Gursharan Singh, Rishik Kolli, and Sharmila Nimbkar

Dr. Trowbridge

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Social Challenges and Impacts

Preface: How is blockchain used in energy infrastructure?

Our blockchain technology is based around the encryption of data which is being passed through a network of the American energy infrastructure in order to combat hacking, foreign interference, and general energy unreliability. This communications can range from encryption of plain text emails to the RF waves being transmitted by devices and sensors, to energy use data from Smart Grid systems and other internet enabled metering devices on the grid. The purpose of this is having a technology that keeps security but also is trusted since data recorded to the blockchain is incredibly difficult to tamper with. Additionally, this ledger of energy usage and generation data can be harnessed by companies to streamline their processes. Because of the infrastructure of ledgers in place the communication between devices such as computer servers and any digital based device which uses any sort of signal will be triple encrypted (as is standard in the blockchain) to prevent cyber security vulnerability. The main issue with the energy grid currently is that attackers can infiltrate the networks in place in the energy grid and override permission and take control to do malicious activity. The encryption of blockchain and using its ledger bases system to have a trustworthy network will create a nationwide cybersecurity infrastructure for a secure energy grid.

Societal Challenges:

1) Blockchain is an expensive cybersecurity solution, and could therefore pose a substantial economic burden on American families. The cost of the implementation of cybersecurity, will end up being passed down to the customer via higher energy bills. Looking at our solution from an economic perspective, implementing a blockchain as a principled solution to protect energy infrastructure needs to be cost-efficient and cheap so that our solution can support the entire American population regardless of their economic background. As the American population and world population continues to grow, we need to find a sustainable solution that will meet the needs of all Americans regardless of their socioeconomic background in society. If our solution is not cost-effective, we run into the problem of not meeting the needs of the American population and the potential for energy wastage or vulnerabilities that lead to cyber attacks. If we produce a cost-effective solution for securing energy infrastructure, people from all economic classes would be paying less money from their own taxes and their energy bills would be dramatically cheaper because our solution would make sure that energy is not lost or wasted because of cyber attacks.

   -<u>Why that particular issue/challenge might be faced, and how the challenge/issue will influence the solution and/or impact its implementation and development?</u>

   The economic challenge of our solution might appear because changing the structure of all energy networks and implementing blockchain resources in the computer networks in the factory will definitely be expensive. While implementing our solution, we need to be particularly careful that our solutions are effective and cheap because the costs will be paid by the taxpayers directly or indirectly. The challenge will cause our solution to be heavily cost-effective and lead us to think of ways of how we can balance the

implementation with other positive factors. For example if our solution is going to be expensive, we will think about how we can offset these challenges by thinking about the jobs and GDP that efficient and safe energy production will lead.

2) The next challenge our product would face is the coordination between the government, Dept of Energy, Dept of Defense, and energy companies. For an interconnected blockchain solution to exist in the first place and share information about security threats and data there needs to be coordination between state officials, private company owners, and the federal government. The whole point of blockchain principles is openness of data being shared in the power plants.

   -Why that particular issue/challenge might be faced, and how the challenge/issue will influence the solution and/or impact its implementation and development?

   This particular issue might pop up because blockchain principles are extra regulations that private companies would need to implement and there would definitely be a financial and reliability aspect to implementing the solution and sharing data between federal and state officials. Nation states, interested in the opposition of the United States will try to reverse engineer the technology of blockchain and try to implement ways to break through the system. Biggest threat will come from in person physical cyber attacks engaged by highly talented skilled agents.

3) Another challenge of our solution is the legal variable of our project. Jurisdiction of information will become an issue when info crosses state lines. There is also the problem of who is reliable when our systems do get attacked.

   -Why that particular issue/challenge might be faced, and how the challenge/issue will influence the solution and/or impact its implementation and development?

One difficulty is the legal challenges associated with a nationwide infrastructure intact with important energy facilities. This requires an immense amount of regulation, supervision and moderation by federal agencies. Because this technology will be a part of a system which is part of overstate line boundaries which brings federal regulations into play, and federal courts.

Value Creation:

1) With more sustainable and safe energy infrastructure, one positive impact is reduced greenhouse emissions because of increased energy efficiency in production. The implementation of blockchain technology in the energy grid will ease the way for smart grid technology that allows companies to collect data on energy usage and wastage, allowing the US to effectively streamline its energy grid. According to Energy Central, the US has an energy efficiency rate of 42%, meaning that over 58% of energy generated is wasted due to inefficiencies [2]. The first positive environmental value creation of blockchain implementation is that with a better record of generation and usage through the implementation of blockchain, US energy companies would be equipped with the information and resources they need to make effective changes to the grid that would substantially help the environment.

   The second value creation is a decrease in climate change causing greenhouse gas emissions. This decrease in energy wastage has strong secondary impacts in relation to overall fossil fuels. According to the US Energy Information Administration, in 2019 over 31% (1,618 million metric tons) of US carbon emissions were due to energy generation alone. Therefore, using Internet of Things capabilities through the blockchain to streamline energy generation and transmission can have an impact on greenhouse gas

emissions on the scale of several millions of metric tons. Blockchain enabled energy is therefore a solution that could be critical in the fight against climate change on the large scale.

2) As any technology being developed and having large scale implementation requires human resources to keep it in check through maintenance, it will create an increase in jobs. Increases in jobs will be led by the need to overlook the process and evaluate the networking in place will require more jobs for cybersecurity specialists, and data specialists. Cyber security specialists need to reinforce the blockchain technology which is in place to prevent any security breaches. These cyber specialists will be in charge of making sure the blockchain technology is working properly without and troubleshooting any issues. Data specialist jobs will be required in order to go through bundles of data and analyze trends occurring. The understanding of these trends will allow for allocation of resources on the grid creating a more efficient energy infrastructure. This collection of data will be used to specific the cyber security analysis of the network communication occurring between interfaces at the facilities using our solution.

   More jobs also will create and increase in national GDP, and also save millions of dollars in security breaches for the American economy. According to the International Monetary Federation there is a correlation of .6% increase in employment will in 1% increase in GDP(4). Having high end jobs also has correlation with increasing national education levels which in return increase the GDP even more. This technology has a positive impact in decreasing cyber attacks which cost millions of dollars to the US economy. Decreasing in attacks will create an environment where theft of data will me minimal decreasing company liabilities.

Negative Impacts:

The first and most obvious negative of implementing blockchain technology is that blockchain is currently very expensive. Currently uploading 1 Kb of data to the blockchain costs $2, and recording an entire nation's worth of energy data will require around a data capacity equivalent to 2920 Tb data in quantification [7]. The sheer cost of implementing and maintaining blockchain will most likely be an impediment and a large negative for companies. The perspective of the companies is not the only viewpoint concerning cost, however.

The potential burden that increases in energy prices could cause on families is a possible negative impact of implementing this technology. According to the American Coalition for Energy, the average American household spends 7% of its income on energy. That means that any increase in energy cost could become a burden, especially for households that are already living paycheck to paycheck. They also state, "Energy costs consume more than one-fifth of the after-tax incomes of America's poorest families, the 25 million households in the lowest income quintile." Therefore, since blockchain is so costly, it is bound to drive up the cost of energy at least a little bit, potentially burdening families which are already financially strained.

Another negative impact of our solution comes from using interconnected systems. The potential downside of an interconnected system is there is more potential for hacking and more vulnerabilities in a network that can be preyed upon by malicious foriegn actors and agencies. Although blockchain is incredibly secure right now, perhaps in the future, they may be a potential way to hack the blockchain data ledger and extract encrypted information. Although,

considering that this threat does not actually exist right now, it is only a projected potential threat or downside of implementing blockchain.

Works Cited

1. M. Mith“Advantages or Disadvantages of the Greenhouse Effect”, The Medium. Jan 31, 2019
2. S. Battaglia, “US Now Leads in Energy Waste”, Energy Central. Mar 3, 2013.
3. Center for Climate and Energy Solutions, “Renewable Energy” 2019.
4. International Monetary Federation, “The Evidence that Growth Creates Jobs: A New Look at an Old Relationship” November 9, 2016.
5. U.S Energy Information Administration, “How much of U.S. carbon dioxide emissions are associated with electricity generation?” December 1, 2020
6. American Coalition of Clean Coal Energy, “Energy Expenditures by American Families”, 2016.
7. Y Zhang, T Huang & E.F. Bompard “Big data analytics in smart grids: a review”, August 13, 2018.