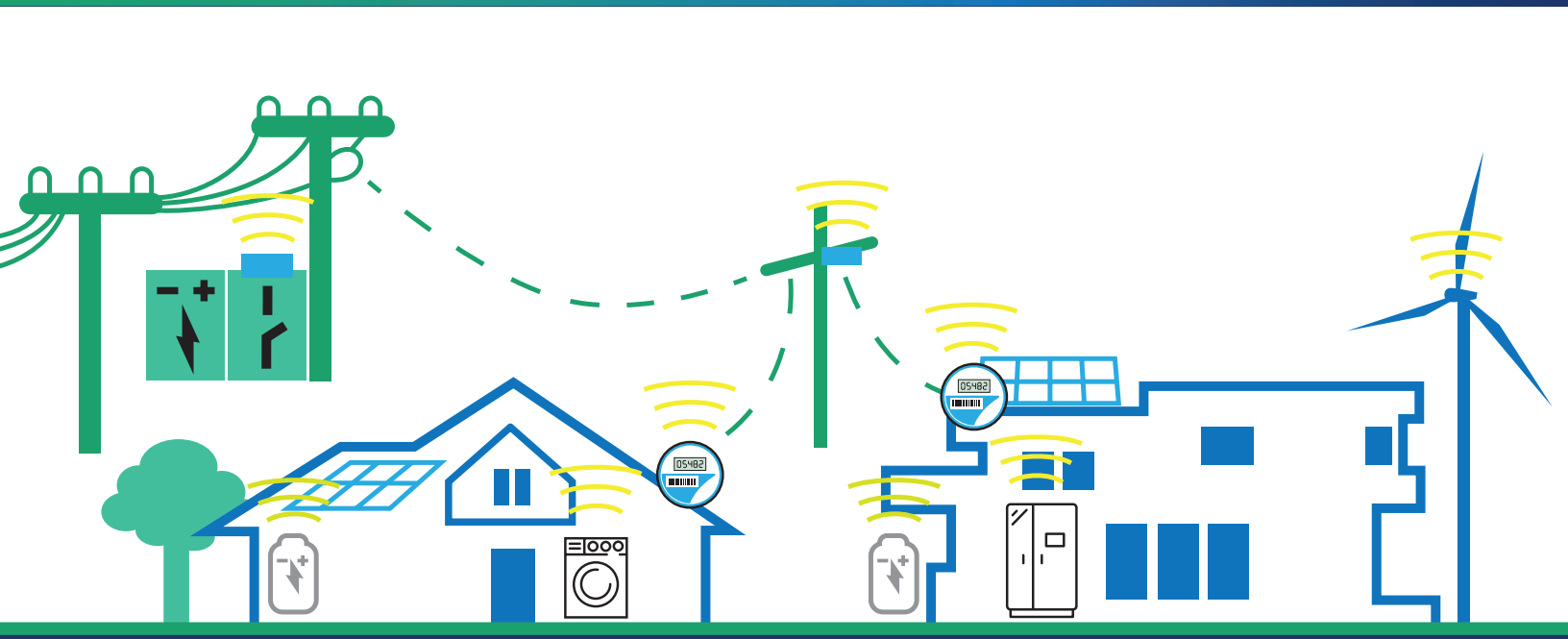
Network Effect Benefits From Electricity Grid Connections

Today and Into the Future

POLICY BRIEF



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When considering the benefits a product provides to you, does it matter to you whether many others also use that product? For many products, the answer is yes.

This simple idea that there are additional benefits to you if everyone else is using the same product is often called a network effect because as more people are 'connected' to the network, the benefits increase. More precisely, anytime there is a way that people are connected—whether it is a physical connection or not—the network effect is defined as the additional benefits to those connected to the network when the total number connected increases.

This policy brief discusses the importance of network effects in settings where the services provided are based on a platform, with a focus on electricity. We discuss several classic examples of network effects that are especially useful for clarifying how and when network effects benefit customers. These examples are used to discuss the potential analogy to the electricity context. The ideas laid out in this policy brief are fleshed out in more detail in the accompanying research paper, titled "Electricity Network Benefits of Active Consumers and Prosumers in a Digitally-Enabled Smart Grid."

Where do we Find Network Effects?

Network effects can provide additional benefits to customers and society as the scale of the network increases in many settings. Such network effects can be especially prominent in platforms that connect different parties, such as users and content providers. Three commonly-discussed cases where network effects are important are telecommunications, the internet, and social media. Each of these three cases can be thought of as a platform that enables connections to be made—hence allowing for the network effects benefits to occur.

Telecommunications are a classic example of a platform that exhibits network effects. Having a phone is worthless if there is no one else who has a phone that you can call. Yet if everyone in the world is connected and can call each other, there are enormous benefits to the phone network through improved communication. Thus, as the scale of the network increases, the value to everyone on the network increases.

The internet is very similar to telecommunications in how it displays network effects. When the internet was first invented, it was a convenient way of passing data between a limited set of universities and research institutes, but the overall value was limited. Since then, the widespread connection of billions of households and businesses has made the internet an essential part of daily life throughout much of the world. Being able to e-mail and videoconference colleagues on the other side of the world unlocks enormous benefits to society—from the exchange of ideas to cultural enrichment. These benefits are network effects that increase with the number of people connected to the internet.

Social media is closely related to the internet in how it exhibits network effects. Social media platforms include Facebook, Twitter, Yelp, WhatsApp, and Instagram. These platforms connect millions of people by allowing information sharing to chosen connections. There is a very clear virtuous cycle for social media platforms when they add new members, because adding new members makes the entire platform more useful for each of the members. Some attempted social media platforms, such as Google+, failed to get off the ground because they didn't have a sufficiently large critical mass of engaged members, demonstrating the importance of network effects to the benefits of social media.

The key characteristic in each of these examples is that the benefits increase with the number of people connected to the network. In the standard electricity system that we see today, customers enjoy reliable supply of energy services at an affordable price due to economies of scale from servicing many customers with the same grid. Network effects are very similar to classic economies of scale, which lower costs of supply. The difference is that economies of scale are about the supply of a product, while network effects are about the demand of the product. As the number of people connected to the network increases, economies of scale are enabled, allowing for lower cost provision of reliable electricity to all. However, this is a very limited sense in which there are effects from being connected to the network—just the tip of the iceberg. There is potential for new benefits that increase with the number of connections from services using new technologies that are just beginning to materialize, as will be discussed shortly.

Technology and Infrastructure Make Network Effects Possible

For network effect benefits to be possible, technology and infrastructure must be in place to enable these benefits. This is true in all of the platforms above. Telecommunications rely on wires, software, and cell phone towers. The internet relies on software, cables, and data centers. Social media relies on software and data centers (and the internet). Electricity provision relies on infrastructure and technologies such as power generation sources, wires, software, and meters.

Clearly, for network effects to be enabled, the appropriate technology must be in place. And as technology improves, new opportunities for additional benefits arise. Telecommunications began with physical wires and landlines. These provided substantial benefits for many decades and still do. But, in the past several decades, cell phone technology and infrastructure has enabled massive benefits from cell phones, which are now ubiquitous and allow people to connect with others from almost any location.

It is similar for the internet. The internet began with dial-up connections being the norm, which allowed for only limited bandwidth and thus reduced services. Massive investments in broadband infrastructure have allowed for fast download times, enabling many other services, such as streaming movies or videoconferencing. These investments unlocked very substantial value to society.

Social media also began in a limited way, with limited functionality due to limits to data storage space. But social media companies have made very large investments in software development and data storage, substantially enhancing the services offered to members. Without these investments, it is likely that social media would be a much more niche form of information transmission.

There are clear parallels between these cases and electricity. The traditional infrastructure investments in electricity provide the wires that allow for universal and reliable electricity service, much in the way that telecommunications infrastructure and the internet infrastructure allow for phone service and internet service. To draw out the analogy more clearly, Figure 1 illustrates the similarities between the enabling infrastructures for electricity and the internet: the electric grid and internet infrastructure:

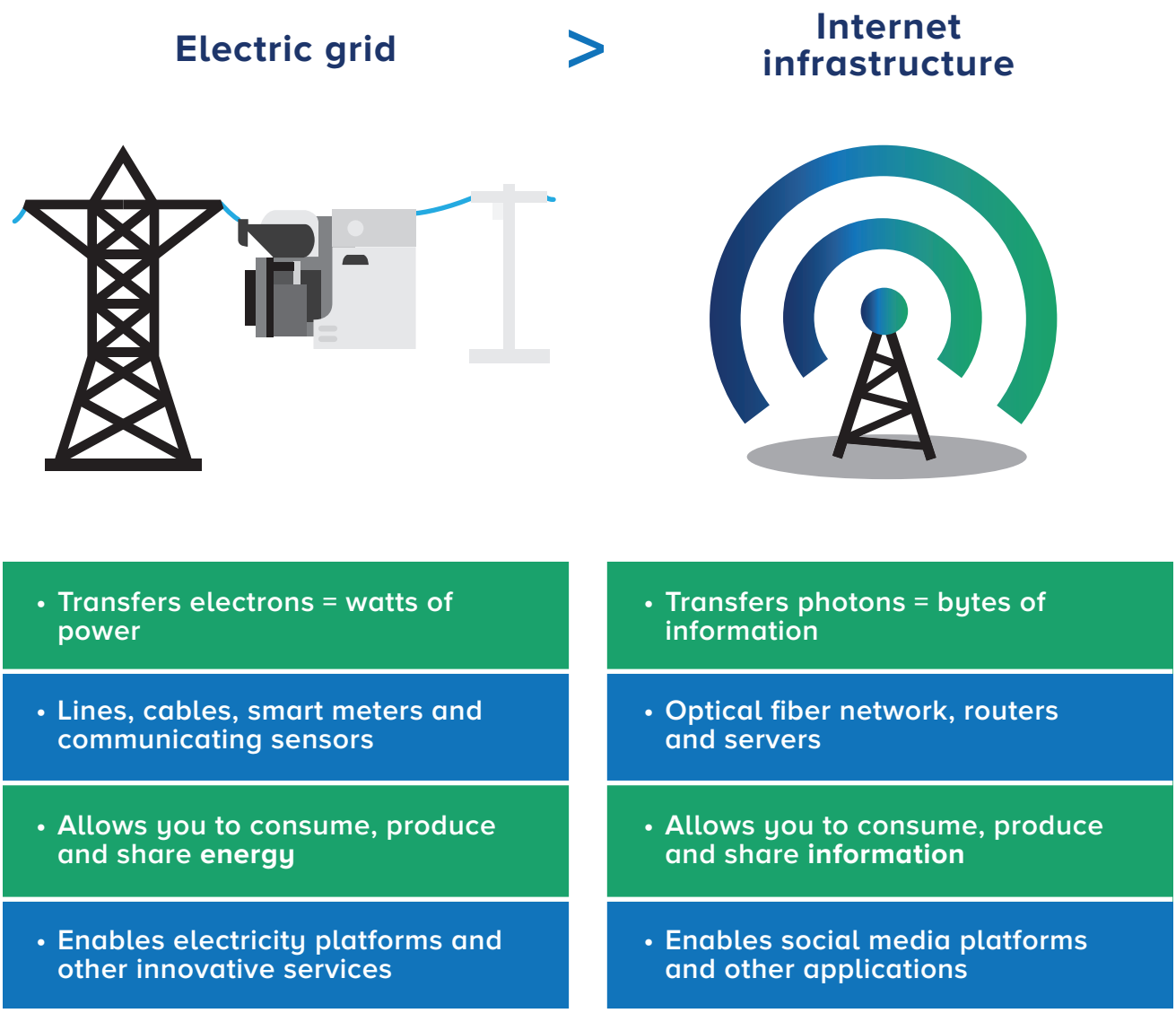
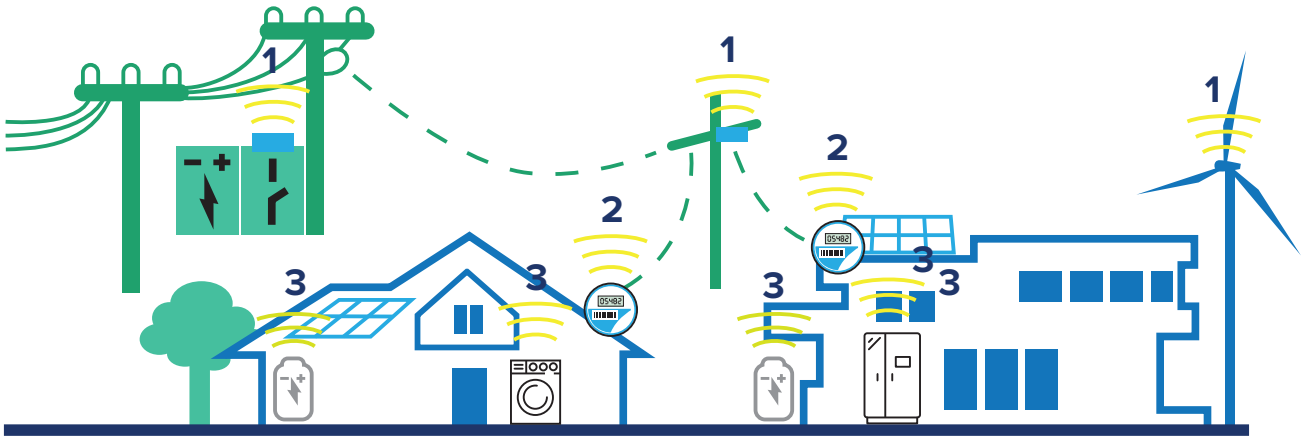


Figure 1. There are multiple similarities between the enabling infrastructures for electricity and the internet.

A key parallel between electricity and the other platforms discussed is how investments in new technologies and infrastructure open the door to additional services that provide benefits to customers and society. For example, investments in smart information and communication technologies in the electricity grid can both improve the efficiency of the electricity network—lowering costs—and also increase the uptake of distributed renewable generation. This would benefit the environment and broader society. More specifically, the efficiency of the electricity network can be improved by allowing for responsive demand by providing information and by enabling more precise management of grid resources, for example through active network management (ANM) that provides control and management systems to assure that the lights stay on. Distributed renewable generation could be enhanced by smart information and communication technologies in a variety of ways, including by allowing for options such as shared solar. Such investments in a digital smart grid could also enable efficient use of distributed storage resources to allow for management of the grid at the lowest cost, providing social benefits to all ratepayers. Several of these benefits are described in Figure 2 below.



BENEFITS OF SMART GRIDS

1. System-level: Real-time monitoring and management of the system
E.g. Distributed energy resources management systems (DERMS) and Active network Management
- Higher reliability of electricity supply
- More efficient use of the electricity network

2. Consumer-level: monitor and collect energy usage of consumers
E.g. Advanced metering infrastructure (AMI)
- Lower cost of billing
- Easily sell excess distributed generation to network or other consumers

3. Appliance-level: control energy usage of appliances
E.g. Home energy management system (HEMS) and Internet of Things (IoT)
- Lower peak generation and network capacity needed
- Potential reduced cost of balancing the system
- Lower electricity consumption and carbon emissions

Figure 2. Smart girds can provide beneifts to customers and the system at multiple levels.

Without the investments in new technologies and infrastructure, the benefits to society from telecommunications, internet, and social media would simply not have been possible. And the same is true for electricity. Without the investments in a digital smart grid, microgrid, and other enabling technologies, the network effects in electricity would still exist, but would be a small fraction of their potential. Indeed, investment in new technologies and infrastructure can enable a variety of energy connections and communities—including shared solar, shared storage, microgrid operation, peer-to-peer trading of solar or storage output, smart charging of electric vehicles, services to renewable generators like active network management, demand aggregation, customized supply contracts, etc. The new network effects will come about because of both the nature of electricity grids as a platform, and the compatible complementary products (such as electric vehicles).

There is a clear analogy to telecommunications here. Initially, telephone calls were a simple process, much like the provision of electricity, but with digitization and investment, more services could be provided and at a higher bandwidth. In addition to telephone calls, we can now send photos and video, browse the internet, or make a video call across the world. The value of these services is high because so many people are connected and actively using these technologies and applications. Similarly, the network effect benefits increase when investment in smart information and communication infrastructure enables more consumers, distributed generation, and smart appliances to be actively interconnected. While complete digitization of electricity supply may be challenging, many processes can be digitized to increase the potential services to customers, thereby increasing the network effect.

Appropriate Regulation is Also Essential to Achieve the Potential for Network Effects

Enabling regulation was a vital ingredient to unlock the network effects benefits from telecommunications, the internet, and social media. For example, the ubiquity of cell phones was only possible from the auctioning off of spectrum to mobile service providers, and by the permitting of cell tower networks. The internet was only possible with government support for the initial infrastructure, supportive regulation that allowed companies to invest, and permitting of the cables. Even social media has benefitted substantially from regulation that allowed such rapid growth of the companies with few barriers.

Electricity is no different. Given the tremendous improvements in smart technologies, electricity holds the promise of being on the cusp of achieving substantial additional network effect benefits. These include speeding the uptake of clean energy as well as direct welfare benefits from new services that consumers value. But these benefits require enabling regulation. The investments in new technologies and infrastructure are crucial. Equally important is the permitting of the installation of the new technologies and infrastructure. Thus, forward-looking regulation will be necessary to unlock the substantial potential for network effect in electricity—both in currently existing electricity markets and through the creation of new markets that provide new services.

What If We Remove the Network Connection?

Technically, it is possible to "island" a household or business from connections to networks. There could be no connections for phone service (cell or wired), no internet, no social media. The loss to customers and society in forgoing the network effects would be immense. Indeed, there is growing academic work on the high value of electric grid connections to households in developing countries. Similarly, there could be no connection to the electricity network, such as by islanding a household and providing electricity from a distributed system. This may seem appealing on the surface for personal energy independence reasons, but it comes at a very substantial opportunity cost from lost existing and potential network effects (and likely higher overall costs as well).

In the current electricity system, this would be foregoing the peace of mind and reliability offered by the electricity grid. However, the greater losses are likely to be from the inability to benefit from future network effects (and environmental improvements) that are only possible with a network connection. Instead of grid-connected distributed energy resources that sell excess generation to neighbors or the grid, we would have isolated energy resources with no opportunities for new services. And instead of grid-connected consumers providing flexibility to help balancing the system, we would have individual systems with large generation and storage capacities and costly investment in high levels of flexibility to ensure covering demand at all times. Islanding a household from the electricity grid would not only lead to wasted resources or higher costs, but also entirely dissipate the current and future network benefits. Indeed, with a digitally-enabled grid, there will be substantial opportunities for value that may even help form stronger in-person community bonds.

Final Takeaways

The main takeaway from our investigation into network effects in electricity is that they already exist, but what is even more important is that there is real reason for optimism going forward about extensive future benefits from a digitally-enabled grid that only grid-connected customers will receive. Just as in the analogous cases of telecommunications, the internet, and social media, achieving these benefits will require a supportive regulatory environment, as well as investments in new technologies and infrastructure.

Acknowledgments

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