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# DESERT REPORT

SPECIAL ISSUE

## RENEWABLE SOLAR ENERGY

Prospects and Problems

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# What Drives This Need For Electricity?

## Will renewable sources be enough?

We understand the need to end our reliance on fossil fuels – including those used to generate electricity. We already use hydro-electric power and, to some extent, nuclear power, but energy provided by wind and solar is becoming increasingly popular and is seen as viable alternative. But how viable is it really?

Between 1921 and 1950, consumption of electrical energy *increased by a factor of thirteen.*[1] Although this growth in electrical usage slowed significantly in the most recent decade, it will almost certainly increase again as, for example, electric vehicles become the norm,[2] and as residential dwellings come to rely more heavily upon electricity for heating, cooling, and other household uses.[3] But there is another serious issue waiting in the shadows that has not received the kind of coverage that it should. The electronic technology industries are poised to massively increase their consumption of energy, mostly electrical. It is this increase in demand which is to be addressed in this article.

**5G Communications**

5G is the 5th generation of wireless technology. This is promoted as not just another G. It is a G specifically designed to provide universal connectivity unlike anything we've seen before. The scale of the network and necessary infrastructure is enormous. Although it is not yet fully developed, it has already been rolled out in a number of countries.[4] 5G is a stunningly complex, capable, and very ambitious telecommunications system.

The telecommunication industry expects that by increasing high speed connectivity the system can efficiently provide the capacity for massive data growth. 5G is described as not only a lot faster than anything that has come before, but also provide greater connectivity for many devices simultaneously. The system is intended to allow for uninterrupted sharing, streaming, and browsing, and to have superior network reliability, imperceptible latency, and a huge increase in network capability.[5]

5G enables "mission-critical communications" which include, for example, remote control of critical infrastructure, vehicles, and medical procedures. 5G is intended to connect a multitude of embedded sensors in virtually everything. This is referred to as the Internet of Things (IoT).[6] 5G is to be a vast network with top speed connectivity between everyone and everywhere. "One suggested target is a 1000x increase over the current capacity."[7] In addition, 5G is expected to drive global growth, increase economic output into the trillions of dollars, and create millions of new jobs. Ultimately it will change the way the world connects and communicates. The industry claims that these developments are in response to "the world's demand for high-speed connectivity."[8]

But . . . there are dark sides, including for instance the energy needed to power the system. 5G is understood to be "power-hungry."[9] This is described in numerous papers and websites, and it appears to be widely accepted.

There are a number of reasons for this. 5G necessitates an immense infrastructure that will certainly be costly not only in financial terms but also in energy costs. More specifically, the 5G infrastructure includes base stations (specialized forwarders for the cellular mobile network that provides wireless connectivity to devices on the move).[10] These base stations adapted to 5G will draw up to twice (or more) the power of 4G base stations.[11]

In addition, a great many of them will be required because of the higher spectrum bands, a need for more antennas, and a denser layer of small cells (miniature cell towers).[12]

Because the system uses higher frequencies (millimeter wavelengths), indoor penetration is not optimum. Therefore the small cells will need to be installed approximately 250 meters apart especially in densely populated areas. New York City for example, will require approximately 3,135,200 small cells that will have to be manufactured and maintained.[13] Also needed will be many miles of fiber optic cable, network equipment, and more.[14] These are just a few examples of the many changes required.

The current mobile system uses wireless connectivity to cell phones and tablets. But this will increasingly include cars, drones, industrial and agricultural equipment, robots, home appliances, medical devices, and so on.[15] Despite the industry's assurances that 5G is more power efficient, the sheer increase in deployment is thought to more than cancel out any power efficiency in the system.[16] The expectation is that telecommunications network operators will face significant growth in their energy costs.[17] In fact 5G is likely to double or even triple energy consumption once the networks are fully operational. Overall energy demands are described as "staggering." To address this issue, the telecommunications industry is actively researching and developing ways to address this "energy problem."[18]

Meanwhile 6G is already in development and promises to offer a connection speed that is ten times faster than 5G and is expected to completely revolutionize mobile connections as we currently know them.[19] Clearly the need for electricity can be expected to continue increasing.

Oh, one more thing: customers will need new smart phones and other devices that are compatible with the 5G network system. Perhaps we can expect to need new ones again when 6G rolls out?

**Cryptocurrency**

Satoshi Nakamoto (the name used most likely by an anonymous developer or group), launched the world's first cryptocurrency, Bitcoin, in 2009. It is now the best known and most popular cryptocurrency by market capitalization.[20] Many others have since followed. His intention was to create a decentralized payments platform that would revolutionize how everything was bought and sold. He believed that his system would enable quick, borderless transactions. It didn't work out that way. Instead of facilitating financial transactions, cryptocurrencies have mainly become speculative assets.[21]

Cryptocurrency is a virtual currency designed to be used as a form of payment in the same way money is used. But cryptocurrency is outside the control of any one person, group, or entity. This means that there is no third-party involvement in any of the financial transactions. It uses encryption techniques to control the creation of monetary units and to verify the transfer of funds.[22]

Blockchains were invented specifically for cryptocurrency. They are the decentralized ledgers of all transactions that take place. Entries are encoded. Transactions are recorded in "blocks" and linked together on a "chain" providing a complete record of all cryptocurrency transactions. This technology enables the existence of cryptocurrency.[23]

Regardless of the widely differing perspectives and opinions about cryptocurrency, there is one thing all appear to agree on: "The digital gold rush has come with a catch: massive electrical consumption." In other words, "Bitcoin is extremely energy-hungry." One frequently mentioned example is that it uses more energy than the annual electrical consumption of Finland or Denmark.[24] The problem seems to be the *process* of mining the cryptocurrency which uses computers (competitive mining computers called rigs) to do so. Even increasing machine efficiency doesn't appear to ameliorate the tremendous need for electricity.

This is how the mining is described (although somehow not easy to comprehend): "Bitcoin, along with other cryptocurrencies, works on a simple concept. Every ten minutes the bitcoin protocol – essentially, the code underlying bitcoin – generates a math equation with a numerical solution. In order to mine bitcoin, the miner needs to guess what that solution is. As more people (i.e. computers) try to guess that number, the protocol adjusts itself to make the number harder to guess, so more computing power is needed to make more guesses quickly."[25] When multiple miners participate, the computations increase in complexity. Electrical usage increases as they compete for rewards, and the "work" that needs to be done to find the right numerical sequence increases as well. This in turn means that electrical consumption continues to escalate.

More recently, a number of companies started giant mining operations. These are huge facilities with many racks with specialized bitcoin-mining computers which consume even greater amounts of electricity. Since these operations can run quite hot, more cooling is needed to maintain the equipment's functioning. And once again, electrical consumption increases. The bottom line is that cryptocurrency involves the need for vast amounts of power.[26]

**Data Centers**

Data centers are physical facilities that organizations use to store, process, and disseminate data and applications for daily operations. Almost all businesses and governments build and maintain their own data centers or they have access to someone else's. There are also large data center services provided by hosts like Amazon, Microsoft, Sony and Google.[27, 28] At present there are two kinds of data centers. Those developed first are now referred to as legacy data centers. Newer iterations are the cloud based data centers which are increasing in popularity. Electricity is critical to data centers because no electricity means no data centers. In fact to make everything run smoothly, the equipment needs a constant and steady supply of uninterrupted electricity.[29]

As more and more data is produced, the need for electricity also continues to grow. In the legacy data centers, the servers, lights, cooling, monitors, humidifiers, and other critical IT equipment pieces require electricity. To begin to understand what that means, we need to know that the sheer size of these data centers is staggering. They range from 100 square-foot

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*must end is deeply disturbing for many.*

In support of continuing to grow our GDP, a group of economists argue that it is possible to decouple economic growth from energy usage.[9] Called a circular economy, the proponents of this idea argue that the material requirements of our civilization can be met by massive recycling of resources and that increases in efficiency will make solar energy sufficient for our needs. Even with the imagined recycling and efficiencies, if such an economy continued to grow, it would still need new inputs of materials and energy to keep the larger circle turning. It seems intuitive that an endlessly growing economy on a finite planet is impossible.

Some climate activists maintain that our only chance for a reasonable future will require an *immediate and abrupt* end to the use of fossil fuels.[10,11] They also argue that direct efforts to restore the natural biosphere must be initiated, including both an end to industrial agriculture and to urban expansion. These writers are less helpful in explaining how this is to be done without creating extraordinary social dislocations along the way.

Another group of writers argue that although difficult, a less abrupt and planned reduction in our economy is possible. Known as the Degrowth movement, it proposes a new order where economic activity is no longer at the center of everything; democracy is direct; income and wealth are distributed according to egalitarian principles; vital resources, infrastructures, and spaces are held in common; technology is convivial and serves social purposes; resource throughput is minimized; and working hours are reduced by cutting consumption, production, and wasteful expenditures.[12]

The utopian nature of this vision is obvious, and proponents of the Degrowth movement acknowledge that there are no known groups that have fully demonstrated its practicality. They insist that a capitalism as we know it is incompatible with their proposed society, but they also point out examples where communities have lived well without growth. These ideas are interesting, but they have gained rather little attention in the United States.

An alternate but related view argues for what is called a *steady state economy.* The fundamental principle is that the overall size of the economy, as measured by Gross Domestic Product (GDP), should not grow, but that adjustments to labor, resources, investments, and social amenities would be possible as conditions require. To be stable, such an economy must provide a decent standard of living throughout the world, and if it is not to outrun the resources of the planet, it would of necessity entail what the industrial nations of the world consider a lower standard of living.

A 2013 study published in *Ecological Economics*[13] examined the connection between Gross Domestic progress (GDP) and a broader indicator of well being which included environmental health and social benefits. Between 1950 and 2003 and across seventeen countries, the study found a genuine direct correlation between GDP and well-being – *until a certain threshold was reached, and after this, the correlation fades.* This suggests that nations should indeed focus on building GDP as they come out of poverty, but once they are reasonably well off, other measures become more important and relevant.

The modern notion of a steady state economy can be attributed to a 1973 publication, *Toward a Steady-State Economy* by Herman Daly.[14] More recently, he and Brian Czech founded the non-profit Center for Advancement of the Steady State Economy (CASSE) which is the most visible advocate for the steady state movement in the United States. Somewhat unlike the proponents of Degrowth, CASSE is formally organized and its website lists its goals as well as intermediate objectives.[15]

Given the level of consumption in the United States and the unquestioned acceptance of our consumer culture, the prospect of a shrunken economy is nearly beyond imaging. But before assuming that no change in lifestyle is possible, several observations can be made. By most standards, the quality of life in Europe is equivalent to that in the United States, but they have maintained this standard with a Gross Domestic Product per person that is about half of ours. A second observation can made from our experience with COVID. Our economy shrank; large gatherings were constrained; oversea travel was nearly impossible; and shopping for more than essentials was deferred. It was unpleasant, but we survived. If we think about our greatest losses, these were the opportunities for our children to attend school, our opportunity to visit family in other cities, and a quiet meal at a restaurant. Our material deprivations were not the ones that mattered; it was our personal connections that we missed. A steady state economy may be survivable after all.

Predicting the future in a time of climate change is a highly uncertain endeavor. We must act on the basis of what seems most probable, but we must also acknowledge that our knowledge of the natural world is incomplete. Similarly, we have been unable to adequately anticipate the changes created by our new technologies. A lengthy and perceptive discussion of these changes has been written in a book by Vaclav Smil called *The Grand Transitions: How the Modern World Was Made.*[16] He argues that none of the transitions – population explosion, agricultural advances, harnessing of energy, changing economics, environmental losses – could have been foreseen or understood while they were underway. The conclusion which Smil draws is that in our present state of uncertainty, all our options must be kept open.

Renewable solar energy may be a key to surviving our environmental crisis, or it may be seriously insufficient. We will almost certainly find our culture radically transformed – ideally through planning that affirms the best of our human nature and maintains the integrity of our planet. It would be an error to commit to any strategy without attempting to consider the consequences that might ensue.

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buildings – considered small – to hyper-scale 400,000 square-foot data centers that house thousands of data cabinets. A data cabinet is a server or a data storage cabinet that can be placed on the floor space to organize IT equipment and data.[30] Whenever someone uses any internet service, it will connect to one of the thousands of data centers around the world.

In 2006 there were 11 million servers in data centers worldwide. In 2020 there were 18 million.[31] Studies have shown that as humankind's annual digital activities increase, the overall energy consumption will also increase. Now it is especially the large cloud data centers (often referred to as hyperscale centers) that are steadily increasing their electrical consumption.

The industry's stated intention is to balance the increase by significantly investing in "green initiatives" such as energy efficient equipment and the use of renewable energy – mostly wind and solar.[32] Considering that data centers are already among the highest consumers of electrical power,[33] this brings us to the question: can wind and solar provide enough power to satisfy industry's continually increasing demand?

**Google**

It is interesting to take a look at what Robert Bryce calls, "the Giant Five: Google, Apple, Amazon, Facebook, and Microsoft," because most of the services they provide are heavily dependent on the growing use of electricity.[34]

For example Google, regarded as one of the world's richest and most powerful corporations, is wholly dependent on electrical power; massive quantities of it. Like all members of "the Giant Five," it has its own electric grids to provide continuous electricity to data centers and fiber-optic networks. In addition Google's use of electricity is doubling approximately every three years. As the information available on-line increases, electrical consumption increases.[35]

Bryce writes, "Electricity is the world's most important and fastest-growing form of energy. It is also fueling nearly every aspect of the Information Age. Google represents the most obvious manifestation of this merger of bits and electrons."[36] Growth in this business appears unstoppable. Electrical power is relied on to make this growth happen.

**Conclusion**

This article raises the question, "Where will all this electricity come from?" and it illustrates how massive this demand already is and how it will continue to increase. Furthermore the industries described in this article are not the only ones requiring massive amounts of electricity to power their operations, especially with the global trend toward increased consumption and economic growth. Residential use of electrical power will increase for heating/cooling and various appliances. The electrification of transportation is already ongoing. Furthermore the human population continues to grow which will increase the need for power to operate all that we use.

Coincident with this significant increase in demand for electrical power, we are attempting to ameliorate climate change and other environmental issues. Generating electricity in a way that does not negatively impact the environment appears to be elusive as illustrated by several articles in this issue of Desert Report.

This raises additional questions: What will the impact of uncontrolled growth be on our planet? And how will the electricity be distributed? Our aging power grid cannot handle the current needs for electricity as described in a June 2, 2022 article in the Washington Post.[37] Will power outages become the norm? It is unclear what is being done to address this.

The logical conclusion appears to be that the only way to adequately meet these challenges is to slow down or even decrease growth. The companies that drive this growth cannot be expected to support any movement toward this. It would threaten not only jobs but, more importantly to companies, profits. But what do we want, as consumers, as citizens, as people? This brings us right back to "Fundamental Choices." We do need to slow down; we do need to decrease growth and consumption. Our current upward trajectory is, most likely, not sustainable. Therefore our present and our future depend on the choices that we, individually and collectively, make now.

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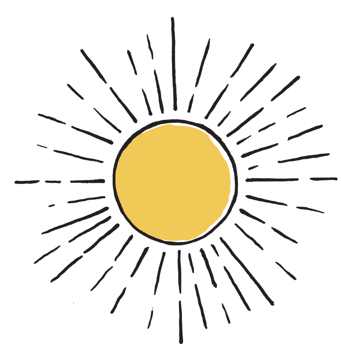
*Footnotes cited in the article can be accessed at www.desertreport.org by selecting "references" at the bottom of the home page.*



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