagrees and asserts that off-grid, net-zero dispersed energy systems are a viable alternative to centralized grid-based systems. Net-zero energy buildings/ communities are entities that create enough on-site energy to satisfy their internal energy needs without having to rely on external sources.

Furthermore, Jobenomics believes that America should strive to be demand-driven where every building and every community is energy sufficient—able to produce and store the energy it needs—at the point-of-consumption. Integration of dispersed generation with existing grid-centric electric power system will not be easy mainly due to the massive political, regulatory and legal power of the dominant utility companies—as evidenced by *Energiewende*.

Germany's *Energiewende* (German for energy transition) is a national initiative to transition Germany from fossil and nuclear fuels to a renewable energy target of 60% by 2050. According to the German press corps, the German government is restructuring the largest German utilities, into "good" and "bad" technology companies. The "bad utilities" are focused on shuttering fossil fuel and nuclear businesses, while the "good utilities" are focused on growing renewable suppliers and developing new service businesses, such as smart metering, distributed generation management, consumption analytics and energy management. It will be fascinating to watch *Energiewende* transform the German energy sector from a centralized model to a more decentralized, distributed model. Lessons learned will be especially valuable for policy-makers in democratically-elected Western economies.

California has its own version of *Energiewende*. According to California's governor, "California has the most far-reaching environmental laws of any state and the most integrated policy to deal with climate change of any political jurisdiction in the Western Hemisphere."[1] In his 2015 Inaugural Address, Governor Brown announced three ambitious new 2030 goals: increase from 33% to 50% electricity derived from renewable sources; reduce automotive petroleum by up to 50% and increase building efficiency and clean heating fuels by 100%. In 2017, the California Senate has proposed raising the renewable target to 60% by 2030. California's energetics architecture is replete with more distributed power, expanded rooftop solar, micro-grids, an energy imbalance market, battery storage, integrated information technology and electrical distribution, and millions of electric and low-carbon vehicles. These mandates were implemented by executive order by the Governor and enforced by the California Public Utilities Commission.

Today's supply-side energetics architectures are inefficient, given existing and emerging ETR technologies, processes and systems. America produces and distributes electricity, heat and transportation fuels primarily by a centralized supply-side approach. America's supply-side energetics model was initially created to deliver energy from principal sources of energy, such as coal mines, oil refineries, rivers, dams and ports. This energy was then delivered over long distances to population and industrial centers. Substantial losses occur across the entire energy value chain, whether it is in production or generation, during distribution over 5 million miles of pipelines and electrical grids, or in inefficient burning or waste heat loss at the point-of-consumption. A 2012 EIA report states that "roughly two-thirds of the fuels used for generation are lost in the generation and distribution of electricity." [2]

The bulk of the losses occur at the generation facility. The most efficient electrical power generation plants are hydro and tidal power plants with 90% power efficiencies (i.e., the amount of potential or kinetic power turned into electricity). Natural gas plants are roughly 60% efficient. Nuclear, coal and oil-fired plants are 40% efficient. The most inefficient power generation plants are solar and geothermal plants with 15% to 20% efficiencies.

New technology and cogeneration systems are rapidly enhancing energy efficiencies of these plants.[3] Cogeneration technologies have double the energy efficiencies of combined heat and power plants.[4] Cogeneration involves the recovery of otherwise-wasted thermal energy to produce electricity or heat. Despite some recent success stories, supply-side energetics are reaching the point of diminishing returns compared to demand-side energetics.

The second highest amount of supply-chain electrical losses occurs during transmission and distribution. The U.S. electrical grid is the world's most massive commercial monolith, annually distributing $366 billion worth of electricity over 3 million miles of power lines from 7,000 power plants that are owned by 3,300 utility companies who employ 500,000 people who service

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[1] Office of Governor Brown, Inaugural Address, 5 January 2015, http://gov.ca.gov/news.php?id=18828
[2] EIA, Today In Energy, Energy Perspectives, 18 December 2012, http://www.eia.gov/todayinenergy/detail.cfm?id=9250
[3] EIA, What is the efficiency of different types of power plants?, https://www.eia.gov/tools/faqs/faq.php?id=107&t=3
[4] EPA, Combined Heat and Power Partnership Efficiency Benefits, http://www.epa.gov/chp/basic/efficiency.html

159,000,000 American customers[5,6]. Unfortunately, this 50-year old monolith is aging, requiring tens of billions of dollars to maintain annually and investments of up to $2.0 trillion[7] by 2030 to modernize and protect. According to a recent analysis[8] of federal energy records, about once every four days, part of the nation's power grid is struck by a cyber or physical attack. A 2014 testimony[9] by Admiral Rogers (NSA Director) to Congress revealed the possibility of a Chinese or Russian cyberattack against the U.S. power grid, which could cause cascading regional blackouts lasting days to months—with catastrophic economic damage and loss of life.

Electricity Related Losses during Transmission & Distribution

Source: EIA Annual Energy Outlook 2017, Table 2, Year 2017

Quadrillion Btu	Commercial	Residential	Industrial	Transportation	Grand Total
Delivered Energy	8.82	10.90	24.95	28.40	**73.08**
Electricity Related Losses	**9.01**	**9.37**	**6.41**	**0.08**	**24.87**
Total	17.83	20.27	31.37	28.48	**97.96**
Losses % of Total	**51%**	**46%**	**20%**	**0.3%**	**25%**

The U.S. energy consumption in 2017 is projected to be 97.96 quadrillion Btu across all sectors from all sources.[10] Of the 97.96 quads, 25% will be electricity related losses in electricity transmission and distribution. However, energy losses vary significantly by sector. About half of the energy that commercial and residential consumers purchase is lost (51% and 46% respectively), whereas industrial plants operate more efficiently with electricity-related losses of only 20%. Since the transportation is mostly petroleum-based, its electricity related losses are minimal. The widespread adoption of electric vehicles is likely to change the transportation equation.

From an energetics architecture perspective, wouldn't it be much wiser to generate electricity as close to the light bulb as technically possible as opposed to generating it miles away? Disbursed demand-side energetics architectures offer much higher potential for energy efficiency by producing energy on-site. If residences and businesses could create and store energy on-site, there would be little need for outside electrical supply and expensive utility-grade electrical grids. The problem with on-site power generation has been the high cost of dispersed generation equipment. However, this is changing. Dispersed generation is becoming increasingly affordable to individual homeowners and small businesses due to lower installation costs, lower operational costs, smarter information and network technologies, and innovative leasing, subscription, and net-metering services.

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[5] American Public Power Association, 2014-2015 Annual Directory & Statistical Report, U.S. Electric Utility Industry Statistics, http://www.publicpower.org/files/PDFs/USElectricUtilityIndustryStatistics.pdf
[6] Edison Electric Institute, Electricity 101, http://www.eei.org/electricity101/pages/value.aspx
[7] U.S. Quadrennial Energy Review, Summary For Policymakers, Aging Infrastructure and Changing Requirements, Page S-4, http://energy.gov/sites/prod/files/2015/04/f22/QER%20Summary%20final_1.pdf
[8] USA Today, 27 March 2015, http://www.usatoday.com/story/news/2015/03/24/power-grid-physical-and-cyber-attacks-concern-security-experts/24892471/
[9] C-Span, 20 November 2014, Cyber Threats, http://www.c-span.org/video/?322853-1/hearing-cybersecurity-threats
[10] EIA, Annual Energy Outlook 2017, Table 2, Energy Consumption by Sector and Source http://www.eia.gov/forecasts/aeo/

An analysis by the Energy Department's National Renewable Energy Laboratory (NREL) estimates that U.S. building rooftops could generate close to 40% of national electricity sales using rooftop photovoltaic (PV) systems.[11] Jobenomics thinks that NREL's 40% rooftop estimate is likely to be a conservative estimate considering the advent 3rd generation PV systems that could be used throughout the exterior of the building as opposed to only rooftops. 1st generation silicon solar panels and 2nd generation solar thin-film photovoltaic technologies are restrained by the Shockley-Queisser limit of 34% power efficiency (the amount of sunlight power turned into electricity), whereas 3rd generation multi-layer solar cells may be able to approach efficiencies near 86%. Consequently, next-generation solar systems are likely to be much more efficient and significantly cheaper than current 1st generation solar panels. In addition to efficiency, multi-layer solar cells are likely to have many more applications, such being embedded in roofing shingles (already happening) as well as window glass and vinyl siding appliques.

Dispersed electrical generation is not a new concept. In fact, it is often the dominant way of doing business in many parts of the world that are dependent on diesel-powered generators as opposed to 24/7 electrical power supplied by utilities. In the United States, there are approximately 12 million residential electrical generators: 9 million used for emergency or backup power and 3 million for primary power. From an environmental perspective, most of the 9 million emergency generators are noisy and dirty and limited to 200 hours per year. The 3 million primary power generators are more expensive due to cleaner burning fuels (propane), better fuel efficiencies and more interconnectivity to household systems. As renewable energy costs decrease, the likelihood of mass deployment of residential dispersed electric and heat generation will increase.

Few American policy-makers realize that gains in demand-side energy efficiency have produced far greater gains in energy conservation and greenhouse gas mitigation than all renewable energy advances combined. The IEA's inaugural 2013 Energy Efficiency Report[12] states that energy efficiency savings from 11 developed economies[13] are equivalent to one-quarter of all petroleum products consumed annually by the U.S. transportation sector.

Energy efficiency has moved from the "hidden fuel" to the "first fuel," exceeding output from any other supply-side fuel sources. In 2010, this new first fuel reduced total fuel consumption in the 11 IEA member countries by an estimated 65%. By reducing demand at the point-of-consumption, energy efficiency enables energy conservation, reduces the pressure on the energy infrastructure, augments energy assurance and security, and improves health and wellness via mitigation of toxic emissions.

For a modern energetics architecture to be truly transformative, policy-makers must focus on the demand-side of the equation. A majority of 150 million U.S. homes and small businesses could be energy efficient or energy independent within a few decades. Also, a distributed/dispersed, point-of-

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[11] National Renewable Energy Laboratory, NREL Raises Rooftop Photovoltaic Technical Potential Estimate, 24 March 2016, http://www.nrel.gov/news/press/2016/24662

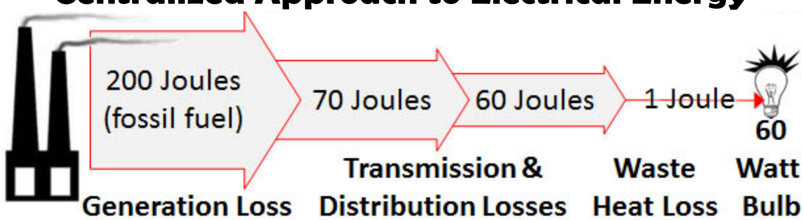
[12] IEA, Energy Efficiency Unit (EEU), Energy Efficiency Market Report 2013, http://www.iea.org/publications/freepublications/publication/EEMR2013_free.pdf

[13] United States, United Kingdom, Germany, France, Italy, Denmark, Finland, Netherlands, Sweden, Japan and Australia.

consumption, intelligent architecture that integrates multi-sources of indigenously-produced energy (wind, solar, biomass, geothermal, hydro and natural gas) could produce many millions of net new jobs nationally and tens of millions internationally. If underwritten by government loans and guarantees, as the government does for mortgages, demand-side energetics is likely to attract significant private sector investor interest.

Fortunately, the Trump Administration does not have to start from scratch on a modern Demand-Side Energetics Architecture. As mentioned earlier, California has its version of *Energiewende* which was primarily implemented by executive order by the Governor and enforced by the California Public Utilities Commission. Along with other states, the Administration could use California as a model and work with Congress to implement an aggressive Energetics/Climate Change architecture that could create tens of millions of jobs, millions of startup businesses, boost GDP, protect the environment and significantly reduce consumption by generating power at the point of use.

Centralized Approach to Electrical Energy



Using today's centralized supply-side energetics approach to electrical power generation, less than 1% of the total energy consumed is ultimately converted into light energy. The other 99% is wasted across the supply chain. On average, 200 joules of energy are needed to deliver 1 joule of power (1 joule = 1 watt second), the amount required to illuminate a 60 watt incandescent light bulb. By replacing the 60-watt incandescent light bulb with a 15-watt fluorescent lamp, energy efficiency increases by 75%. Replacing fluorescent lamps with light emitting diodes (LEDs) increase energy efficiency by additional 30%. Moreover, LEDs last five times longer than fluorescent lamps, which last eight times longer than incandescent bulbs.

Using demand-side energetics approach, the vast amount of energy produced at the point of consumption would ultimately be converted into kinetic energy or stored as potential energy. From a Jobenomics perspective, Elon Musk's Demand-Side Energetics Architecture is not only state-of-the-art but available now, highly-scalable and dual-use since it can be used for both electrical power generation and transportation. Musk essentially has unified multiple Tesla/SolarCity companies (electric powertrain systems, lithium Gigafactory, home Powerwall battery storage systems, solar roofs, solar installation and maintenance services, and renewable energy financing) that can collectively produce energy at the point of use at home, in a business or on the go.

It is not inconceivable that wireless electricity (also known as wireless power transmission or electromagnetic power transfer without the use of wires or cables) that could be as common in homes and businesses as Wi-Fi is today. Wireless energy coupled with stationary or transportable solar power could power wireless buildings or charge portable wireless devices without the need for chargers, charging stations or batteries. The net result of such a Demand-Side Energetics Architecture could reduce energy consumption in homes and businesses by an order of magnitude. It is not hard to imagine a day when every household light and appliance is powered wirelessly via a miniature renewable energy receiver and managed by the internet-of-things to ensure maximum energy efficiency. That day is available today. All we need is a modern Demand-Side Energetics Architecture and will to make it happen sooner than later.