Power2Peer

Blockchain Innovation for Energy Independence

Annual Report 2018

www.Power2Peer.com

Executive Summary

Over the last five years, there have been major changes in energy. The proliferation of distributed generation has increased as renewables have become more affordable. Taken together with centralized generation, there is plenty of electric supply. But renewable resources are significantly underutilized. In periods of peak demand, power needs are met with carbon-heavy centralized generation and oversized substations. Consumers are left with few choices and little control over their energy.

Power2Peer is creating a **clean energy marketplace** for the blockchain-secured peer-to-peer energy trading with an easy-to-use mobile app, P2PConnect.

Power2Peer: Modernizing the power grid.

At the same time, the rise of the "sharing economy" has ignited interest in the idea of "energy sharing," where friends, family, and neighbors can provide energy to each other. Using new technologies like blockchain, innovators are creating opportunities for consumers to take control. This is the market where Power2Peer plans to make a significant contribution.

Power2Peer's Offer

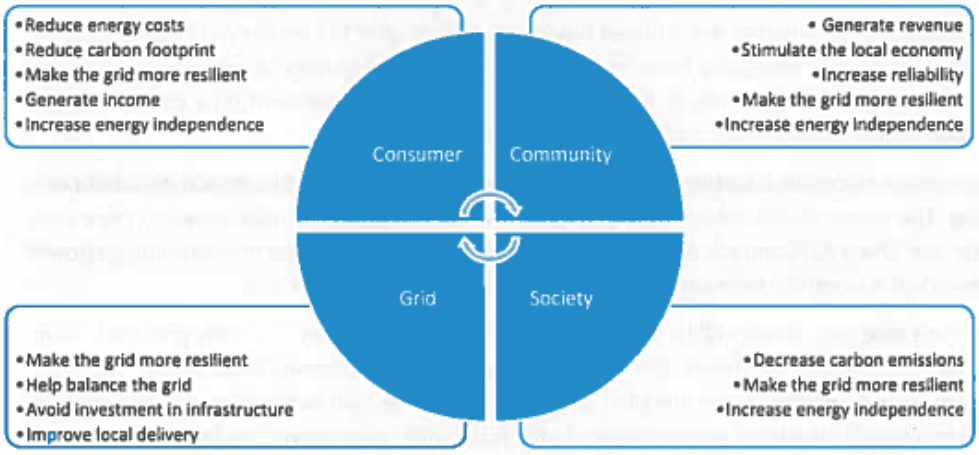
Power2Peer's goal is to create a **clean energy marketplace** by connecting local microgrids powered by solar panels and other renewable resources. No longer will people be completely dependent on a centralized grid operated by large corporations.

P2PConnect will integrate a variety of clean energy sources with a blockchain-secured framework that allows users to buy and sell clean energy locally.

Decentralized power grids are more resilient, more efficient, and better for our environment.

By opting for Power2Peer's program – the *P2PConnect clean energy marketplace with blockchain-enabled peer-to-peer trading* – people will be able to trade energy in local markets, sourcing clean electricity through a network of microgrids. Power is available when needed, even when the utility grid goes down. With solar power, people will contribute to a cleaner environment, minimizing their carbon footprint. Locally produced solar power has a low marginal cost – the sun is free – so consumers will pay less than they would for grid power. By adding storage, solar energy will not be wasted. The benefits to consumers, community, grid and society are numerous (see Figure 1):

Figure 1: The Benefits of Power2Peer, Source: Power2Peer, 2018



The Technology

P2PConnect operates on a blockchain framework, with solar panels providing power data via IoT sensors. Power generation data is sent to a cloud-based analytics engine. The analytics engine feeds into a software-defined adaptive controller connected to solar microgrids and storage. Based on information from the engine, the adaptive controller optimizes resilient power flow and enables peer-to-peer energy trading.

The Power2Peer Difference - Bringing Communities Together through the Latest and Greatest Technologies

- **Connecting Communities**: A physical network of microgrids and energy trading market energizes and connects communities with a shared purpose: making better use of local resources.
- **Advanced Technology:** A unique combination of a fit-for-purpose adaptive controller, smart inverters, cloud and analytics paired with blockchain enables app-based trading and fail-safe operations.
- **Scalable Architecture**: Enabled from the beginning for Big Data and analytics, the P2PConnect platform is future proof and ready for worldwide adoption.
- **Photonic Solar Conversion (PSC)**: Photonic solar conversion panels that generate 20+% more power from the garden variety panels further reduce the cost of energy.

The Sustainable Business Model

Power2Peer anticipates revenues primarily from connection fees and transaction fees. Near-term objectives are to connect multiple microgrids in several cities. Our financial estimates show that the business will be cash positive and generate up to 48% net profit at the end of the life cycle of the system. With more cities coming on board, significant revenue will be generated to create more microgrids across the United States.

For high-efficiency solar microgrids using PSC deployed in 28 cities initially, with each city generating 1 MW of electricity, there is an estimated payback period of 9 years and a cumulative profit of $76 million over five years. The long-term vision is to scale to support thousands of distributed microgrids, including those not owned or operated by Power2Peer. P2PConnect, supported by blockchain smart contracts, will create a much-needed marketplace for power trading between peers. More importantly, Power2Peer will deliver a cleaner, more efficient, and more resilient grid.

Introduction: The Democratization of Solar Energy

Power2Peer's innovative technology and business model will decentralize the delivery of electrical power. Power2Peer will democratize energy by fostering communities where members have control over where they get their energy and how they use it. No longer will people be so dependent on a centralized grid operated by utilities and supplied by carbon-intensive generation.

Power2Peer proposes to create **adaptive solar microgrid systems (ASM) with blockchain-enabled peer-to-peer trading**. The power source is highly efficient solar PV. Energy storage can be added to store solar energy for later use. Using P2PConnect, people will be able to trade energy in local markets and get power through a network of microgrids; everyone benefits from a decentralized power grid.

With Power2Peer's program, power will be available when needed, even when the utility grid goes down. With solar power, people will contribute to a cleaner environment by lowering their carbon footprint. Locally produced solar power has a low marginal cost – the sun is free – so consumers will pay less than they would for grid power. By adding energy storage to the mix, stored solar power can be traded and used when the sun is not shining.

This is not to say the traditional utility companies will be absent in the future. Microgrids will be connected to the centralized grid. Utilities will benefit from a system that makes the most efficient use of all energy resources. When there is a major outage on the grid, microgrids can operate independently, leaving fewer people in the dark, and freeing up utility resources to handle customers without power.

Microgrids have also been shown to help utilities avoid large investments in infrastructure. An often-cited example of a "non-wires alternative" is the Brooklyn Queens Demand Management Program. Instead of investing $1.2 billion to upgrade a substation to meet increased demand, incentives of $200 million were given to customers and the utility to reduce demand for grid power[1]. Utilities also benefit from services that microgrids perform, such as helping to keep the grid balanced.

With P2PConnect, the clean energy marketplace creates local wealth. Today, homeowners using solar panels are producing their own electricity, and many do not use all of what they produce. Such homeowners would be able to generate income by providing surplus power to others in their community. In turn, the extra income from this sale of excess power, together with the money homeowners (both those producing and those buying from the producers) will save by paying less for the energy they consume, will drive more solar investment, attracting those involved in real estate, such as large scale commercial developers. Jobs will be created, as local workers will be needed to build, operate, and maintain microgrids; all this bringing a boost to the local economy.

By creating a clean energy marketplace for transacting energy in the local microgrid environment, Power2Peer and P2PConnect will boost the local economy and support the growth of local community. Supporting Power2Peer represents an opportunity to participate in worthy innovation in its early stages, and to support peer-to-peer markets, which will continue to grow and evolve.

Power2Peer's Technology Platform

To make this happen, Power2Peer will combine game-changing technologies – blockchain, adaptive controllers, Big Data and analytics, and smart micro-inverters as Internet of Things (IoT) devices on the grid. An energy blockchain, paired with adaptive control systems, assures that power is managed efficiently, so that few electrons go unused. With P2PConnect, Power2Peer's user-friendly mobile application, microgrid participants will be able to make the best decisions based on their needs. In addition, adaptive control systems detect power failures and perform critical real-time recovery of power from the nearest microgrid,

[1] *Next-Gen Flexibility is the Mantra for Grid 3.0,* Electric Light and Power, June 19, 2017.

providing a fail-safe power infrastructure across the grid. In the sections that follow are some definitions of terms and a description of Power2Peer's approach.

Blockchain: A New Technology for Trading Energy

At its core, Power2Peer operates on a blockchain-secured platform. Blockchain is a revolutionary technology that supports transparent and secure peer-to-peer transactions without the need for third party verification. Originally, blockchain was developed to support the trading of Bitcoin cryptocurrency. Since its inception, blockchain has evolved considerably with the development of new architectures like Ethereum. What is different from Bitcoin is that the energy blockchain will trade value, not currency. In a peer-to-peer blockchain, members will see where energy they produce is needed, or if energy is available when they need it. They can also see changes in the price of electricity; blockchain enables members of communities to trade energy with one another.

Why Blockchain?

A blockchain is a shared, encrypted, "distributed ledger" that is maintained by a network of computers. The blockchain consists of a linked list – a chain of transactions from initiation to completion – that are synchronized to achieve data protection. The network registers and validates all recorded transactions, using sophisticated algorithms to ensure that every link in the chain of a transaction is valid.

A blockchain is a shared, encrypted "distributed ledger" that is maintained by a network of computers with no central authority. The platform is transparent, immutable, traceable and secure.

Blockchain has a lot going for it: transparency, immutability, traceability, and security. Each blockchain user can access the ledger, thus creating transparency. Immutability means that no transaction can be changed. Traceability is inherent in blockchain architecture – each step in a blockchain transaction is recorded. Blockchain was developed for Bitcoin, so it is easy to see why blockchain architecture has robust security. With its decentralized networks, blockchain does not have a central point of failure so it is better able to withstand hacking. Digital encryptions add to the security.

Plus, blockchains are efficient. In financial settings, blockchain reduces transaction processing time and cost by eliminating the need for a middle man and performing continuous validation to prevent errors. That is why banks and other financial institutions have been drawn to this technology.

In the last few years, blockchain has expanded beyond the exchange of cryptocurrency. Now other items of value are exchanged on blockchain platforms. **Smart contracts** have also been recently added. Smart contracts are account holding objects, predefined rules determining preferences like quality, price, and quantity, that interact with other contracts to make decisions, complete transactions, and store data, all in an automated fashion.

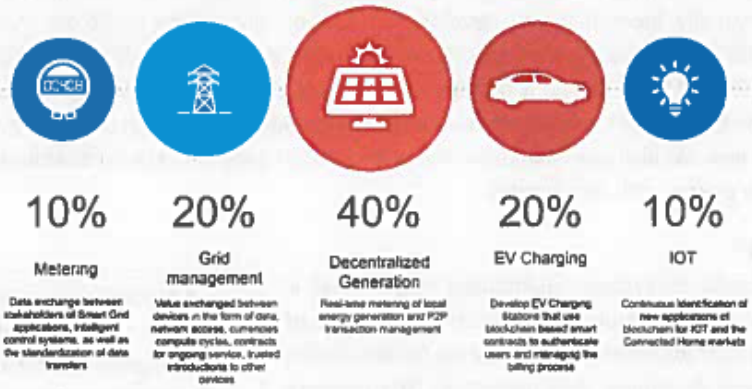
Smart contracts contain pre-defined rules that interact with other contracts, make decisions and store data, all in an automated fashion.

Blockchain in Energy

The energy industry has been slow to adopt blockchain, but in the last two years this technology has received a lot more attention. Frequently mentioned applications include: peer-to-peer trading associated with distributed generation; payment systems for roaming electric vehicle (EV) charging; registration of renewable energy credits; and more efficient processing in wholesale energy market settlement. Blockchain and distributed generation can also help bring electrification to remote areas or help make islands more self-sufficient.

Distributed generation, such as solar and wind, with peer-to-peer trading is the most popular application of blockchain in energy, according to the Indigo Advisory Group, which tracks blockchain applications (see Figure 2).

Figure 2: Emerging Energy Blockchain Uses, Source: Indigo Advisory Group, 2017



Blockchain's distributed architecture is well-suited to peer-to-peer energy trading. Blockchain technology enables neighbors to trade energy on a self-contained market, without going through the utility. Neighbors can initiate trades by connecting to the blockchain platform on their smart phones or tablets. Of course, people may not want to be bothered with monitoring when they produce or use energy. With smart contracts, they can program their energy preferences and automate when they sell or buy power.

There is more that needs to happen, though, for this to work well. This is where the nanogrids and microgrids come into the picture.

Power2Peer's Approach: Power2Peer proposes to assemble a platform that uses blockchain technology to enable members to make transactions with each other. The advantage of blockchain is the persistence of the data from a significant number of transactions. Power2Peer's blockchain will store important data about solar production, storage charge/discharge, and electricity consumption that can be used to understand microgrid and trading dynamics.

> **Use Case #1:** A homeowner with rooftop solar may be away from home during the day when the sun is shining, and panels are producing energy. At the same time, a neighbor at home is looking for less expensive energy to power their air conditioning. Rather than lose that energy or send it back in the grid, the solar owner could offer surplus energy to the neighbor. The neighbor with the rooftop solar maximizes income from solar production; the neighbor with an Electrical Vehicle (EV) maximizes the money saved on energy, because solar energy costs less than grid energy.
>
> **Use Case #2:** A rooftop solar array produces power during the day, but in this situation, the homeowner and neighbors do not need energy. Instead the solar energy charges a battery. In the evening, battery power can be discharged to the homeowner or neighbor who needs it to charge their EV. In the evening, when the price of energy is high due to high demand, the cost of the solar power will be even lower than in case #1.

In the clean energy marketplace, consumers seeking clean power and producers providing it are connected peers. Peer-to-peer transactions will utilize smart contracts – predefined preferences for when they want to use or offer up surplus energy, at what price they would be willing to buy or sell, how reliable they expect the power to be, etc. Smart contracts are created with a hash address associated with a token wallet. For

security, an encrypted public key and an individual private key are used to send tokens to a destination peer.

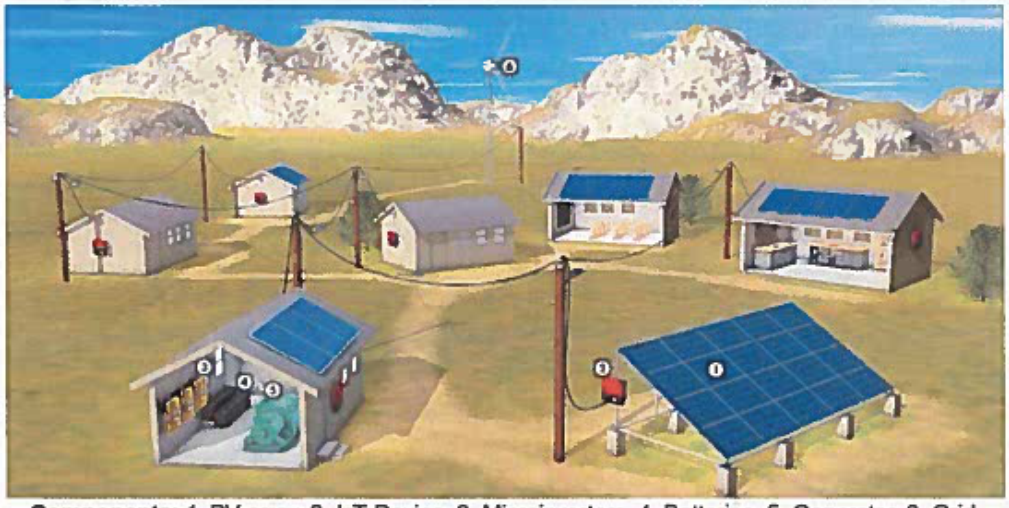
The blockchain framework used by Power2Peer will be Ethereum, the most popular platform for distributed ledger transactions trading Ethers (ETH).

Nanogrids and Microgrids: Bringing Resiliency to the Community

Power from the sun harnessed by thermal and photovoltaic (PV) is good, but often produces excess power that cannot be used during peak daylight hours. Individually operated nanogrids connected to microgrids and microgrids connected to each other provide an outlet for this extra electricity. Linking together more resources provides more access to energy, making electricity more affordable and resilient (see Figure 3).

> Resiliency is the ability of a system to overcome failure and rapidly recover from a breakdown. With electricity, a resilient grid can operate when there is a system breakdown or restore power quickly when it goes out.

Figure 3: Example of Nanogrids and a Microgrid with roof-top and ground solar panels, Source: Power2Peer, 2018



Components: 1. PV array, 2. IoT Device, 3. Microinverters, 4. Batteries, 5. Generator, 6. Grid

Decentralization is the key to the resiliency of the microgrid system. A microgrid is a group of electricity sources and loads. It is often connected to the grid, but it can operate independently or "island" when utility grid power is lost. This ability to island and continue to supply power to facilities within the microgrid is what makes microgrids resilient. Microgrids are often found at hospitals, educational campuses and military bases, precisely because microgrids can continue supplying critical facilities.

> A microgrid is group of electricity sources and loads. It is often connected to the grid, but it can operate independently or "island" when utility grid power is lost.

> A nanogrid can be an individual house, multi-family building, or a small number of houses. The most sophisticated nanogrids use smart thermostats and/or appliances and behind the utility meter (BTM) solar, and storage to meet some or all their energy needs.

Microgrids can be comprised of connected nanogrids. A nanogrid can be an individual house, a multi-family building or a small number of houses. The most sophisticated nanogrids use smart thermostats and/or appliances and "behind the utility meter" (BTM) solar, wind, and/or energy storage to meet their energy needs. In the future, electric vehicles may also be used to power nanogrids. The nanogrid optimizes the use of

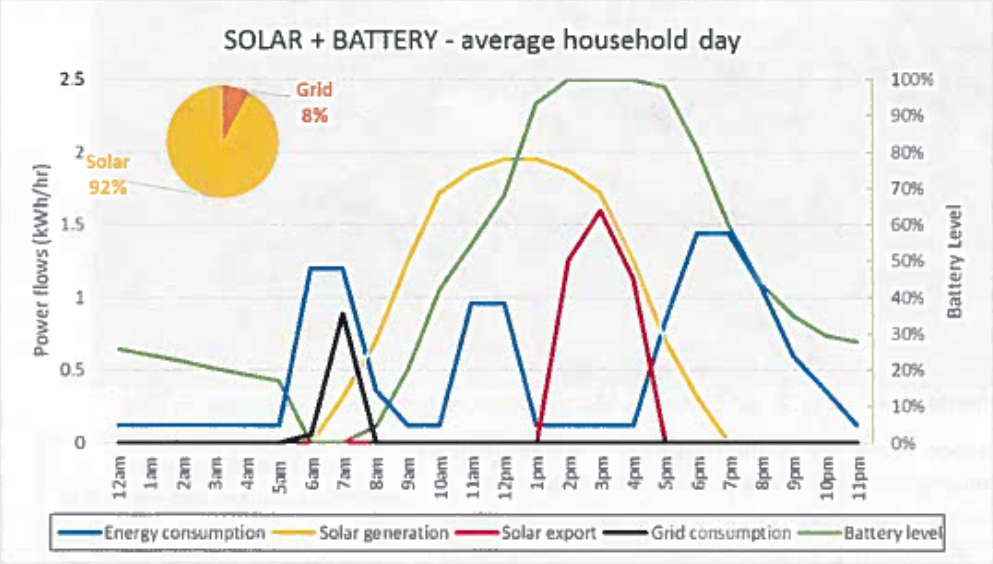
power within a building by adjusting equipment loads depending on the supply that is available. For example, during the day when inexpensive solar power may be available, instead of operating in the evening, when grid power is less available, the washing machine will turn on automatically during the day to take advantage of the solar power.

If the nanogrid is made up of a small number of houses, optimization would be achieved by timing energy usage at the houses to the time of day when its own power is produced using Power2Peer's software defined controller. The nanogrid optimizes its own energy use, which has a multiplying effect when connected to a microgrid. In the future, microgrids will be interconnected with other microgrids, providing even more efficient use of resources, and reducing the need to build more expensive infrastructure.

Energy Storage in Nanogrids and Microgrids

There is growing recognition that energy storage has significant value to contribute to the supply and distribution of power. As part of a nanogrid, energy storage extends the solar resource. Solar power that is not consumed or traded when it is produced can be stored in batteries (see component #4 in Figure 2 above). Stored energy can be used or traded when the solar resource is not available. Figure 4 shows the example of a household in Sydney, Australia, with daily consumption of 12kWh, a 4kW solar system and a 7kWh battery[2]. The figure shows how battery storage allows solar production to be shifted to times of the day when energy demand is high, but solar power is not being produced.

Figure 4: Example of Solar and Storage Working to Maximize Solar Production, Source: RenewEconomy, 2015



As part of a microgrid, energy storage from multiple batteries can be aggregated and used to provide power during periods of extended grid outages. In the future, storage aggregated from a system of microgrids could generate revenue through providing services to traditional utility grids, such as power frequency response, frequency regulation and voltage support for residential and commercial power outlets.

Power2Peer Approach: Power2Peer aims to integrate nanogrids and microgrids to provide more local and distributed resources to the traditional grid. With its adaptive solar microgrid system, consumers will not have to rely heavily on traditional grids which are prone to failure at a single point. Power2Peer intends to extend connections to nanogrids and microgrids beyond adaptive solar microgrids, broadening the

[2] Cooper, Chris, *What the Tesla Powerwall Battery Means for Households*, RenewEconomy, May 2015.

network to include resources like wind, electric vehicles, ground source heat pumps, and other technologies.

Adaptive Controllers, Smart Inverters(IoT), Analytics, Plus Blockchain

Control systems made up of switches and relays have been part of the electrical systems for decades. In recent years, these systems have become "smarter" with the addition of software-defined controllers which can receive signals and initiate actions. More sophisticated communications have enabled interaction with equipment, sensors, and other devices in the home and on the grid, as the Internet of Things (IoT) enters the energy industry.

Smart inverters are one type of IoT device. Roof-top solar arrays have always used PV inverters to make direct current (DC) energy available for use by alternating current (AC) appliances, but now inverters have become "smart" with embedded computer modules. Smart micro-inverters – internet-connected devices that can send real-time power generation data (voltage, current) from each solar panel – provide more granular data. Smart inverters are also now available for battery storage, sending information about charge and discharge cycles.

Power2Peer's Approach: Power2Peer's platform brings together adaptive controllers, smart inverters, micro-inverters, and blockchain to allow the microgrid to adapt to current conditions. A micro-inverter is a smart inverter that is connected to each panel of a solar array. A communications layer, including blue tooth connectivity, sends micro-inverter data to the blockchain. Similarly, the system can be configured to include smart battery inverters. Data from smart inverters also goes to the analytics engines and software-defined controllers. The engines' algorithms help to manage the microgrid, optimizing solar production and potentially storage. Analytics applied to micro-inverter data, for example, can predict potential panel malfunctions by identifying voltage and amperage anomalies in time for the controller to act to prevent a failure.

> A micro-inverter is a smart inverter that is connected to each panel in a solar array to convert DC current into AC current.

The adaptive control system and blockchain know how much solar power is being produced, how much battery storage is available, whether producers have surplus available to share or store, and what price they want for delivering power at a given time. The platform knows whether there are consumers in the community who need power at that time and are willing to pay the designated price. With this information, the platform can manage power flow and facilitate trading.

As shown in Figure 5A, four microgrids are blockchain connected by a cloud-based controller. The controller is driven by data transmitted from micro-inverters installed on each panel and an analytics engine that uses that data to determine the best possible action. Data from each micro-inverter is also recorded in a blockchain ledger.

The controller allows two functions to work with panel arrays and storage that form the microgrid G1, G2, G3 and G4: 1) connection of all nanogrids or microgrids to the blockchain; and 2) monitoring power production from each nanogrid or microgrid. The blockchain platform records the solar production and the state of battery charge (empty, full, half-way, etc.) in the distributed ledger. Peer-to-peer trading is conducted according to smart contracts between residents of the community. When a transaction is made, power then flows to the buyer instead of the utility grid.

Figure 5A: Connecting Microgrids to the Block Chain and Monitoring Power Production, Source: Power2Peer, 2018

As shown in Figure 5B, in case of failure at microgrid G1, the controller will sense that the grid is down and route power from other active grids G2, G3, and G4 to the houses connected to G1 microgrid, thereby creating a resilient power system that is able to reroute the power and prevent power outage caused by natural or man-made disasters.

Figure 2B: Microgrid Resilience in a Fail-Over Condition, Source: Power2Peer, 2018

The sections that follow provide more detail about the market for peer-to-peer energy trading and outline what sets Power2Peer apart.

Market Overview

Over the last five years, there have been major changes in energy. Superstorms such as Sandy and Irma have caused extensive power outages that last for days[3]. At the same time, consumer-owned generation has increased as renewables have become more affordable. Taken together with traditional centralized generation, there is plenty of electric supply in some regions. Depending on location and time of day, there may in fact be many multiples of power producing capacity beyond what is needed to reliably operate the grid. Yet renewable resources remain significantly underutilized. In periods of peak demand, power needs are met with carbon-heavy centralized generation like coal and oil and oversized substations. In other regions, there are large areas that still lack electrification. Consumers are left with few choices and little control over how their needs for power are met.

Historically, utility companies have continued to meet supply and demand by buttressing the existing centralized grid infrastructure. That is not a surprise, as the regulated utility is incentivized to build new infrastructure. Utilities are allowed cost recovery and a guaranteed rate of return on capital investment, a system established when utilities needed to have an incentive to build large scale, long-lived generation, transmission, and distribution assets. It is a different world today.

In recent years, attention has shifted to smart grids, and in some areas, distributed energy resources (DERs). Although there have been numerous demonstration projects, the process moves slowly, and utilities in most areas have been reluctant to scale these initiatives. This renders consumers dependent on the utility grid, with little agency in how their energy needs are met.

[3] *America's Biggest Blackout*, The Rhodium Group, October 26, 2017.

New Entrants to the Market

The past five years have also seen a new movement towards the "sharing economy". The classic example of the sharing economy is the emergence of ride-sharing applications like Uber and Lyft. This movement has also taken hold in the energy spheres of Europe, Australia, and the United States, as millennials have warmed to the idea of "energy sharing", where friends, family and neighbors can provide surplus energy to others when they need it. At the same time, more consumers are taking an interest in clean energy. Others are looking for greater reliability and energy independence. With the innovation of energy blockchain platforms, innovators are responding by creating opportunities for consumers to take control. This is the market where Power2Peer plans to make a significant contribution.

Early notable initiatives include the following:

Grid+

Grid+ is a platform that uses the Ethereum blockchain to give consumers access to wholesale energy markets. The platform acts like an energy retailer with a limited mark-up. The overall goal of Grid+ is to improve efficiency in energy markets by allowing customers to respond to the wholesale price of energy. This decreases the cost of energy and "helps move us all to a cleaner future," explains the official Grid+ website. Grid+ uses a smart device called Smart Energy Agent that makes the best price available and lets the customer pay for electricity in real time. Also, the device balances the load on the grid by controlling smart devices. The Grid+ platform will be available in 2018. Grid+ has raised $40 million USD in its ICO pre-sale in September 2017.

Power Ledger

Power Ledger has developed a series of blockchain energy applications, including a peer-to-peer energy trading application that allows businesses (primarily utilities at this point) to host energy trading on a blockchain platform. Power Ledger's technology enables the sale of surplus renewable energy generated at residential and commercial developments (including multi-unit/multi-tenant) connected to existing electricity distribution networks, or within microgrids. Power Ledger has conducted a trial in Australia and has a commercial deployment in multi-family housing. Power Ledger has raised $34 million AUD in its pre-sale and main sale.

LO3

LO3 Energy, Inc. started with the concept of enabling transactive energy – a software-defined, low-voltage distribution grid that enables market participation by DERs bidding generation of megawatts or kilowatts. The company is known for developing a microgrid in Brooklyn, New York, utilizing blockchain for energy sharing. Recently, LO3 established a collaborative relationship with Siemens and is now developing microgrids in Germany.

SolarCoin

SolarCoin created an innovative rewards program to incentivize installation of solar generation. One SolarCoin represents 1 MWh of solar electricity generation. A verified solar electricity product can get SolarCoins for free. According to SolarCoin, 99% of Solar Coins will be given to solar electricity producers of 97,500 TWh over 40 years.

The Power2Peer Difference

Power2Peer will utilize technological advances to create a decentralized network of solar microgrids which work in tandem with the traditional centralized grid. Near-term objectives are to connect multiple microgrids in several cities. The long-term vision is to scale support to thousands of distributed microgrids, including those not owned or operated by Power2Peer.

Power2Peer Differentiators

There are many advantages to blockchain-supported peer-to-peer energy trading, and Power2Peer provides them all. In particular:

- **Trading for More Efficient Use of Renewable Power:** Power2Peer offers an easy way to trade energy and at the same time divert resources from one place to the desired area of energy usage.
- **Back-up for Outages:** The adaptive solar microgrid can act as a backup for the main grid of the city in the event of natural disasters or other incidents causing thousands of households to be out of power.

What differentiates Power2Peer is that its offering enables communication connection supported by the latest and greatest technology. There are four key areas that set Power2Peer apart from the rest:

- **Connecting Communities**: Power2Peer's physical network of microgrids and energy trading market energizes and connects communities with a shared purpose.
- **Advanced Technology:** Power2Peer brings together a unique combination of a fit-for-purpose adaptive controller, smart inverters, cloud and analytics paired with blockchain.
- **Scalable Architecture**: The architecture of the adaptive solar microgrid system is enabled, from the beginning, using Big Data and analytics in the cloud.
- **Photonic Solar Conversion (PSC)**: The adaptive solar microgrid uses photonic solar conversion panels that generate 20+% more power from the garden variety panels

Microgrids and Markets Create Communities

Power2Peer's physical network of microgrids and energy trading market energizes and connects communities with a shared purpose: making better use of local resources. Each member of the community wants the microgrid to perform well, and can run their own household or business in a way that best suits their needs. Better use is made of local resource. Power is cleaner, more dependable and resilient. Local resources are used more efficiently.

Controller + Micro-inverters + Blockchain: Enabling Trading and Resiliency

Power2Peer is unique in that it puts together adaptive controllers, micro-inverters(IoT), data analytics engine connected with the properties of blockchain – enabling trading and fail-safe operations of microgrids. Other players have pieces, but none have the capability of sending signals from micro-inverters on solar panels to the blockchain. This potent combination will have a major impact on the energy industry.

Big Data and Analytics – Scaling Up for The Future

The architecture of the adaptive solar microgrid system is enabled, from the beginning, using Big Data and analytics in the cloud, "future-proofing" the scale-up of microgrid adoption. The platform is designed to ingest and analyze large amounts of production and other data communicated by micro-inverters. In other words, Power2Peer is ready for Big Data and analytics.

> Big Data and analytics refers to the application of advanced analytics to massive amounts of data. Big Data and analytics are transformational because these applications can handle the volumes, velocity, variety, and veracity data.

Big Data and analytics refers to the application of advanced analytics to massive amounts of data. The industries with the largest investments in Big Data and analytics are banking, discrete manufacturing, process manufacturing, government, and professional services. As the technology matures, the energy industry is expected to experience double digit growth in Big Data and analytics spending.

Defined, volume refers to the handling of large amounts of data; velocity refers to the processing of streaming data, such as power production, that arrives in short time intervals; variety refers to the diverse the equipment connected to microgrids; veracity refers to the ability to consistently validate the data.

In the future, this architecture will enable Power2Peer to collect and analyze data from numerous nanogrids and microgrids, offering insights that will be invaluable for balancing power distribution, managing smart contracts between peers, and enabling adaptive control of solar power systems to achieve persistence and resiliency. The newest variety of analytics – machine learning and artificial intelligence – improve performance of the system by predicting patterns, informing blockchain nodes and further automating decision-making.

An Additional Benefit: Photonic Solar Conversion Technology

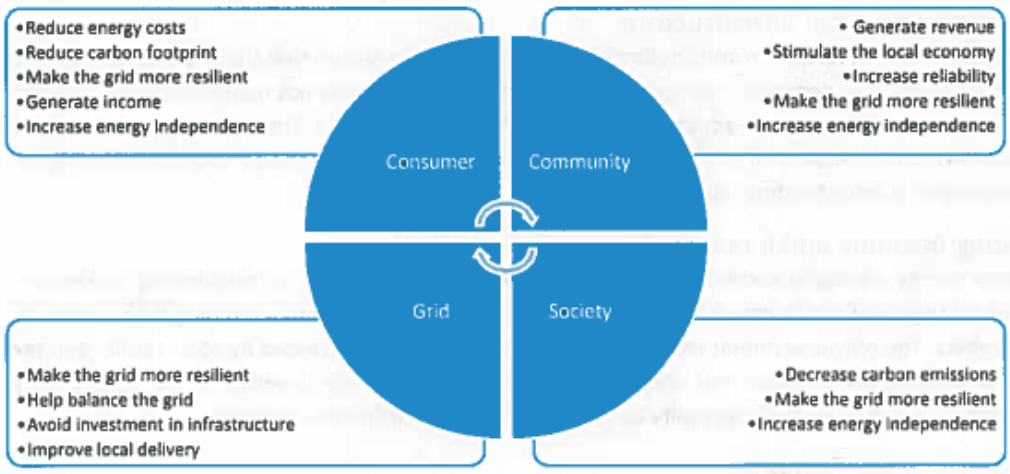
Photonic Solar Conversion panels generate 20+% more power than garden-variety panels, reducing the cost of energy. Power2Peer can also improve the efficiency of consumers' existing solar panels with the PSC technology. PSC conditions photons to match the bandgap of photovoltaic solar cells instead of creating multi-junction solar cells, which become cost prohibitive because of expensive bandgap engineering, e.g. tandem solar cells. Tests of the PSC panels have yielded impressive results, improving the efficiency of solar panels from 15% rated efficiency to 25%. Panels generate 20% more energy per panel on a normalized basis.

Benefits, Impact, and Demands: Getting to Energy Independence

Benefits for the Consumer, Community, Grid and the Society

Society, communities, consumers, and the grid itself will all benefit from the introduction of Power2Peer's blockchain-enabled adaptive solar microgrid system (see Figure 6). When we decentralize the energy grid, everyone wins.

Figure 6: The Benefits of Energy Independence, Source: Power2Peer, 2018



Reducing Energy Costs

Power2Peer can supply energy to microgrid participants at reduced costs compared to grid power. Local power does not have the overhead of centralized generation: the source is free and abundant, the infrastructure suffers fewer electric line losses, and there is less price volatility due to fluctuations in the cost of feedstock for fossil fuel plants. Solar energy can be even cheaper with the installation of PSC coatings.

Decreasing Carbon Emissions

The microgrid can take advantage of solar production that may not be used by a home or residence by providing that energy to the community via microgrids. With microgrids, consumers that are home during the hours when solar panels are most productive will be able to purchase solar from their neighbors who are at work. With the addition of energy storage, solar production that is not used during the day can be stored for later use, either by the battery owner or their neighbor. Moreover, by enhancing the financial return of renewable energy more broadly, Power2Peer represents a watershed moment in the worldwide adoption of solar. **By creating a clean energy marketplace, Power2Peer is creating a massive opportunity for further capital investment and return.** Great for investors, great for our planet.

Shrinking Carbon Footprint

Along with collective communities gaining the ecological benefit of reduced carbon emissions, the environmentally conscious consumer benefits by reducing their individual carbon footprint by using solar. Both also stand to curtail the necessity of future spending on infrastructure, whether due to natural disaster or the old-fashioned inefficiency of energy production. Reducing carbon emissions is an investment in the future that will pay dividends, both environmental and financial.

Making the Grid More Resilient

Using local sources of energy, microgrids help residences, businesses, organizations, and communities to recover power more quickly during storms, hurricanes, and other major interruptions in centralized power supply. Utilities benefit in these situations, as microgrids reduce the volume of outages they need to handle. This frees utility resources to better address customers that do not have access to backup power.

Improving Local Energy Delivery

For traditional utility companies, it is expensive to transmit electricity to remote locations, especially in regions where there is little electrification. The demand for power in rural areas is comparatively less than in urban areas and may not justify investment. Nanogrid and microgrid networks provide these communities with alternate means to generate power, without depending on the whims and infrastructure of utility corporations.

Avoiding Investment in Infrastructure

The utility grid is often overbuilt in anticipation of future growth or to ensure that there is enough capacity to meet infrequent peak demands. The anticipated growth in demand may not materialize, due to failed real estate developments or the adoption of energy efficient appliances. Distributed generation and microgrids that deliver additional energy to meet peak demand have been shown to help utilities defer large investments in infrastructure, such as substations.

Generating Revenue and Income

Using clean energy microgrid systems, communities can sell surplus energy to neighboring residences, businesses, or organizations to generate revenue. Individual members can earn by trading their surplus to other members. The only investment required is for installation, in part financed by solar credits and tax equity, and ongoing maintenance and operations. In the future, with the development of a secondary token market, there may be an opportunity to trade ElectroTokens with non-members.

Stimulate the Local Economy

Local communities participating in microgrids become actively involved in power generation and are "energized" by their participation. Microgrids help the community to be energy self-sustainable, which in turn brings economic activity to the local area. Microgrids need to be installed and maintained. There are jobs for installation of solar coatings that make solar panels more efficient. There is work in registering members and distributing keys to the blockchain network. Also, investment brought into the community encourages innovation in renewable energy technologies.

Increasing Reliability

According to the US Department of Energy (DOE), the US suffers more power outages than any other nation in the developed world. Microgrid systems can help communities prepare for outages by providing a source of back-up power when the grid goes down. A microgrid built with smart contracts and smart energy devices (smart switches, sensors and IoT), using locally generated power, can operate independently from the centralized grid.

Helping Balance the Grid

Power systems designed using Power2Peer's adaptive solar microgrid systems could help utility grid operators balance the grid during system capacity constraints or voltage fluctuations. By communities making better use of power generated locally, and managing power more efficiently through blockchain and smart energy technology, utility companies will ultimately see less strain on their systems, leading to fewer catastrophic malfunctions.

Increasing Energy Independence

ASM systems can help communities, businesses, and nations, particularly smaller islands, to be more energy secure by reducing the need to import energy from abroad, particularly in the case of political or financial instability. With the implementation of solar microgrids, power outages and dependence on utility will no longer be the norm in such places.

Impacts

There are two major areas where an "order of magnitude" impact can be estimated: consumer savings and carbon emissions.

Consumer Energy Cost Reduction

The use of more efficient solar panels can lower energy costs. With Photonic Solar Conversion (PSC) based microgrids, Power2Peer expects to **increase the energy output of individual panels by 22% to 25%.** In addition, blockchain reduces administrative costs. The price of peer-to-peer trading of the solar kW will be close to 12 cents per kWh as compared to average 20 cents per kWh from Eversource or National Grid reducing the cost by 40%. Even without the PSC coatings, energy cost reductions are expected to be 20%.

PSC – Photonic solar conversion is a method for conditioning photons from solar spectrum towards the band-gap of the solar cell thereby increasing efficiency and energy output.

Decreased Carbon Emissions

The adaptive solar microgrid system will significantly reduce the carbon emission by reducing coal, oil and natural gas generation. The 2016 statistics provided by carbonfund.org indicate that the US electricity generation sector is responsible for the production of 1,821 million metric tons of carbon annually. Per GW, that's approximately 4,550 metric tons of carbon.

With better utilization of unused solar resources, the grid will be less dependent on carbon-intensive centralized generation. The production of 130 GW by PV will reduce approximately 591,792 metric tons of carbon emission, a significant impact. The use of PSC panels which provide more power per panel will further lessen dependence on carbon-heavy generation.

Industry Support and Demand

Initially, Power2Peer will be focused on markets in North America and India. These are areas where the group already has traction and where there is market receptivity, driven by regulations, incentives, and sustainability objectives. Additionally, for India, there is a preponderance of solar energy in the region.

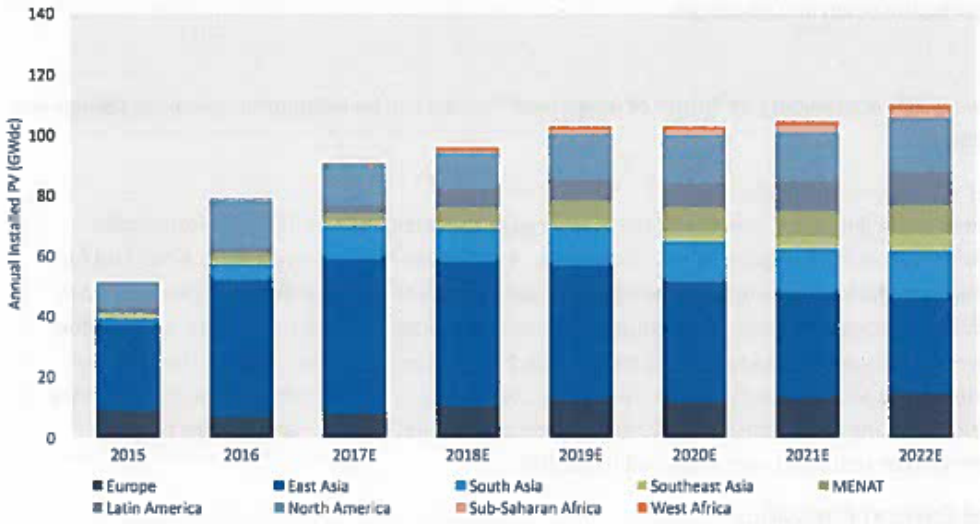
According to Veena Kumari in the Future of Microgrids in India[4], there are 5000 trillion kWh of solar energy that are available to be harnessed each year. There is also a need for electrification in remote locations, making conditions ripe for development of distributed networks of ASM systems.

There is little research on the forecasted growth of the solar microgrid market, even less for the nascent energy sharing market. Still, the market trajectory for solar microgrids can be understood by examining three separate markets: PV, energy storage, and microgrids.

PV has increased dramatically as the technology has become more efficient and affordable. According to Bloomberg New Energy Finance report for the Sustainable Energy in America 2017 Factbook[5], in 2016 new PV installations included 2.3 gigawatts(GW) in the residential sector, 1.1 GW in the commercial and industrial sector, and 8.9 GW in the utility sector, totaling 12.5 GW across all sectors.

Greentech Media Research provides further insight into the expected growth of the global solar market by market segment (see Figure 7). The North American market is tempered in the short term, due to uncertainty about federal policy. The South Asian markets are continuing to add PV as countries like India are upping their commitment to clean energy.

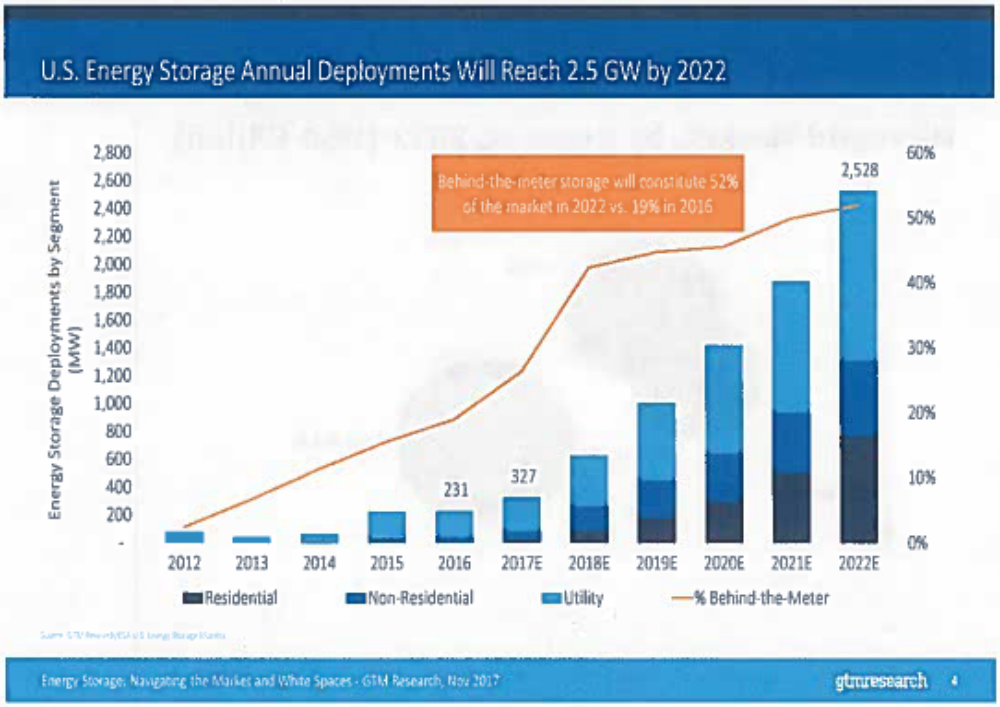
Figure 7: Global PV Demand by Region, 2015-2022E, Source: GTM, Global Solar Demand Monitor: Q3 2017



The market for energy storage has experienced significant growth over the last year, as the technology has matured, although the market is still relatively small. By the end of 2017, there will be close to 700 mWh or 300 MW of energy storage in the United States according to GTM. Most of the energy storage is being used for backup power or resiliency. In the commercial and industrial sector, storage is being used primarily for demand charge reduction. Energy storage has grown 55% percent from 2016 to 2017 and is forecasted to grow to 2.5 GW by 2022. While much of this increase is utility-scale storage, there is considerable growth in commercial and industrial and utility-scale storage. By 2022, 52% of storage is expected to be behind-the-meter storage, as is the storage in this offering (See Figure 8). This change is predicated on the implementation of more dynamic rate structures that are time and location based.

Figure 8: U.S. Energy Storage Deployment Forecast, 2012 to 2022, Source: GTM Research/ESA U.S. Energy Storage Monitor)

[4] Kumari, Veena, *The Future of Microgrids in India*, Veena Kumari, International Journal of Research in Engineering and Technology, Volume 6, Issue 2, February 2017.
[5] *2017 Sustainable Energy in America Factbook*, Bloomberg New Energy Finance, 2017.

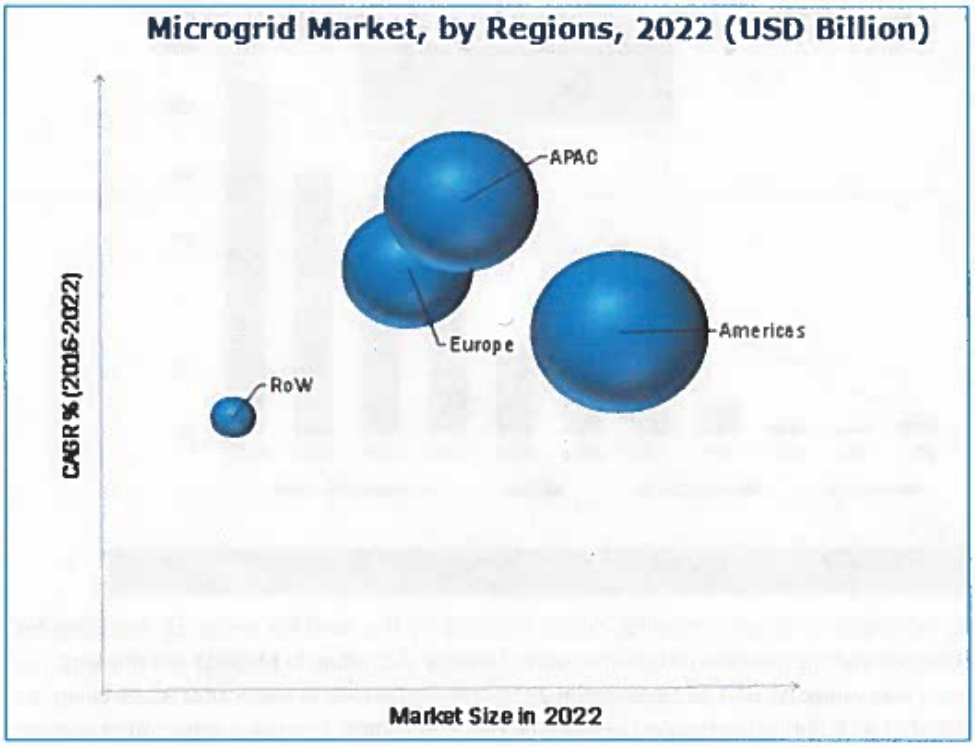


The market for microgrids is steadily growing, driven primarily by the need for resiliency, the drive for electric infrastructure and the desire to reduce the costs of energy. According to Markets and Markets, the microgrid market was valued at USD 16.58 Billion in 2015 and is expected to reach USD 38.99 Billion by 2022, at a CAGR of 12.45% during the forecast period (see Figure 9)[6]. North America is expected to account for 71.4% of global revenue by the end of 2025. The increasing number of new solar PV microgrids for utility in Northeast and West regions of the U.S. is expected to have a positive impact.

The global microgrid demand stood at 1.48 GW in 2016 and is projected to reach 6.54 GW by the end of 2025, expanding at a CAGR of 16.3% from 2017 to 2025. Remote microgrid market demand was 568.2 MW in 2016. The segment is expected to foresee tremendous gains owing to the upcoming installation of new projects in the Russian Arctic.

[6] "Microgrid Market by Offering (Hardware- Power Generation & Energy Storage System, Software, and Service), Connectivity (Grid Connected and Remote/ Island), Grid Type (AC, DC, and Hybrid Microgrid), Vertical & Geography - Global Forecast to 2022", Markets and Markets, 2017

Figure 9: Microgrid Market Forecast, Source: Markets and Markets, "Microgrid Market by Offering (Hardware- Power Generation & Energy Storage System, Software, and Service), Connectivity (Grid Connected and Remote/ Island), Grid Type (AC, DC, and Hybrid Microgrid), Vertical & Geography - Global 2017



Business Models

The Sustainable Business Model

Power2Peer expects to earn its revenues primarily from blockchain transaction fees and connection fees. The near-term objective is to connect multiple microgrids in several cities. The long-term vision is to scale to support thousands of distributed microgrids, including those not owned or operated by Power2Peer. P2PConnect, the user-friendly mobile application secured by blockchain, will create a much-needed marketplace for peer-to-peer clean energy trading.

Power2Peer will charge a small fee per each transaction within its market, like Ethereum and other blockchain platforms. There may be additional revenue from a small fee for interconnecting other microgrids.

Our financial estimates show that the business will be cash positive and generate up to 48% net profit at the end of the life cycle of the system. With more cities coming on board, significant revenue will be generated to create more microgrids across the United States. For high efficiency solar microgrids using Photonic Solar Conversion, deployed in 28 cities initially, with each city generating 1 MW of electricity, there is an estimated payback period of 9 years and a cumulative profit of $76 million over five years. The long-term vision is to scale to support thousands of distributed microgrids, including those not owned or operated by Power2Peer. P2PConnect, supported by blockchain smart contracts, will create a much-needed clean energy marketplace for power trading between peers. The use of PSC panels is enough to make the business profitable, even if current tax credits, such as the U.S. solar investment tax credit (ITC), are eliminated.

After the payoff period, most of the income from sales of solar power will go to the company. Operations and maintenance (O&M) is required, but is typically low. According to NREL in Best Practices in Photovoltaic System Operations and Maintenance[7], with efficient planning and delivery, O&M can be $10/kW/year. In the case above, 1 MW of production would amount to 6% of revenue from microgrid solar power.

Although revenues are modest, they are sufficient for the business to be sustainable. More importantly, Power2Peer will deliver a cleaner, more efficient, and more resilient grid.

The Collaborative Business Model

The ideal markets for Power2Peer are communities and individual premises within these communities: schools, malls, community centers, and neighborhoods in urban and rural settings. The exchange creates a community for peer-to-peer trading. Buildings within communities may lack access to solar power. At the same time, communities have an interest in the benefits that adaptive solar microgrids can bring – revenue, resiliency, reduced emissions, and stimulation of the local economy. Power2Peer is already pursuing opportunities in these areas.

Collaboration with Malls, Community Centers and Schools

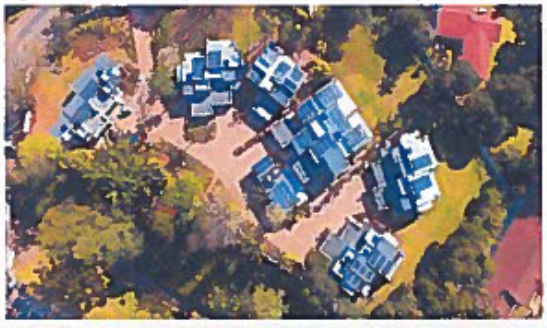
Over 90 million Americans cannot access solar power. Renters, low-income households, and owners of buildings with shady rooftops are locked out of the market for rooftop solar panels. In addition, a quarter of America's population is dependent on utilities and state incentives for the supply of clean, consistent, and renewable energy.

Buildings with large, expansive rooftops are the ideal candidates for adaptive solar microgrids. Malls have thousands of square meters of roof space available for solar PV installation. Mall real estate owners and management companies are seeking ways to reduce the cost of electricity, particularly for energy intensive end-uses such as heating, ventilation, and air conditioning.

Power2Peer has had preliminary discussions about installing rooftop PV with Whole Foods and The Simon Property Group, a Boston area real estate management group. However, simple PV power plants may not be able to meet peak demands of these companies' facilities during summer months when air conditioning loads are high. Those facilities will need to rely on obtaining additional power through connection with a network of other solar power grids managed by adaptive control systems. That is where Power2Peer comes in. Property developers and managers would purchase clean energy for the energy needed to run facilities.

Collaboration with City Officials for City Microgrids

Figure 10: Example of a community solar microgrid



Cities and their neighborhoods are another market that is ripe for the adaptive solar microgrid. Many cities in the U.S. want to reduce carbon emissions and are now promoting use of clean energy such as wind and solar for reducing dependence on coal and gas fired power plants. Renewable Portfolio Standards in many states also require power companies to accrue carbon credits by purchasing power from renewable energy sources. In the wake of superstorms such as Sandy, Harvey, Irma, and Maria, cities are seeing the need to have resilient power, especially to run critical facilities. The centralized power grid becomes too vulnerable during extreme weather events, so cities are considering distributed networks of microgrids to keep power flowing.

[7] Best Practices in Photovoltaic System Operations and Maintenance, National Renewable Energy Laboratory, December 2016

In the city of Burlington, MA (pictured above), with the support of city hall, Power2Peer has proposed a resilient microgrid to generate power for the city. An adaptive solar microgrid demonstration will be conducted on the roof of a new facility at Greentown Labs, located in Somerville. **This facility will demonstrate the first adaptive blockchain-enabled solar PSC microgrid with peer-to-peer power trading. The project is currently funded by a solar loan provided by Sungage, and the project is implemented by 180 South Solar.**

The ASM will be owned and operated by Power2Peer and powered by PSC panels. The accounting of kW production and peer-to-peer trading will take place on the Power2Peer blockchain framework.

At present, the traditional utility distributes power to the City of Burlington. The adaptive solar microgrid will interconnect with the utility network. Solar-generated power will be delivered through existing wiring and net-metering.

Once the demonstration project is completed, Power2Peer will embark on setting up microgrids in numerous cities. Each adaptive solar microgrid with 1 MW system will support over 2600 houses in New England region. Each household will connect using an existing grid connection and a net-meter. The individual households will enter into self-executing smart contracts on Power2Peer's adaptive solar microgrid. The P2PConnect platform will charge end-users an estimated 20% less than grid price for each kW.

So, You Want a Solar Array in Your Backyard

There is, of course, more to participation than trading ElectroTokens. A member of the community might want to consider building a solar array on their property that could provide an additional source of income. As an example, the total cost of installing a nanogrid solar array generating 18000 kilowatt hours (kWh) per year is $57,000. The life expectancy of the solar array is 25 years. If the owner were to sell all power generated by the array to neighbors at $0.17 per kWh, the simple payback period for the investment would be 7 years. If a PSC coating were installed on the panels in the array, fewer panels would need to be installed. The cost of installation would fall to $20,215 and the payback period would be reduced to 3 years. For the next 10 years, the owner of the array could expect to earn approximately $3,000 per year, assuming some low operations and maintenance costs.

Key Take-Aways

This is an ideal time to become actively involved in how electricity is generated and delivered. By investing in Power2Peer, buyers will have an opportunity to support energy independence, decrease carbon emissions, and strengthen the resilience of the grid.

- **Growing Markets:** The markets for solar and microgrids are growing. The rise of the "sharing economy" has ignited interest in the idea of "energy sharing". Using new technologies like blockchain, innovators are creating opportunities for consumers to take control.
- **Trading for More Efficient Use of Renewable Power:** Power2Peer offers an easy way to trade energy and divert resources from one place to the desired area of energy usage.
- **Backup for Outages:** The adaptive solar microgrid can act as a backup for the main grid of the city in the event of natural disasters or other incidents causing major outages.
- **Connecting Communities:** Power2Peer's physical network of microgrids and energy trading market energizes and connects communities with a shared purpose – making better use of local resources.
- **Advanced Technology:** A unique combination of a fit-for-purpose adaptive controller, micro-inverters, and analytics paired with blockchain enables trading and fail-safe operations.

- **Scalable Architecture:** The architecture of the ASM is enabled, from the beginning, for the scale-up of microgrid adoption. The Power2Peer Team and Track Record of Success

Power2Peer Team

Dr. Nish Sonwalkar (ScD., MIT), Founder and Chief Evangelist

Inventor and Entrepreneur, has over 25 years of experience in the development of innovative technologies related to solar thermal applications, open cycle ocean thermal energy conversion (OC-OTEC) evaporators and molecular dynamics of energy materials and nano-interfaces, such as Si and copper interfaces and optical coatings. As the former Principal Research Scientist and faculty at MIT, he developed the combined molecular dynamics (MD) and laser Raman spectroscopy methodology for the design of new material interfaces. He has also served as PI on numerous NSF research and SBIR awards related to surface science and education technology. (see biographical sketch)

Eric MacDonald, Director of Technology

Eric MacDonald is a software architect with experience developing scalable and efficient platforms for blockchain technology. He is a key architect of the Adaptive 2.0 platform for EdwiseTech Inc., using both J2EE and LAMP stacks. Specific to the commercialization of the Power2Peer blockchain platform, Mr. MacDonald is responsible for leading the developers in creating a robust platform, performing quality assurance, and troubleshooting problems

Binod Pant, Senior Software Engineer

Binod has over 20 years of experience developing software for one of the largest mathematical software companies, Mathworks. An expert in blockchain architecture and distributed database systems, he will be the primary front-end developer for the smart contracts and token exchange.

Richard P. Lewandowski, Chief Operating Officer

Mr. Lewandowski has over 30 years' experience in the field of renewable energy. He is the Founder past CEO of Prism Solar Technologies, Inc., a NY photovoltaics (PV) module manufacturer. Founder, Past President and CEO of Direct Global Power (DGP): Founder and former CEO of SunWize Technologies, Inc., one of the largest PV distributors in North America. Former Vice President of Technology of Besicorp Group, Inc. Former President of BioEnergy Group Inc., Founder, past President and Board Director of the New York Solar Energy Industry Association (NYSEIA). Founder and past President of the Illinois Solar Energy Industry Association. Former President of the ASES Chapter - Illinois Solar Energy Association. Present Board Director for the New York Solar Energy Society.

Mamta Sonwalkar, VP of Operations

Mamta has over 20 years of experience in development of software solutions for publishing, education and information technology and embedded software development. She is an expert in agile development process and has successfully developed and deployed adaptive learning, LMS, and LCMS platforms. She will be in charge of the Power2Peer Boston's Ethereum based platform for blockchain innovations. She has a degree in computer science and entrepreneur certificate from the MIT Enterprise Forum.

Kevin Debasitis, VP Strategic Partnerships

Kevin has over a decade of marketing experience in the solar energy industry. He was the Director of Business Development for third generation thin film PV technology Konarka Technologies developing and deploying projects around the world. At Nexamp, a leading regional commercial/utility solar plant developer, he managed the full development cycle of commercial solar projects from concept to design, financing and EPC execution. At ElectricFilm, a low light harvesting PV technology firm, Kevin was Vice President of Sales focused on the commercialization of light harvesting technology to power a broad range of sensors for the Building Internet of Things.

Swamini Shah, Manager of Finance and Administration

Swamini has over five years of working experience in corporate law firm. Over the year she has led the financial management and intellectual property management of SunDensity. She is responsible for the legal contract, grant funding management and reporting for the company. She is also responsible for administration of the company policy, procedures and operations. She earned a BSL-LLB Law degree from India and MBA from UMASS, Boston.

Sean Zorger

Sean has over 15 years of experience in development of multimedia assets for online courses and technologies. He has developed effective websites, animations, and educational video objects for multimedia authoring environments. He will be responsible for the Power2Peer Boston website design and development deployments as Power2Peer Boston grows with blockchain innovations.

Advisory Board

John Piret, MIT Energy Initiative

Dr. Piret leads Newbury Piret international M&A activities, with an emphasis on assisting European buyers who seek expansion opportunities in the US market. As an investment banker and CEO, Dr. Piret has negotiated private equity investment, licensing and joint venture/strategic alliances agreements. His specialties include strategic and financial advisory services with an international focus; in-depth acquisition search for the US and abroad; managing cross cultural relations and problem-solving; and performing sale, licensing, and valuation advisory of US assets. He is an expert at valuing and evaluating technologies, intangibles, and companies, and is a Certified Valuations Analyst [CVA]. Dr. Piret has extensive experience in the formation and development of technological and engineering companies. Previously, he was President and founder of Corion Technologies, Inc., a maker of static electricity elimination instruments for process industries, focusing in sales, manufacturing, engineering and product development.

He is a Director of Hyannis Port Research, Inc. and of the European American Chamber of Commerce - France. He is a Mentor at MIT's Venture Mentoring Service, the CleanTech Open, and MassChallenge, as well as a Harvard i-Lab student advisor. He also served on the Advisory Committee for Shareholder Responsibility for Harvard University's endowment fund, as a Director of Nascent Technology Corp. (a UAV avionics company), and as a member of the President's Council of the Olin College of Engineering.

Val Livada, MIT Sloan School

Dr. Val R. Livada, PhD serves as Advisor of Vanguard Solar, Inc. He is a Founder of Weybridge Partners, Winchester, MA and serves as its Chief Executive Officer. He served as a Vice President of Pugh-Roberts Associates, a technology management firm established by MIT Entrepreneurship Professor Ed Roberts. Dr. Livada served as Consulting Partner of Synchrony Venture Management, Investment Arm. He is Co-founder and Principal at Dome Associates, a group of MIT alumni focusing on issues of innovation and entrepreneurship. He is also Principal at IP Vision, as well as Weybridge Partners. Dr. Livada has spent over 25 years as a management consultant to both Fortune 200 and emerging companies. He has over 30 years of experience in the areas of strategic planning and organizational dynamics with detailed knowledge in the areas of innovation, product development and R&D management. Dr. Livada has worked with Global 300 companies such as GM, Nokia, BD, and Hitachi, startup ventures, regional solar development organizations and university technology transfer groups. During his career, He has combined expertise in the areas of strategic planning and organizational dynamics with a detailed knowledge in the areas of innovation, product development and R&D and management. Prior to establishing Weybridge Partners, he was the leading practitioner in innovation management for the PA Consulting Group. He has been instrumental in establishing US operations for several established and emerging European companies, including Nokia Research and Pro2Kem. Dr. Livada is Member of Advisory Board at InTeahouse. He serves on the Boards of Monarch Antenna, Aphios Corporation, AutoHarvest Foundation, and the Built Environment Coalition. Dr. Livada is also an advisor to Unitied Technologies Business Innovation Board, Greentown Labs and BGI. He Livada serves as Member of the Advisory Board of Porticus Technology Inc. He served as Member of Strategic Advisory Board at Synchrony Venture Management, LLC. He served as a Director at Braxton Associates, an international strategy planning consulting firm. Dr. Livada has been a Guest Lecturer and Senior Lecturer on Corporate

entrepreneurship at the MIT's Sloan School, Management of Technology Program for the last 12 years. He serves at Cambridge University/MIT Institute on a variety of topics including Innovation, Entrepreneurship and Growth as well as Industry/University relations. Dr. Livada received his undergraduate degree from MIT and his MA and PhD from Tufts University.

Alistair Pim

Alistair Pim is Vice President, Innovation & Partnerships for NECEC, a non-profit dedicated to making the Northeast the best place to start and grow a cleantech business. He and his team have responsibility for the Cleantech Open accelerator in the northeast, Cleantech Navigate and the Strategic Partner network programs. Prior to NECEC, Alistair was VP of Business Development and Alliances in the Global Smart Cities segment at Schneider-Electric, where he was responsible for developing the partner ecosystem. Alistair has extensive experience in the energy technology industry initiating and developing strategic relationships regionally and globally with IT industry leaders and local government, then building and managing teams to leverage these relationships for mutual business benefit and customer value. Prior to Schneider-Electric Alistair was with start-up SynQor Inc, working as GM European operations, and VP WW Sales.

He has travelled to over 50 countries, and lived in UK, France, Malaysia and now the US.Alistair serves on the cleantech committee for the MIT Enterprise Forum and served on the Executive Committee and the Board of Directors of ASAP (Association of Strategic Alliance Professionals), and is a CSAP (Certified Strategic Alliance Professional). He holds an MBA from Cranfield School of Management (UK) and a BS in Engineering Science from the University of Exeter (UK) and lives in Boston.

Amitesh Singh

Amitesh has over 17 years of expertise leading, developing and launching world class products and services in Control Automation, IoT, Analytics and Manufacturing intelligence. With deep passion and proven leadership in technology and energy sectors, Amitesh has developed and deployed state of the art automation and intelligence systems for several leading energy companies like EnBW, ConocoPhillips, Exxon Mobil, and Saudi Aramco to name a few. He has led the development of almost two dozen cutting edge products that run plants generating over 40% of world energy over 17 years of his career. Currently, he heads the development of a leading distributed control system for a fortune 500 company. With an MBA from MIT Sloan and an Engineering degree from IIT, he brings business objectivity to contemporary innovation.

Officers and directors

Dr. Nish Sonwalkar	Founder, Chief Evangelist, andDirector
Mamta Sonwalkar	Director and VP of Operations

Dr. Nish Sonwalkar

Inventor and Entrepreneur, has over 25 years of experience in the development of

innovative technologies related to solar thermal applications, open-cycle ocean thermal energy conversion (OC-OTEC) evaporators and molecular dynamics of energy materials and nano-interfaces, such as Si and copper interfaces and optical coatings. As the former Principal Research Scientist and faculty at MIT, he developed the combined molecular dynamics (MD) and laser Raman spectroscopy methodology for the design of new material interfaces. He has also served as PI on numerous NSF research and SBIR awards related to surface science and educational technology.
Positions held: Founder and Chief Evangelist, Power2Peer, Inc. - January 2018 to Present (8-10 hours/week), Founder and Chief Scientist, SunDensity, Inc. - March 2016 to Present, Founder and President, IntellADAPT - June 2014 to Present (primary job)

Mamta Sonwalkar
Mamta has over 20 years of experience in the development of software solutions for publishing, education and information technology and embedded software development. She is an expert in agile development processes and has successfully developed and deployed adaptive learning, LMS, and LCMS platforms. She will be in charge of the Power2Peer Boston's Ethereum based platform for blockchain innovations. She has a degree in computer science and an entrepreneurship certificate from the MIT Enterprise Forum. Positions held in the past 3 years: VP Operations, Power2Peer, Inc. - April 2018 to Present, IT Project Manager, Maloney Properties, Inc.
- December 2014 to March 2018

Number of Employees: 7

Related party transactions

The company has not conducted any related party transactions.

Ownership

- Nishikant Sonwalkar, 49.73% ownership, Common Stock Mamta
- Sonwalkar, 49.73% ownership, Common Stock
- 151 Investors, 0.54% ownership, Common Stock

Classes of securities

- **Common Stock**

  The Company is authorized to issue up to 10,000,000 shares of common stock. There are a total of 8,043,168 shares currently outstanding, which includes the sale of 43,168 shares to 151 investors through a crowdfunding campaign the company conducted on the startengine.com platform, which raised $86,336. The crowdfunding offering terminated on March 8, 2019.

  Voting Rights *(of this security)*

The holders of shares of the Company's Common Stock, $0.00001 par value per share (the "Common Stock"), are entitled to one vote for each share held of record on all matters submitted to a vote of the shareholders.

Dividend Rights

Subject to preferences that may be granted to any then outstanding preferred stock, holders of shares of Common Stock are entitled to receive ratably such dividends as may be declared by the Board out of funds legally available therefore as well as any distribution to the shareholders. The payment of dividends on the Common Stock will be a business decision to be made by the Board from time based upon the results of our operations and our financial condition and any other factors that our board of directors considers relevant. Payment of dividends on the Common Stock may be restricted by law and by loan agreements, indentures and other transactions entered into by us from time to time. The Company has never paid a dividend and does not intend to pay dividends in the foreseeable future, which means that shareholders may not receive any return on their investment from dividends.

Rights to Receive Liquidation Distributions

Liquidation Rights. In the event of our liquidation, dissolution, or winding up, holders of Common Stock are entitled to share ratably in all of our assets remaining after payment of liabilities and the liquidation preference of any then outstanding preferred stock.

Rights and Preferences

The rights, preferences and privileges of the holders of the company's Common Stock are subject to and may be adversely affected by any additional classes of stock that we may designate in the future.

What it means to be a Minority Holder

As a minority holder of common stock, you will have limited ability, if any, to influence our policies or any other corporate matter, including the election of directors, changes to the Company's governance documents, additional issuances of securities, company repurchases of securities, a sale of the Company or of assets of the Company, or transactions with related parties.

Dilution

Investors should understand the potential for dilution. Each Investor's stake in the Company, could be diluted due to the Company issuing additional shares. In other words, when the Company issues more shares, the percentage of the Company that you own will

decrease, even though the value of the Company may increase. You will own a smaller piece of a larger company. These increases in number of shares outstanding could result from a stock offering (such as an initial public offering, another crowdfunding round, a venture capital round or additional angel investments), employees exercising stock options, or by conversion of certain instruments (e.g., convertible notes, preferred shares or warrants) into stock.

If we decide to issue more shares, an Investor could experience value dilution, with each share being worth less than before, and control dilution, with the total percentage an investor owns being less than before. There may also be earnings dilution, with a reduction in the amount earned per share (although this typically occurs only if we offer dividends, and most early stage companies are unlikely to offer dividends, preferring to invest any earnings into the Company).

The type of dilution that hurts early-stage investors mostly occurs when the company sells more shares in a "down round," meaning at a lower valuation than in earlier offerings.

If you are making an investment expecting to own a certain percentage of the Company or expecting each share to hold a certain amount of value, it is important to realize how the value of those shares can decrease by actions taken by the Company. Dilution can make drastic changes to the value of each share, ownership percentage, voting control, and earnings pershare.

Transferability of securities

For a year, the securities can only be resold:

- In an IPO;
- To the company;
- To an accredited investor; and
- To a member of the family of the purchaser or the equivalent, to a trust controlled by the purchaser, to a trust created for the benefit of a member of the family of the purchaser or the equivalent, or in connection with the death or divorce of the purchaser or other similar circumstance.

SIGNATURES

Pursuant to the requirements of Sections 4(a)(6) and 4A of the Securities Act of 1933 and Regulation Crowdfunding (§ 227 .100-503), the issuer certifies that it has reasonable grounds to believe that it meets all of the requirements for filing on Form C and has duly caused this Form to be signed on its behalf by the duly authorized undersigned, on April 30, 2019.

By: N. Sonwalkar

Name: Nishikant Sonwalkar

Title: Chief Executive Officer & President

FINANCIAL STATEMENTS AND FINANCIAL CONDITION; MATERIAL INDEBTEDNESS

Financial Statements

Company prepared financial statements for the period ending December 31, 2018 can be found attached to this document. Company prepared financial statements for the period from January 5, 2018 through May 31, 2018 are also attached to this document.

Financial Condition

Results of Operation

We have not yet generated any revenues and do not anticipate doing so until we have completed the building and delivery of product, which we do not anticipate occurring until 2019 Q2. Based on our forecast, with the liquidity of the crowdfunded raise amount of $86,336, we anticipate that we can operate the business for 6 months with a burn rate of $14,300 without revenue generation.

We do not have an operating history in the microgrid business yet.

Power2Peer is a new startup company and does not have the operational history. However, based on the current burn rate which is close to $14,300 per month which includes the following expenses:

- Rent of the facilities at the Venture Development Center
- Computational facility for running blockchain platform Fabrication
- of demonstration set-up for resilient solar microgrid
- Software development for the network controller, IoT sensors, and inverters for the solar panels
- Hardware related to the demonstration sites—solar panels, inverters, electrical circuit components, sensors, actuators, and controller panels
- Office expenses

Milestones:

- Milestone 1(a): Development of minimum viable product
- Milestone 1(b): Fabrication of demonstration site
- Milestone 1(c): Field trial data and analysis for full product development

Financial Milestones

Assumptions with proprietary Photonic Solar Conversion* (PSC) technology:

LCOE from the grid	$0.20
System Size	15240 watts
Electricity generated	18000000 watts / year
Panels	39
Average hours per day	4.5 Boston, MA
Total money raised	$60,000,000
42 panels generate	15240 watts
Panels needed for 15.24 KW	39 panels
Cost of one panel	$97
Cost of Energy	$.31 per watt
Micro Invertor cost per watt	$0.08 per watt
Invertor cost per panel	$30.00
Construction cost perwatt	$1.25 per watt
Total cost of panels	$3,820
Total installation cost	$19,050
Total invertor cost	$1,172
Number of nanogrids per MW	66
Power generated by microgrid per city	1000000 Watts
Total set up cost per nanogrid	$24,025
Cost of 1 MW	$1,576,430

* The PSC technology is owned by a related company, SunDensity, Inc.. Products utilizing the PSC technology will be purchased by the Company from SunDensity, Inc. in arms-length transactions.

Milestone 1: Deployment of nano-grid in Burlington, MA as the minimum viable product software-defined network controller with blockchain enabled peer-to-peer transactions: This milestone for the 15.4 kW systems with 60 solar panel connected via IoT microinverters will allow us to test all our financial assumptions.

Milestone 2: Deployment of the first 1MW microgrid in Sommerville, MA.

This will be the first full-scale demonstration of our systems with over 1000 households connected to our Power2Peer blockchain platform and generation of revenueasperourprojectionsforthefirstfull-scale1MWmicrogridwith3333Solar panels.

Milestone 3: Deployment of roll out schedule for 28 microgrids over the next five years will follow the projections.

Projections: The company is investing for the continued growth of the brand, and, as is generating sizeable net income losses as a result. Management currently forecasts 2019, 2020, 2021, 2022 and 2023 revenue of $2.72 million, $8.16 million, $13.6 million, $21.76 million and $29.92 million respectively, generating a cumulative revenue of $76.16 million and believes the company will generate positive net income beginning in 2021. The projected operating expenses and cost of goods sold respectively are $1.57 million and $30,000, $4.72 million and $90,000, $7.88 million and $150,000, $12.61 million and $240,000, $17.34 million and $330,000.

Power2Peer expects to earn its revenues from blockchain P2Pconnect platform usage fees, solar power sales, and security token trading. The near-term objective is to connect multiple microgrids in several cities. The long-term vision is to scale to support thousands of distributed microgrids, including those not owned or operated by Power2Peer.

Lifecycle Profit Expectations:

Our financial estimations show that the business will be cash positive and generate up to 48% net profit at the end of the life cycle of the system. With more cities coming on board, significant revenue will be generated to create more microgrids across the United States. For high-efficiency solar microgrids using Photonic Solar Conversion, deployed in 28 cities initially, with each city generating 1 MW of electricity, there is an estimated payback period of 9 years and a cumulative profit of $76 million over five years. The long-term vision is to scale to support thousands of distributed microgrids, including those not owned or operated by Power2Peer.

Liquidity and Capital Resources

The company is currently generating operating losses and requires the continued infusion of new capital to continue business operations.

$86,336 was raised through a crowd funding campaign, which will enable us to create the MVP and related marketing assets for further fundraising campaigns. The company now seeks to raise close to $2 million from qualified investors as the seed round. The initial crowdfunded capital will last for six months, and allow us to work on getting non-dilutive funds from the SBIR and other similar foundation grants raising $225,000. The company will also get debt financing from the banks in the form of solar loans for building the demonstration solar nano-grid of $85,000.

Post-funding, the company plans to install solar microgrids of 30 MW, which will remain significant solar energy assets.

Indebtedness

None.

Recent offerings of securities

Crowdfunding offering at $2/share.

Valuation

$16,000,000.00 pre money

We have not undertaken any formal efforts to produce a valuation of the Company from a third-party. The price of the shares merely reflects the opinion of the Company as to what would be the fair market value. The following assets constitute the rationale for the current valuation of the company: 1. The company's founder and the team have developed proprietary technology for a "Software Defined Network Controller for Solar Microgrids secured by blockchain technology platform" (provisional patent). 2. The company has developed a technology framework for use of IoT, big-data analytics and AI engine for creating scalable resilient solar power systems. 3. The company brings a seasoned management team with combined experience of 50 years in solar industry Dr. Nish Sonwalkar, Kevin Debasitis and Rick Lewandowski. 5. The company has created an alpha concept Minimum Viable Product for the deployment of blockchain secured resilient solar microgrids with peer to peer transactions. 6. The company has a highly scalable business model where solar power producers get connected to clean energy consumers using smart contracts and create a marketplace for energy transactions between producers and consumers, capitalizing like AirBnB on the rise of the "sharing" economy. 7. Similar companies like PowerLedger, LO3, Grid+, WePower are valued between $20 million to $40 million and most of these companies have raised significant funding from Initial Coin Offering (ICO).

REGULATORY INFORMATION

Disqualification

No disqualifying event has been recorded in respect to the company or its officers or directors.

Compliance failure

The company has not previously failed to comply with the requirements of Regulation Crowdfunding.

The company will make annual reports available at www.power2peer.com/annualreport in the section labeled annual report. The annual reports will be available within 120 days of the end of the issuer's most recent fiscal year."

COMPANY PREPARED FINANCIAL STATEMENTS FOR Power2Peer Inc. for the period Jan. 5, 2018 through December 31, 2018.

Power2Peer
Balance Sheet Standard
As of December 31, 2018

	Dec 31, '18
ASSETS	
Current Assets	
Checking/Savings	
BB5425	24,222.89
BBChk5409	12,882.94
Total Checking/Savings	37,105.83
Total Current Assets	37,105.83
TOTAL ASSETS	37,105.83
LIABILITIES & EQUITY	
Equity	
Crowdfunding	43,508.60
Shareholder's Contribu...	6,400.00
Net Income	-12,802.77
Total Equity	37,105.83
TOTAL LIABILITIES & EQUI...	37,105.83

Power2Peer

Power2Peer
Profit and Loss Standard
January through December 2018

	Jan – Dec '18
Ordinary Income/Expen...	
Income	
interest income	52.89
Total Income	52.89
Gross Profit	52.89
Expense	
Bank Service Charges	82.50
Hardware	169.38
Maintenance	807.95
Marketing	
Conference	1,007.75
Content Development	1,500.00
Travel Expense	428.73
Marketing – Other	6,448.31
Total Marketing	9,384.79
Meals and Entertainm...	821.04
Patent	140.00
Postage and Delivery	10.00
StartEngine	1,340.00
Transportation	100.00
Total Expense	12,855.66
Net Ordinary Income	-12,802.77
Net Income	-12,802.77

Power2Peer

Power2Peer
Statement Of Cash Flows
January through December 2018

	Jan – Dec '18
OPERATING ACTIVITIES	
Net Income	-12,802.77
Net cash provided by Operating Acti...	**-12,802.77**
FINANCING ACTIVITIES	
Crowdfunding	43,508.60
Shareholder's Contribution	6,400.00
Net cash provided by Financing Acti...	**49,908.60**
Net cash increase for period	**37,105.83**
Cash at end of period	**37,105.83**