

The Necessary Integration of Renewable Energy Resources with Civil Structures

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### Abstract

Mankind and the world as we know it has always adapted to problems as we are confronted with them, often with little thought of future consequences. This essay discusses the possible solutions to the declining health of our surrounding environment. The evolution of power generation was shaped as the need for such resources arose. With growing populations came growing cities, mass structures and freeways. With them came a need for massive amounts of electricity. Why the engineers, architects, and civil planners did not incorporate energy efficiency and Renewable Energy into these wondrous displays of man's ability, escapes me. Perhaps the reasons were a lack of technology, lack of funds, or the monopolies of power that will continue to deny the need for energy efficiency. What I do know, is that it is now a necessity to incorporate these technologies into our currently existing and newly built structures, for the sake of our planet and our future.

*Keywords:* Renewable Energy (RE)

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### **Failure to Adapt**

Nobel prize winning scientist Christian de Duve once said “The cost of our success is the exhaustion of natural resources, leading to energy crises, climate change, pollution, and the destruction of our habitat. If you exhaust natural resources, there will be nothing left for your children. If we continue in the same direction, humankind is headed for some frightful ordeals, if not extinction.”

The impact of pollution from civilizations’ continuous need for electricity is a concern for many people. One would think incorporating renewable resources and energy efficiency into our structures is a common practice. However, the potential cost of doing so has kept many civilizations from such practices. There are many ways to accomplish this goal today by incorporating Renewable Energy (RE) into our civil structures such as bridges, buildings, and roads. Companies that have failed to adapt to Renewable Energy technologies are potentially keeping society from progressing or in other words, adapting. Advances in technology in the field of civil engineering and renewable resources and energy have given us the capability to fully integrate environmentally friendly technology and should be implemented.

### **Dirty Energy (History)**

It is easy for people to point blame when they think about the technologies being used today. They could blame their parents or grandparents’ generations, and say that they didn’t care about the future, or they could say that they simply did not have the knowledge. Each generation is faced with its own problems. That generation is then charged with the due diligence to find a

solution to that problem. Most of the time that solution will be the cheapest, fastest and easiest one.

Believe it or not, usable electricity was not always around, electricity had to be generated and then manipulated, eventually giving life to many of our modern-day comforts such as light bulbs and electric heaters. In fact, according to “History of Electricity, n.d” we can trace our use of electricity early into the 1800’s.

“One of the first major breakthroughs in electricity occurred in 1831, when British scientist Michael Faraday discovered the basic principles of electricity generation. Building on the experiments of Franklin and others, he observed that he could create or “induce” electric current by moving magnets inside coils of copper wire. The discovery of electromagnetic induction revolutionized how we use energy. In fact, Faraday’s process is used in modern power production, although today’s power plants produce much stronger currents on a much larger scale than Faraday’s hand-held device” (“History of Electricity” n.d).

Humanity has come a long way since then. The generation of electricity has since turned into an industry and a business. Everybody in the world that uses electricity pays for this resource. But this resource must come from somewhere and in this case, it is coal. “In the era of modern power plants, coal has always generated more electricity in the U.S. than any other fuel source. In recent decades, we have seen other sources compete for second place: first hydroelectricity, then natural gas, nuclear power, and natural gas again”. (“History of Electricity” n.d)

During the great depression, power lines began to bring electricity to rural areas causing energy use to double every 10 years. Petroleum and coal were the primary means of energy

production, the cost of which was declining steadily. The problem of commercial energy for all was solved. Homes were happy and electrified; the promised technology has finally arrived. Gasoline, coal and nuclear energy use then continued to increase at an alarming rate, unchecked. Efficient energy use was simply not a concern until 1979 when war and political disputes caused the price of petroleum to sky rocket (“A Short History of Energy” n.d). As human population grew, the need for infrastructures and new technologies grew as well. Many systems and structures currently in place were developed to best suit the (then) current needs of society.

### **Pollution**

When we look at the world around us, it is not hard to see the effects pollution has had on this world. Smog, litter and a hole in the ozone layer are just a few. As many of us look at the world that we call home, we do not know what it was like untouched by mankind. We have created machines that have taken an unforgiving toll on our planet. Most of us, whom grew up in the late 20<sup>th</sup> and early 21<sup>st</sup> centuries have then become increasingly reliant on these technologies. In fact, if it wasn't for pollution or the price of gasoline then the thought of using renewable resources probably wouldn't be much of a concern right now.

While mankind excelled and continued creating new and interesting technologies, we also continued putting our needs and wants before the health of our world. Mankind created the need for electricity, the generation of which has cause many problems. “Electricity generation burns large amounts of fossil fuels and produces several important air pollutants, including carbon dioxide, sulfur dioxide, and nitrogen oxides” (Human activity and air pollution, 2006, p.1).

According to “*Electricity and the Environment*” (2018), the transportation and actual usage of electricity is a clean process. It's only is the generation of which that causes problems.

“In the United States, about 64% of total electricity generation in 2017 was produced from fossil fuels (coal, natural gas, and petroleum), materials that come from plants (biomass), and municipal and industrial wastes” (Electricity and the Environment, 2018).

So why does all this matter? Well in the process of using these materials to produce electricity, they are also producing bi-products in the form of combustion gas emissions. This includes but is not limited to Carbon dioxide (CO<sub>2</sub>), Carbon monoxide (CO), Sulfur dioxide (SO<sub>2</sub>), Nitrogen oxides (NO<sub>x</sub>), Particulate matter (PM), Mercury. All of which have negative affects on human health and the environment. (Electricity and the Environment, 2018).

### **Technology at our Fingertips**

Advances in civil engineering and renewable resources and energy have given us the capabilities and knowledge to allow mankind and 1st world civilizations to fully integrate green energy and recyclable materials into our infrastructures and communities. These technologies include but are not limited to, hydroelectric, solar, solar thermal, solar photovoltaic, wind, biomass, geothermal and tidal. All of which, have the capability of producing electricity without harmful bi products.

There may be an explanation to why we haven't completely integrated these RE technologies into our structural environment. According to “*Whole system design*” (2009), “During the 20th century, engineering became more and more specialized as scientific and technological knowledge increased exponentially...21st century engineers are no longer trained across fields of engineering as they were before and thus no longer keep up with the latest breakthroughs in every field. As a result, opportunities are often missed to optimize the whole system” (p.5).

Is the solution to our problem a better interaction between the fields of engineering? Perhaps, and hopefully that is something these fields can better improve, especially with the relative ease of communication now days.

The goal is not to get rid of the current method of producing electricity, because it is extremely reliable and there are situations that need that sort of reliability, such as hospitals. However, with the technology that we have available to the masses, why would we not make each individual infrastructure as self-sustaining as possible? It only makes sense that a bridge, road, home, or large building, has renewable energy options built into it, in addition to being as energy efficient as possible. Wouldn't it feel nice to know that the electricity that you are using to watch your television came from the solar panels sitting on top of your home and not from an electricity generating powerplant that burns countless gallons of fuel to bring that same amount of power to you?

With the technology to install solar panels on a home available, doing so could enable 70% of that homes' electricity consumption to be from the solar panels (on average 5,600 kWh per year). This would require an installation of a 3-kW solar system on their roof. "5,600 kWh is the equivalent to 6,000 lbs. less in carbon emissions, planting trees on half an acre, not driving your car for 7,500 miles" ("How Much Do Solar Panels Cost", n.d).

Those are impressive numbers just for a home, now imagine how much electricity could be produced or saved if a skyscraper downtown implemented solar technology and complete energy efficiency. When you think of the outside of a skyscraper, for the most part you see windows. Which are also able to implement solar technology to help reduce the usage of regular industry produced electricity. Since electricity must be used as it is produced, the reduction in the

use of their product would force suppliers of electricity, simply to produce less. Therefore, reducing the amount of electricity produced and in turn reducing pollution.

We all know the feeling of walking along the road on a hot summer day, and the sun is just blazing down upon you. The United States of American has countless miles of roadways just in itself. According to *Solar Roads* “In the 48 contiguous states alone pavements and other impervious surfaces cover 112,610 square kilometers - an area nearly the size of Ohio ...It is believed that continuing development adds another quarter of a million acres each year and that typically two-thirds of the cover is pavements and one-third is building roofs” (“Our Journey”, n.d). But, what if all those miles of roadways could also produce electricity via, solar power? Well that’s just what *Solar Roads* is doing. They are developing ways to integrate solar technology with our roads and the numbers are impressive.

“Sun power offers a 230- Watt solar panel rated at 18.5% efficiency. Its surface area is 13.4 square feet. If the entire 32,868.61 square miles of impervious surfaces were covered with solar collection panels, then:  $((32,868.61 \text{ mi}^2) \times (5280 \text{ ft} / \text{mi})^2) / (13.4\text{ft}^2/230\text{W})$   $((32,868.61 \text{ mi}^2) \times (27,878,400 \text{ ft}^2 / \text{mi}^2)) / (13.4\text{ft}^2/230\text{W}) = (916,324,257,024 \text{ ft}^2) / (13.4\text{ft}^2/230\text{W}) = 15,727,953,665,337 \text{ Watts}$  or over 15.73 Billion Kilowatts. Considering only the average of 4 hours of peak daylight hours (1460 hours per year) this gives: 15.73 Billion Kilowatts x 1460 hours = 22,966 Billion Kilowatt-hours of electricity” (Our Journey, n.d.).

As we begin to understand the amount of new technologies that have been introduced to us it isn’t hard to see how we can begin to integrate these technologies into our structures. We even begin to question why our own homes do not have this same technology that is readily

available. Let alone mass building or structures that consume massive amounts of electricity. Even a slight decrease in the usage of petroleum generated electricity is better than nothing at all.

Greater integration of RE into the environment is dependent on how urban planning, architectural design, engineering and a combination of technologies can be integrated. There are countless ways infrastructures could use green technology. Such as using recycled materials for the materials a building is constructed with. Also ensuring that same building is designed with the most efficiency as possible. With the available technology and the eventual cost savings of implementing renewable energy and energy efficiency it only makes sense at this point to do so.

### **Against the Grain**

Thinking about whom we buy our electricity from, most people that live near each other will usually say the same company. That is because since the beginning of electricity generation the industry has been an extremely difficult and expensive one to enter. Even in 1882 for the first electric industry (General Electric), Thomas Edison needed mass funding. According to *“Electricity and the Environment”* (2018),

“In order for the magic of electricity to truly take hold in American life, new industries were needed to build the generators to supply electric power, as well as the new appliances and electric lights that used it. In 1882, with J.P. Morgan funding his efforts, Edison launched the businesses that would later be known as General Electric. In September of that year, he opened the United States’ first central power plant in lower Manhattan—the Pearl Street Station.”

Even today Electricity Generation remains a monopoly, perhaps not on purpose, but regardless a monopoly. As with any company they don’t want to lose money, so when new technologies emerge that threaten profit, who is to blame them for trying to keep such products

hushed, or high priced. Why not make it difficult or expensive for homes or businesses to implement? After all, they would be losing business.

As with all things, there are disadvantages to using renewable energy. First off, being able to integrate renewable energy would require almost a complete reimagining and reconstruction of civil communities. Civil planners would have a whole new project to tackle trying to figure out the best way to do this. In addition to reconfiguring society, price is also a factor. It would be difficult to get business's, home owners, and government officials to stretch their wallet in order to acquire this integrated technology. Why would they spend money they don't need to?

As mentioned before, electricity is consumed as it is produced. Which also means it is necessary to produce large quantities of electricity, a challenge renewable energy still faces today. As cited

“There are still challenges to generation of large quantities of power in renewable energy technology compared to traditional forms of energy generation like fossil fuel. Fossil fuel still produces large quantities of electricity today, by far. This, essentially, means that it can't be solely relied upon to power the whole nation. This means that either we need to set up more such facilities to match up with the growing demand or look out for ways to reduce our energy consumption. This phenomenon indicates that a balance of different energy sources will still prevail for some years to come.” (Advantages and Disadvantages of Renewable Energy, 2017)

Renewable energy can also be unreliable. This is an obvious disadvantage to RE and probably the only reason that petroleum-based energy production will most likely be around forever for as long as the resource last. Renewable energy is reliable on mother nature as well.

“Renewable energy technologies totally depend on the weather (for e.g.: sun and wind) to be able to harness any energy. In case atmospheric conditions are not good enough, renewable energy technologies would lack the ability to generate any electricity. This might instigate campaigns by the authorities to reduce energy usage in order to serve the population for a longer period.” (Advantages and Disadvantages of Renewable Energy, 2017)

Even with RE being dependable on mother nature, it is still a valuable source of electricity generation that can substantially cut down on the toxic gas emissions by reducing the consumption of petroleum produced electricity. The coal or petroleum generation of electricity will most likely always be around and will always be a lucrative business, however, with the demand of that specific electricity down, the price will rise, further reducing the use of their product. The generation of electricity is going toward RE and gives more reason these large wallet companies should invest into the future of RE.

### **Conclusion**

Mankind has come far since the first light bulb, from cities running off direct current generated from burning coal, all the way to huge factories completely run by robots and a 5g wireless internet connection. We start to wonder where we missed our mark. Renewable Energy seems to be that mark, an area of improvement for human environment and nature. Mankind has countless structures, buildings, and roads, many of which renewable energy, recycled materials, or energy efficiency were never considered during their design or construction. We must reduce our dependency on fossil fuels as a method of electricity generation over a century old and begin adapting to our new challenge. Mankind missed this evolutionary mark as we developed our massive cities and now must integrate this readily available technology.



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