NAD Grid

MANY YEARS AGO THE INTERNET CONNECTED THE WORLD OF INFORMATION. TODAY, NAD GRID IS CONNECTING THE WORLD OF ENERGY.

WHITEPAPER

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1. ABSTRACT

With electricity generation becoming more distributed and democratized, three issues have become more apparent and need to be solved. First, despite being physically connected, geographically distributed electricity generation and consumption lack intelligent connection to better align supply and demand in real time. This inefficiency leads to wasted generation and harm to the physical infrastructure. Second, end users increasingly want to have choices, but the market limits the ability of producers to identify and cater to specific market preferences.

There is a pressing need to connect producers with end users to elicit market clearance based on preferences and price points. Last but not least, the difficulty of gradually reduce emission because of the lack of more granular differentiation of generation among non-renewable sources; two nuclear power plants can have very different carbon footprint levels depending on the technology and equipment.

In this white paper we describe a platform that combines decentralized ledger technology (blockchain) and centralized services to enable peer-to-peer (P2P) exchange of electricity and provides an elegant and sustainable solution to the critical problems just described.

This platform has 3 core components:

1. A decentralized ledger as the foundation for the transactivelayer
2. Two centralized services, NAD Exchange and NAD OTC form the businesslayer
3. Userapps

A smart contract will be derived from either order matched in the NAD Exchange or final deal agreement from the NAD OTC. The derived smart contract will execute the monetary and electricity transaction on the decentralized layer.

Atthemomentofsmartcontractexecution,paymentisprocessedinthewayofbalancetransfer from buyer to seller inside of the shared ledger that the blockchain maintains. The utilities will then physically take in the specified number of kWhs from seller into the grid via actions from the smart inverter, immediately supplying the grid with the specified number kWhs requested by the buyer, through the smart meter—all while keeping other traffic intact and ensuring important safety metrics like load and frequency remain within a tolerable threshold. Similar actions are already taken when utilities receive solar generation surplus from households. Additional cross-utilities balance settlement is done if buyer and seller are located in different utility service areas.

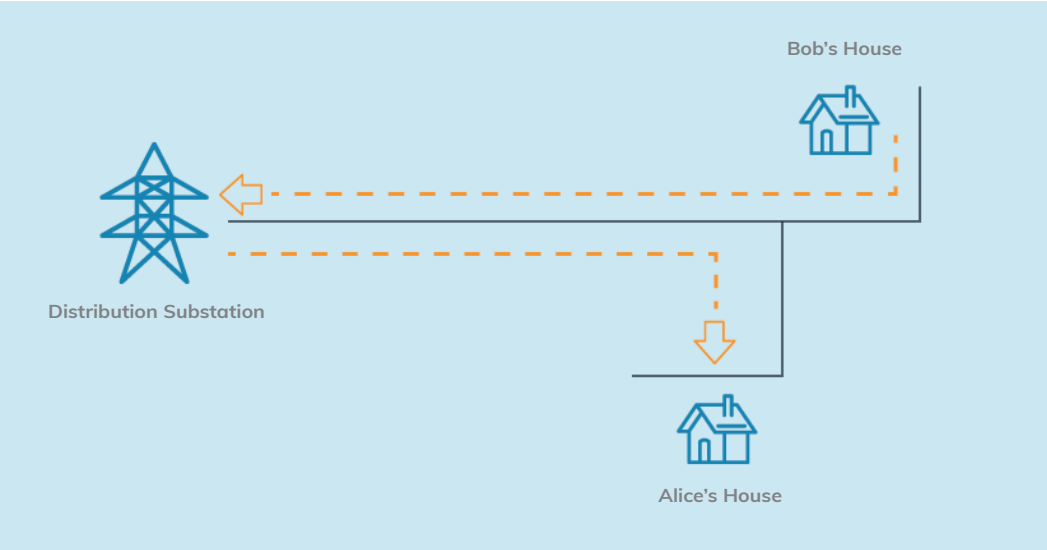

Figure 1. Transactive Flow within the Same Substation

Figure 2. Transactive Flow in between Substations

Currently, since utilities that do this are transporting power for buyer A and seller B as opposed to transporting electricity for itself, they are traditionally entitled to charge infrastructure costs. Customers participating in NAD will continue to use the physical infrastructure to receive and send power, and utilities charge a distribution fee for maintenance of the physical infrastructure as before.

This exchange platform can dramatically transform the efficiency, fairness, and novelty of electricity markets. This inspired our name, NAD, which comes from Nicotinamide Adenine Dinucleotide, one of the two essential biological electron carriers in photosynthesis.

2. INTRODUCTION

The supply of electricity was historically considered a natural monopoly, and a select few large players were given control. Over time, electricity generation was open to competition, but the infrastructure side of the grid remained monopolistic and managed by public utilities. Because of this, electricity is delivered to end users under a heavily regulated environment. New technologies and the widespread deployment of distributed energy resources (DER) are raising important questions to the way the grid is managed.

Hydroelectric power stations were built in the U.S. in the late 19th century, however mass adoption of renewable energy was curtailed by the growth of the coal industry and the development of subsequent forms of conventional non-renewable energy sources. Not until the late 20th century did large-scale renewable energy production emerge, because of price distortions, technological obstacles, and insufficient public awareness of environmental degradation in the intervening decades.

In recent years, the fundamental forces shaping the electricity market have shifted dramatically. Just over the past decade, solar panel installations have shown an average annual growth of 68%[1]. In 2016, solar became the top type of new capacity additions in the U.S. for the first time, including 7.7 GW of utility-scale and 3.4 GW of distributed systems, surpassing all other technologies including wind, natural gas, and coal. The declining costs, innovative financing, and policies such as the Public Utilities Regulatory Policy Act (PURPA), the Investment Tax Credit (ITC), and Renewable Portfolio Standards (RPS) are the main drivers of sharp increases in renewable energy capacity deployments.

2.1 ELECTRICITY SUPPLYCHAIN

This section briefly describes the traditional electricity supply chain to contextualize the extant problems we aim to address. The traditional electricity supply chain can be divided into four components: generation, transmission, distribution, and retail.

[1] https://www.seia.org/solar-industry-data.

2.1.1 GENERATION

Generation is the creation of electricity from fossil sources (coal, oil, and gas), nuclear sources (thorium and uranium), and renewable sources (solar, hydro, geothermal, wind, and tide). Generation predominantly takes place in centralized power plants owned by large investor owned utility companies like Duke Energy, AEP, National Grid, Southern Company, and others. In the US and throughout the world, electricity generation has predominantly been based on fossil fuels and Nuclear sources. However, for the past decade, renewable resources have increasingly become a popular choice for energy generation. As of 2016, the production of electricity from renewable sources has grown to account for more than 24% of the global electricity supply. Although DERs (Distributed Energy Resources) like household solar still account for just a small portion, current trends indicate DERs are poised to play an increasingly significant role in the US energy market of the future, especially as Community DER and Microgrids gain more legislative and regulatory support across the nation.

2.1.2 TRANSMISSION

Transmission is the delivery of electricity from power plants to distributors or local utilities. This interconnection is itself a grid and is monopolized by a few corporations. Power loss over transmission, often cited as incentive for more DERs, is minimal: for high voltage transmissions the loss is between 1.1% to 0.5%, even over thousands of miles.

With the introduction of numerous individual producers to the grid as well as power sourced from various parts of the US, consumers can expect a more reliable electricity supply at a competitive, stable price.

2.1.3 DISTRIBUTION

Distribution is the delivery of electricity from the transmission network to consumers. Distribution is essentially transmission at a localized, granular level. Power is delivered to households in a neighborhood via substations, poles, and lines owned by local utility companies.

2.1.4 RETAIL

Retail is the sale of electricity to consumers. Utilities sometimes take on the role of electricity retailer, and broker the electricity from generation to consumers themselves to charge a margin on top of the wholesale price they receive from the generation companies.

With the introduction of an electricity exchange directly accessible by both producers and consumers, the retailer or broker is removed, thus reducing utility bills for consumers. Electricity producers could also participate in both real-time and day-ahead markets at a price they set.

2.2 REGULATED MARKETS VS. DEREGULATEDMARKETS

Regulated markets feature vertically-integrated utilities that own or control the entire supply chain from generation to retail. Regulated markets are highly monopolized and leave customers with no ability to shop for energy provider. Regulated markets dominate most of the Southeast, Northwest, and West (excluding California) of United States.

Conversely, in deregulated markets, utility companies divest ownership in generation and only operate in transmission, distribution, and retail. Electricity generators sell electricity into a wholesale market and utilities purchase electricity to sell it to customers. Utilities differ in whether they are responsible for some or all of the transmission, distribution, and retail categories. So far, 24 states (including most Northeastern states, Illinois, Texas, and California) have introduced deregulation to open up generation for competition. Of these states, 18 have introduced retail choice, which allows consumers to choose their own energy provider.

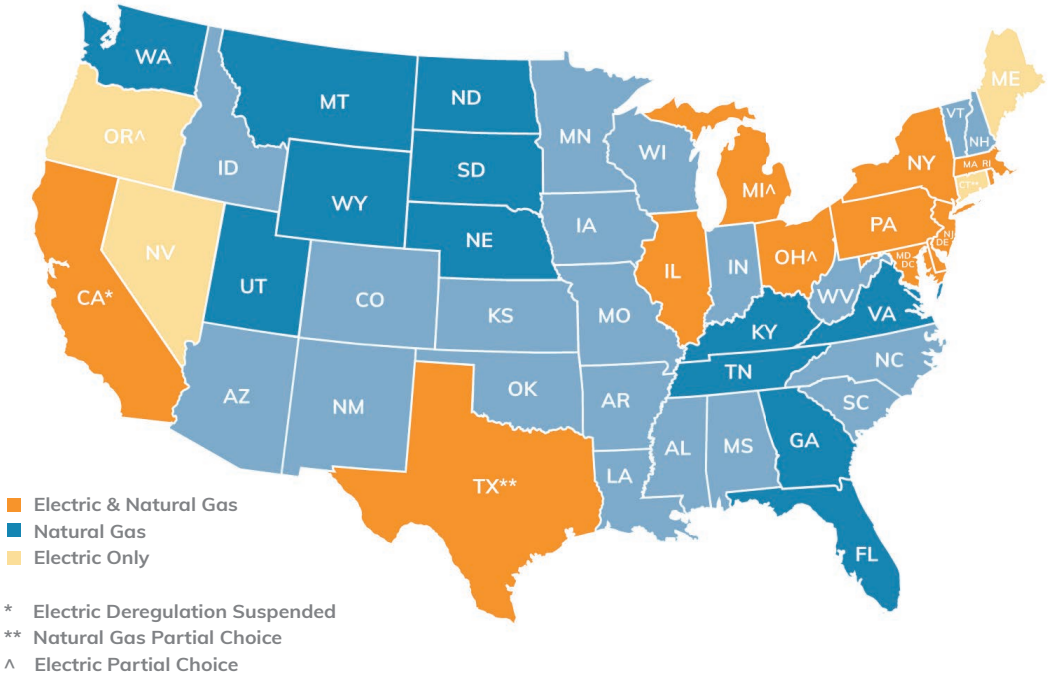

Figure 3. Regulated and Deregulated Markets
(Image Source: www.deregulationofenergy.com)

2.3 NETMETERING

How do energy prosumers (consumers who both consume and produce energy)which have installed renewable energy systems interact with utilities? The short answer is that they can sell electricity to the grid when they produce a surplus. PURPA requires most utilities to buy the electricity produced by non-utility (residential, small commercial, and community-owned)

qualifying facilities, whenever the price is not higher than the applicable "avoided cost" rate. PURPA was passed to encourage energy efficiency and renewable electricity investments, among other things. When consumers generate electricity from solar panels, it reduces the amount of energy they purchase from utilities and lowers their monthly electricity bills. If the renewable energy system produces more energy than needed at a given time, the excess power can be exported to the grid. The energy exported is then credited at a price determined by state regulation and can be deducted from the consumer's next or future bill in the same calendar year.[2] Currently, the accounting of the energy that prosumers take from and export to the grid is done by a process called "net metering". This process involves a bidirectional meter that spins forward to track electricity taken from the grid and backward to track exported electricity, thus measuring the net electricity consumption.

However, net metering might not be a sustainable solution for consumers, utilities, or the electric system. Net metering was initially a niche practice enacted to encourage distributed energy resources (DER), such as solar installations, but with increasing rates of solar penetration it is becoming a widespread practice. A growing number of reports are showing that the revenue required to maintain the fixed costs of the grid must come from the shrinking base of non-participating consumers.[3] Either non-participating consumers or utilities are essentially subsidizing solar power prosumers. Without changes, allowing more and more prosumers to participate, this model will become even more unsustainable when solar power penetration further grows in the future.

Due to the limitations of the Net Metering policy, solar panel users are unable to actually profit from surplus energy they produce. They are, instead only able to discount their electricity bills andanysurplusislost.Asaresultnewsolarinstallationsaregenerallysize-limitedtoasizethat roughly covers the owner's typical power consumption, an estimation from analyzing past electric bills. On average, less than a third of roof real estate is utilized for solar for single family houses. With alternative buyers offered through the exchange, customers can opt out of Net Metering policy and fully utilize their entire roof to be a true electricity producer, rather than mainly saving cost by covering typical usage with solar. This is beneficial to both consumers and solarcompanies.

2.4 UNSATISFIED CONSUMERPREFERENCES

Consumers currently only have one source to trade electricity, and this source originates from local utility companies. For example, rooftop solar users only have one option when they produce more electricity than they can consume: sell it back to the grid at a fixed price. The existing mechanism is problematic for its inefficiency, unsustainability, and lack of alternatives. Our P2P electricity exchange platform provides individual producer and consumer with an alternative: trade electricity with your peers in a dynamic, efficient, zero-fee, clean-energy-friendly market.

[2] The specifics of these arrangements, including the price at which exported electricity is credited, vary from state to state, and are typically negotiated between state regulators and electric utilities.
[3] http://www.emrf.net/uploads/3/4/4/6/34469793/emrf_net_metering_study_11-12-16.pdf.

3. VALUE PROPOSITION

NAD offers a cutting-edge solution to the problems described above, namely the costly lack of alignment between electricity demand and supply, and the extreme limitations on consumer choice. Our mission is to establish an efficient P2P electricity exchange that immediately creates significant value to consumers, electricity producers, electric grid operators, and the environment in eight ways.

1. Discourages over-generation with fair market price
2. Reduces harm to the grid with real time alignment of supply and demand
3. Improve reliability of service by enabling electricity sourcing from multiple suppliers
4. Reduces electricity rate by competition
5. Increased revenue from more electricity production for residential solar users
6. More demand response savings with real time prices
7. Gradual carbon emission reduction with Selective Sourcing
8. Sustainably promotes cleaner energy generation by differentiating with carbon footprint levels and directly linking demand to the different levels

In the short term, we propose a P2P electricity exchange market that features:

- **Zero Transaction Fee:** NAD provides customers with a cost-effective electricity exchange platform and supports tremendously large numbers of transactions.
- **Convenience and Transparency:** NAD gives customers easy access to trading electricity and keeps all transactions transparent with advanced Blockchain technology.
- **Selective Electricity Sourcing:** On NAD Network, producers are obligated to label their energy source with a carbon footprint grade. The carbon footprint grade is the amount of carbon dioxide, methane, and nitrous oxide emitted in kilograms per kilowatt-hour (kWh) of electricity generated. Most people may not be aware of the fact that 0 emission doesn't yet exist. Solar panel currently ranks as the 5th cleanest energy production method after hydro, nuclear, wind and biomass. Traditional sources like nuclear, coal, and gas have varying levels of carbon footprint dependant upon the generator's method of conversion, equipments, etc. Consumers should have the ability to specify an overall cleanliness with a carbon footprint grade for their electricity consumption profile. A known use case here is to provide a platform for P2P clean energy transactions which appeals to consumers or firms that are either environmentally-conscious or are affected by carbon markets. An example here would be an electric vehicle charging station which is programmed to source only zero carbon footprint electricity, and thereby achieve truly zero emission.
- **Centralized Exchange and OTC Transaction:** Users have the freedom and convenience trading electricity either through NAD Exchange, a centralized exchange with real-time market price, or through NAD OTC, by negotiating price with the counterparty and execute the transaction with smart contract.

In the longer term, we aim to achieve the following:

- **Create a Power Efficient Electricity Market:** NAD will build up a de facto free market and maximize the efficiency of energy market.
- **Resolve Reliability Problems:** NAD will help to resolve the existing reliability problems and maintain a stable electric system.
- **Encourage Faster Adoption of Renewable Energy:** NAD will encourage the adoption of geographically-distributed generation points for all major forms of renewable energy like solar, wind, and hydro. This overcomes the unreliability of energy source due to variations in local weather, hence significantly improving the consistency and reliability of the entire web of renewable energy generation.
- **Incentivize Distributed Storage of Renewable Energy:** NAD's easy and efficient free trade of electricity will incentivize individuals and entities to install distributed storage, which will further promote renewable energy.

4. TECHNICAL OVERVIEW

4.1. WHY BLOCKCHAIN?

The future of the market is the autonomous control and management of trading for physical-world resource allocation such as electrical power, as Melanie Swan states in the Blockchain: Blueprint for a New Economy. A tradenet like NAD is built upon Blockchain technology and has the ability to assess dynamic supply and demand and automatically execute or trigger transactions in a trustless environment. We have witnessed a variety of blockchain applications in the financial sector that helps better clearing/settlement and auditing. We believe that these use cases are common between the financial sector and the energy sector. The energy sector is a big market that have not yet seen many disruptions both logically and financially.

4.1.1. ZERO COST

Energy trading in the electricity market operates at a high frequency with the availability and price of energy in the market changes every minute. As a result, numerous low-value payments are made across the network. Under such circumstances, traditional payment methods which charge a fee based on a percentage of the transaction amount (or even worse with a flat fee component) are not ideal: over the course of the fiscal year, these transaction fees total to a significant amount. Even some existing public Blockchain technologies such as Bitcoin and Ethereum charge fees to reward the miners who coordinate the network.

Table 1. Comparison of Transaction Fees

VISA	PAYPAL	BITCOIN	ETHEREUM	NAD
1.43%~2.4%	2.9%+$0.3	>$2.5 (unstable)	<$1.4	ZERO

[4] Swan, Melanie. Blockchain: Blueprint for a New Economy. O'Reilly, 2015.

Our vision is to leverage the consortium blockchain technology and build a zero-fee transaction platform that facilitates thousands of simultaneous micro-transactions without price distortions. We will describe below how we will implement this vision via the NAD Lattice.

4.1.2. SECURITY AND CORRECTNESS

The central theme of Blockchain technology is the decentralized ledger of transactions that's fully replicated onto every node in the network. Double-spending is thus difficult to achieve if the majority of nodes in the network are honest and are doing their verification in earnest. Security is also a hallmark of Blockchain technology, as an attack of any kind in the NAD Lattice requires a swarm of computation power of more than 51% of the participants in the network. In addition, in a consortium blockchain where identities of all participating peers are known, conspiring evil attacks is just not a wise move as the identity of the attacking party would be revealed by others in the network during auditing.

4.1.3. TRANSPARENCY

All information about every transaction between a user's account and other accounts is transparently recorded in a global ledger. All transactions involving a particular account in the global ledger can be reviewed at any time by the account owner.

4.1.4. PRIVACY

Privacy and transparency, though seemingly conflicting, are likely to coexist in the blockchain. One could confidently rely on cryptographic primitives and secure multiparty computations to guard personal trading data (energy consumption data) and while at the same time be open for auditing.

4.2. DESIGN APPROACH

4.2.1. THE MECHANISM OF NAD

As energy generation becomes more decentralized and distributed, the system will need both physical and topological connections to remain reliable and robust. NAD will be the interconnected software overlaying the physical connections which coordinates the generation and consumption nodes for optimal efficiency. NAD can be built on top of the existing grid infrastructure and consists of 4 components: the NAD Lattice, NAD Exchange, NAD OTC, and graphic user interfaces.

Users will have easy access to energy trading by logging into either the app or desktop visual interface which communicates with the NAD Exchange. The NAD Exchange is the backend service for the app and desktop interfaces which collects and quotes different real-time electricity bid ask prices, similar to stock market. In addition, all ask orders are required to label the carbon footprint of their energy source. Once the NAD Exchange matches two parties with

a transaction, the result will be normalized into a smart contract that automatically executes with the payment completed on the NAD Lattice, a zero-fee, decentralized Blockchain payment network.

Alternatively, current conventional private negotiation will continue to be supported and made simpler by NAD OTC. Counterparties meet, negotiate, and settle on an agreement that gets normalized to a smart contract that executes in the NAD Lattice.

4.2.1.1 CONSORTIUM BLOCKCHAIN

Gretchen Bakke says in her book *The Grid*[5] that the power grid is by far one of the most sophisticated and completed machinery ever created by human beings. In order to stimulate the transition of the energy market from the traditional way to distributed way, we want to utilize this grid, and we want to bring joint forces of existing players in this domain together to push this forward. Therefore, we base our solution in a consortium blockchain.

Unlike public blockchains, consortium blockchains is a permissioned network. The majority of the network would have to agree to include a new member, and typically, participating member identities are known and thus can be audited and traced. Despite the difference in membership enrollment, consortium blockchain shares the same purpose and goal with public blockchain—maintaining a shared ledger and facilitate value transfer within an trustless environment.

A well-designed system in the energy sector should be expected to have high availability, maximum security, high throughput, and good scalability. Considering these criterion, a consortium blockchain is in all aspect a more reasonable choice.

In our particular setting, the members in the consortium network will be big players in the existing energy market. Namely, utilities, power retailers, distribution owners, ISOs, microgrid operators, and power plants. These players have the incentive to join the blockchain and take responsibility to maintain the network not only because it helps these existing players in terms of customer retention and customer acquisition, but it also opens up a lot of new business opportunities in the future. These opportunities include but are not limited to better DER valuation models, more flexible OTC energy deals, more green energy penetration, and more power storage penetration.

4.2.2. EXISTING GRID INFRASTRUCTURE

The current physical infrastructure of the electric grid is designed to support the traditional one-way energy flow from central power plants to customers. There are efforts across the U.S. to modernize the electric grid infrastructure, adding more sensors and communication to better support the shift in central power plants to many sites of local and distributed energy generation.

This physical infrastructure is currently owned and operated by electric utilities. The utilities of the future will continue to own and operate the grid and will have a challenge ahead in ensuring the safe, reliable, and optimal flow of energy as the grid becomes increasingly

[5] **Bakke, Gretchen. *The Grid: The Fraying Wires Between Americans and Our Energy Future*. Bloomsbury USA, 2017**

complex. Utilities are seen as the order maintainers of the shared ledger as well as keepers of the pipes and wires: they manage the operational requirements through the shared infrastructure while consumers exchange the generation and consumption of energy, making them prime users of the system where they are paid for coordinating energy flow and maintaining the stability of the grid. Utilities are viewed as partners in this effort and are integral to the future of NAD.

4.3. NAD LATTICE FOR PAYMENTS/CLEARING

NAD Lattice is the core payment network/balance clearing component in the NAD network system. The shared ledger keeps track of the balance of each end users in the system. When user A starts a transaction to pay to user B, the transaction is broadcasted to the network. Nodes in the blockchain will update the balances of both users in the shared ledger. By the end of a billing cycle, retailers (utilities) will review the shared ledger and lay down the bill to each users in its region. End users (households, commercial users) will receive their bills with their transactions on NAD Lattice reflected as an additional item in the bill. On receiving their bills, users are free to audit the ledger and verify the additional item in their bills.

In addition, cross-utilities clearing is also facilitated through the ledger. Imagine a scenario where buyer A from region A is matched with seller B from region B for X kWhs on the NAD Exchange, utility in region B is essentially taking in B's energy for free, and utility in region A is

buying more power and essentially giving it away for free to A at this point. The two utilities will need to settle these debits/credits. The use case of cross-utilities clearing is similar to cross-bank clearing which has seen a variety of innovations through blockchain technologies. Cross-utilities clearing will be done in realtime and since the process is done on the blockchain, there's no need of a third party.

4.3.1. TRANSACTIONS

4.3.1.1. VERIFICATION

One of the drawbacks of a public blockchain is the substantial amount of computational power that is necessary to maintain a distributed ledger at a large scale. Consensus process in consortium blockchains, however, is controlled by a pre-selected set of nodes on a voting-like basis, and can therefore support much faster and scalable transactions. See table 2 for a comparison of transaction speed in different payment systems as of 08/12/2017.

4.3.1.2. FAST AND CONSTANT SPEED AT SCALE

On top of fast and reliable transactions, the consortium blockchain architecture eliminates the need for miners and therefore enables free transactions. The balances in the shared ledger can be updated however frequently. At the end of a billing cycle, utilities lay down billing details according to the shared ledger. Users pay their power bills issued by utilities in the same way they've been doing for years, but with transaction details and debits/credits reflected. The lack of transaction fees is another advantage over traditional Blockchain systems where a small fee

is deducted from the amount transacted to award the miners for keeping the system running. Having no fees allows electricity buyers to purchase electricity at the optimal price when the amount of total electrical power is sourced from multiple sellers without worrying that the purchased energy is transacted at a higher price than its actual worth thanks to undue fees.

Table 2[6] .

BITCOIN	ETHEREUM	IOTA	PAYPAL	Visa
7 tx/s	10-20 tx/s	182.8 tx/s	193 tx/s on avg 450 tx/s peak	2000 tx/s on avg 56,000 tx/s peak

4.4. NAD EXCHANGE

The backend service of the exchange should behave similar to a stock exchange that focus on a single asset, in this case electric power or kilowatt-hour (kWh). This should be a highly available and scalable service focused on order-matching of the bids and asks for kWh.

4.4.1. SELLERS IN THE EXCHANGE

As mentioned previously, sellers will be asked to label their electricity carbon footprint grade. Without labeling, only consumers without a carbon footprint grade constraint will be potential buyers.

4.4.1.1. MARKET ORDER

This is more or less similar to a market order in stock exchanges. The electricity behind the market order will be sold to the highest bidder.

4.4.1.2. LIMIT ORDER

Storage capacity will be required for limit orders for selling electricity. The storage can be private storage on premise or grid storage that's part of local utilities infrastructure. This is another possible revenue source for utilities, which is renting out their grid storage.

4.4.2. BUYERS IN THE EXCHANGE

The only decision buyers need to make is if to use the selective sourcing feature or not. Whether or not this constraint is set, client application will automatically source the cheapest electricities given the constraints.

[6] **Figures are retrieved from:**
https://www.tik.ee.ethz.ch/file/74bc987e6ab4a8478c04950616612f69/main.pdf;
http://www.altcointoday.com/bitcoin-ethereum-vs-visa-paypal-transactions-per-second/;
https://twitter.com/DomSchiener/status/858379721029111808

4.4.2.1. SELECTIVE SOURCING

This feature is specific to NAD Exchange.
When consumers selects a carbon footprint grade value for their selective sourcing strategy, the NAD system will construct a profile like the following (example).

20% - solar
15% - wind
42% - nuclear power plant A
13% - nuclear power plant D
10% - coal power plant E

The above profile should have an overall carbon footprint within the constraint Y set by the consumer.

4.5. NAD OTC CONTRACTS

Over the counter contracts are a traditional and popular way for large producers and consumers/retailers to trade electricity. This will continue to be supported but made easier in the NAD system via NAD OTC which can be thought of a programmatic contract that executes the final agreement of an over the counter deal.

Typical contracts are of the form, $X per k/m/gWh for a duration of Y. The X and Y are mainly the negotiation elements in an OTC encounter, and makes many of the other things standardizable. NAD OTC will be significantly easier and cheaper to construct than traditional paper OTC contracts.

4.6. APPLICATION & USER INTERFACE

There needs to be a centralized service collecting bids and asks and an app allowing users to manage, buy, and sell electricity. Graphical interfaces to ease participation in the exchange and management of account and activity will need to be implemented in Android, IOS apps, and as well as emerging smart home platforms such as Amazon Echo and Google Home. Market and limit orders equivalent for buying/selling electricity should be available.

5. EDEN TOKENS, ETHEREUM, AND SELECTIVE SOURCING

5.1. WHAT ARE EDEN TOKENS

Eden Tokens (EDN) represent access to the Selective Sourcing service where NAD system will build an electricity sourcing strategy based on a specified overall carbon footprint level.

Each Eden Token will represent the right of selective sourcing an amount of 10 kWh (kilowatt hour) via a specified carbon footprint level. By consuming one Eden Token, users can purchase electricity at any carbon footprint level they want.[7] As reference, according to 2016's consumption data published by EIA (Energy Information Agency), typical monthly consumption for residential is about 900 kWh, and for industrial is about 100,000 kWh.

The Selective Sourcing service behind Eden Tokens will be open to consumers from all sectors, and we expect strongest demand for the service from industrial and commercial consumers given the potential tax incentives receivable from reducing carbon footprint by using this service.

5.2. THE MISSION FOR EDEN TOKEN

For a very long time into the future, zero emission energy will need to complemented by traditional sources like nuclear and coal. With that reality, the NAD Grid team strives to provide a more sustainable way to promote zero emission electricity by creating a market and demand for them.

Selective Sourcing allows consumers to gradually reduce their carbon footprint. Eden Tokens will be used to access this service and indirectly motivate more zero emission electricity production.

5.3. ISSUANCE AND CIRCULATION

Eden Tokens will be generated with ERC20 ethereum smart contract. Ethereum will be used as the underlying network for Selective Sourcing. This is to be distinguished from NAD system internal electricity trading which will run on the consortium blockchain.

There will be a finite total of 4 billion Eden Tokens. 2,400,000,000 (60%) Edens Tokens will be sold through private and public token sale. The details of distribution will be further explained in Section 5.4.

At the token main sale, the exchange rate of ETH to Eden will be determined so that each Eden Token will approximately be valued at $0.02. Each Eden token gives its holder the right to use Selective Sourcing for 10 kWh.

5.4. EDEN TOKEN SALE

5.4.1. LAUNCHING ON EARTH DAY - 04/22/2018

On Earth Day of 2018, the Eden token will be offered to the public for the first time. The total number of Eden token is finite at 4,000,000,000.

[7] **Users still need to pay for the price of electricity. Users consume Eden Tokens for the selective sourcing service.**

2,400,000,000 (60%) Eden Tokens will be sold through private presale and public main sale. The overall hard cap for token sale is 42,500 Ethers, and private sale will be capped at 39,000 Ethers. The public token sale will be offered to the public on 04/22/2018, which is the Earth Day. This is to show NAD Grid's commitment to promoting clean energy and restoring a green world.

1,000,000,000 (25%) Eden Tokens will be reserved for future use, such as incentive programs for users and collaboration with other entities such as innovative utilities, solar companies, environmental organizations, etc.

The founding team will keep 600,000,000 (15%) tokens. These tokens will be time-locked and 25% of these tokens will be released respectively 3 months, 6 months, 9 months and 12 months after the token sale.

Our targeted Eden Token Sale will have a 10 million USD soft cap, which is the rough estimate of cost to get to the pilot stage which we plan to get to within a year. We will commit whatever is left after building the product to scaling the platform and service first regionally in the US, then nationally and internationally.

5.4.2. EDEN(EDN) TO ETHER(ETH) EXCHANGE RATE

1ETH : 35,000 EDNs
Or each EDN is 0.00002857 ETH

5.4.3. CAPITAL ALLOCATION

Below is a preliminary estimation of the development cost of the NAD Network. All funding raised exceeding the estimated budget will be spent on scaling NAD Network and services nationally.

Total: $9,500,000

- Software Engineering: $4,500,000
  - Decentralized transaction layer: $1,500,000
    - Decentralized ledger: $400,000
    - Clearing system: $100,000
    - Smart meter interfacing: $500,000
    - Smart inverter interfacing: $500,000
  - NAD Exchange: $1,000,000
  - NAD OTC: $1,000,000
  - Selective Sourcing: $1,000,000
  - Application/User Interface: $500,000
- Utility Customization: $500,000
- Initial User Acquisition: $2,000,000
- Marketing: $1,000,000
- Legal: $500,000
- Administrative: $500,000

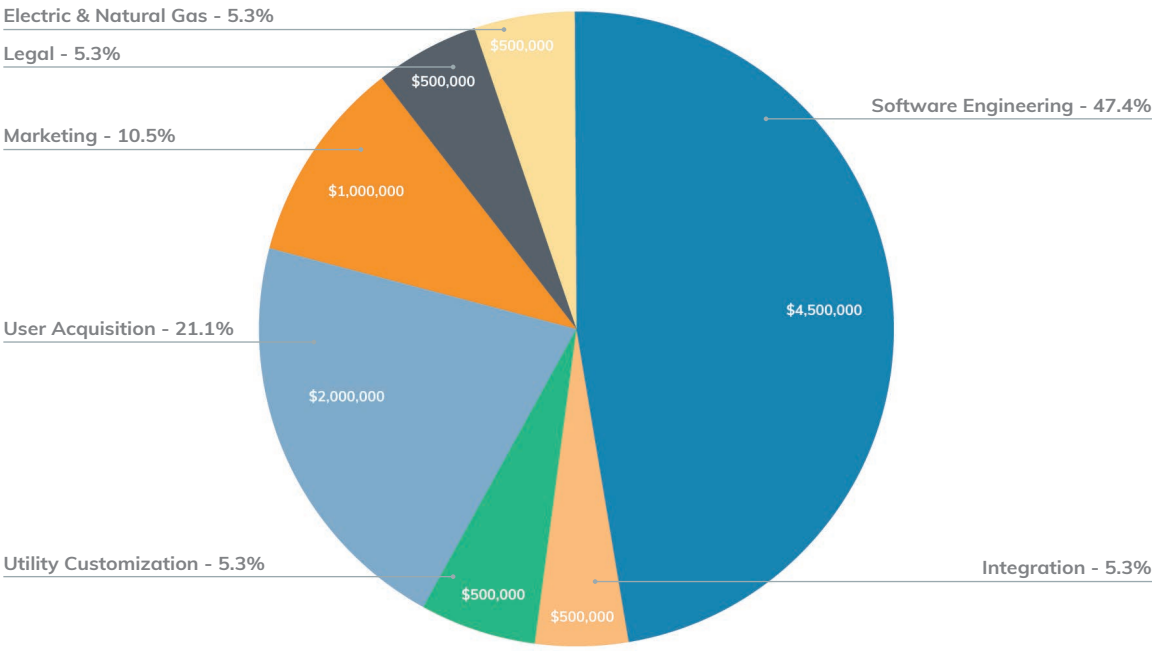

Figure 4. Capital Allocation

6. BUSINESS MODEL

6.1. SELECTIVE SOURCING

Our selective sourcing feature provides easy access to government policy compliant electricity, and this could be highly beneficial to industry level consumers. A percentage cut can be taken from total value of electricity sourced using this feature. Not using this feature simply means no requirement on carbon footprint grade for the electricity, and no fee would apply in such case.

6.1.1. USE CASE: TRUE ZERO EMISSION SOLUTIONS FOR PUBLIC BUS SYSTEMS

Technology developments in battery electric buses are turning them into viable competitors with conventional diesel and natural gas units, and many transit agencies in the U.S. are either experimenting with pilots or moving to large-scale deployments. Consider the case of Los Angeles Metro, which has been mandated to transform its entire fleet to battery electric units by the year 2030. NAD would make it possible for this fleet not only to have zero emissions at the tailpipe, but to actually achieve true zero emission mobility by sourcing it with renewable energy.

Using numbers from 2014, there are a total of 872,027 buses in the US. Each bus runs on average about 5,000 miles a year. If running on electric power, each mile could cost on average approximately 50 cents. The total cost of the electricity needed to power an all electric bus fleet of 2014's size, would be $2,180,067,500. If NAD Grid takes a 1% cut for using the selective sourcing feature, we would receive an annual revenue of $21.8 million from this single project.

6.2. DEMAND RESPONSE

Many industrial and commercial processes are becoming more automated, and some like Tesla are building fully automated factories. The enormous amount of electrical power needed by these industrial and some commercial consumers not only cost a lot of money, but can put unnecessary stress on the grid.

Demand response is optimizing these processes by running them when electricity price is low or when overall demand is low, and shutting them off when electricity is more costly or supply is short.

With real time electrical price information from the NAD Exchange, we can offer the most optimized demand response service that not only save millions of dollars for these consumers but also help keeping the stress on the grid within tolerable range.

6.3. OFFERING ANALYTICAL REPORTS AND DATA

Massive amount of interesting data will be collected by the exchange infrastructure. When jointly analyzed with other data sources, useful results could emerge that will benefit customers, utilities, and research. An example here is more granular data on consumer preferences and demand will be available with exchange transaction data that aren't previously available, and can help utilities to optimize investments to better serve these preferences and demands.

Our plan is to sell beneficial data features to customers and utilities and to anonymize and donate the raw data for research purposes.

6.4. RELIABILITY SERVICE

6.4.1. THE UNPREDICTABILITY OF SOLAR AND WIND

It's obvious to see that we can never completely depend on solar panels or wind turbines due to the unpredictable nature of weather. More reliable sources of energy generation will need to pick up the "slack" when the weather's not cooperating.

As it turns out, this is a very hard problem. The power plants which supply electric power in the place of solar or wind energy are generally nuclear or coal-based and are very slow and expensive to start up. If these power plants are kept running when there's no demand for the electricity they produce, a lot of electricity will be wasted due to the lag of power storage

technology at the moment. For power to be reliably supplied by these power plants when solar and wind energy are unavailable, these power plants will need to accurately predict the weather many hours in advance, which is not currently not possible. On top of that, many regions have weather that changes far too often for the power plants to economically power on and off at the corresponding rate.

California has also the highest number of residential solar generations. Previous decades of stable and predictable electricity demand curve has been morphed into a curve that resembles a duck, and have caused severe problems for utilities in California. Experts have correspondingly called this phenomenon the “duck curve”.

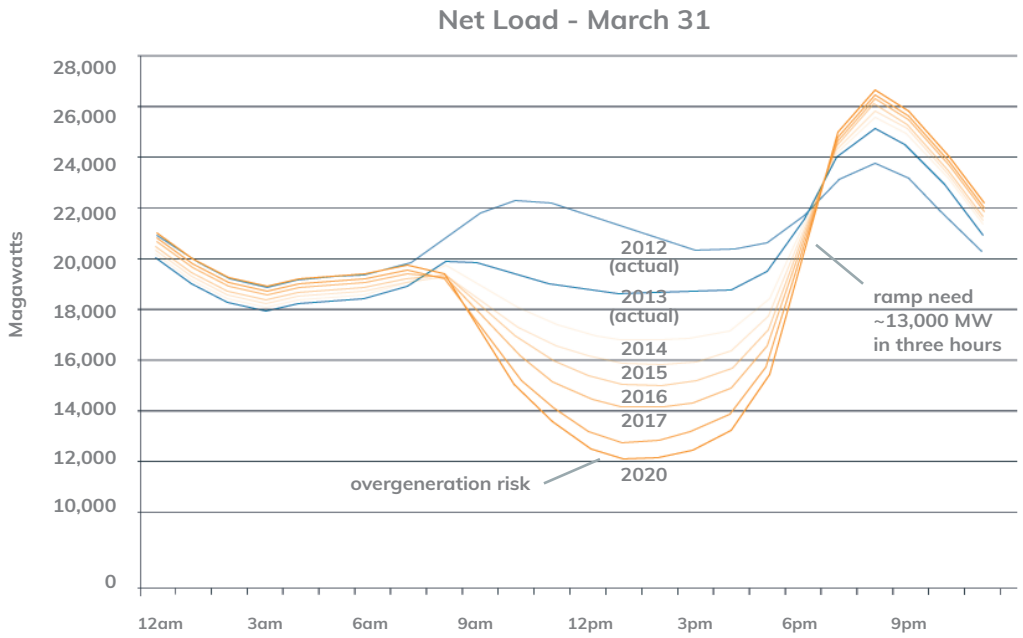

Figure 5. The CAISO duck curve from CAISO 2013

6.4.2. SMOOTHING OUT ELECTRICITY DEMAND

With the free market of the NAD Exchange, energy prices will automatically adjust to discourage production and encourage consumption when supply overshadows demand. This combined with other incentives could flatten the electricity demand curve in regions with high number of self producers. NAD Grid Corp will charge utilities a monthly service fee for this reliability service.

7. ROADMAP

7.1. PHASE 1: Q4 2017-Q2 2018

During Phase 1, the main focus for the entire team is to develop business partnerships, launch a pilot on a utility testbed, and build marketing plans.

The team will start with partnering with utilities in California and Illinois—two deregulated markets with different policies and climates. In addition to that, the team will also develop relationship with grid infrastructure vendors to seek insights for potential product integration. We will launch a pilot in a utility testbed in this phase too. The ideal testbed will be a microgrid and the pilot will consist of 3 milestones: dry-run/simulation with real data, small scale deployment, and eventually full-microgrid deployment. In parallel to the pilot, the software team will develop the NAD Lattice prototype and integrate into the pilot as a bookkeeping layer.

So far NAD Grid is on the track. We've had constructive progress in partnerships and pilot deal. More details will be disclosed in upcoming updates.

Q4 2017:

- NAD Grid was incorporated as a Silicon Valley tech company.
- The core team was built.
- Official website: https://nadgrid.com/ was released.
- Industry research was done. The team interviewed different market participants including energy traders, regulators, utilities, solar companies, power producers, and consumers.
- White Paper v1 was released.
- The team decided to switch to consortium blockchain from an IOTA architecture.
- Legal experts were engaged to ensure compliance.

Q1 2018:

- NAD Grid team pitched to large groups of audience at different big crypto events such as World Crypto Economic Forum and Blockchain Connect Conference. NAD Grid started to get lots of attention from the community.
- Redesign of the platform was finished. The new design completely switched to consortium blockchain, removed hardware dependency, introduced 2 layer system, and introduced Eden Tokan.
- White Paper v2 was released.
- The team met with regulators, big industrial players, and NGOs to negotiate future collaboration. NAD Grid is forming industrial partnerships with reputable and innovative entities in the energy space.
- Product development has been steadily implemented. Visualization design and integration test are underway.

Q2 2018:

- Earlier this quarter the Lattice prototype will be released and tested by simulation with real grid data.
- System visualization prototype release.
- NAD Grid will complete private token sale and public token sale (launched on April 22nd).
- Phase 1 of pilot launch - economic dispatch of single load in microgrid
- 5 additional engineers hired for work in NAD Exchange, NAD OTC
- UI & UX designers hired

7.2. PHASE 2: Q3 2018-Q1 2019

The software team will further develop the NAD Lattice MVP. The Lattice MVP will have basic functionalities, enabling large numbers of transactions. However, the Lattice MVP will be subject to further developments and changes based on rollout performances.

The software team will develop centralized exchange prototype from Q3 2018 to Q1 2019. The prototype will serve the initial customers acquired. The centralized exchange will be further improved in Phase 3.

The user interface will be developed from Q3 2018 to Q1 2019. Initial customers should be able to use it to make simple electricity exchanges. The functionality of the desktop and app will be enhanced according to customer feedback.

During this period, with the accomplishment from the pilot in Phase 1, we will establish an official partnership with one major utility company in a deregulated state. The local utility company will provide the physical infrastructure, run a full node in the NAD Lattice network, and the NAD Network will enable direct transactions among individual customers. Utility companies eliminate the risk of temporarily holding the electricity and continues to make a profit by providing and maintaining the physical infrastructure. We plan to acquire initial 10,000 customers in Phase 2. Customer acquisition will be a joint effort from both NAD Grid and the local utility.

Q3 2018

- The team will development of the NAD Lattice 1.0 complete.
- The team will development of the NAD Exchange 1.0 complete.
- Phase 2 of pilot - demonstrate economic dispatch for multiple load in microgrid
- UI & UX designs done.
- Hire a senior sales head
- Get 2 more utilities onboard

Q4 2018

- Lattice, NAD Exchange, NAD OTC 1.0 release.
- Phase 3 of pilot - full demonstration of NAD system in microgrid
- Complete development and test of UI
- Officially establish the first utility in the consortium
- Acquire 2 industrial or commercial consumers
- Acquire 1,000 residential users
- Initiate emission grading of power generation with government
- Hire additional PMs and engineers
- Expansion to UAE & South Africa

Q1 2019

- Improve system based on feedbacks from users
- Acquire 9,000 new users
- Emission level labeling of producers in current system
- Establish industry standard on carbon footprint grading of power generation
- Selective Sourcing trial with single consumer
- Demand Response trial with single consumer
- Hire additional PMs and engineers

7.3. PHASE 3: Q2 2019 -Q3 2019

During Phase 3, NAD will establish partnerships with two to three major utility companies in deregulated states and acquire 100,000-200,000 customers. NAD aims to become the dominant electricity exchange platform in two to three major markets in the U.S.

The software team will finalize the Lattice development. At the end of Phase 3, the Lattice will be a fully functional system that is able to serve tremendously large numbers of transactions. The security of Lattice along with other features such as auditing will also be enhanced overtime.

The NAD centralized exchange, OTC service, desktop interface, and mobile app will be finalized in Phase 3. The software team will continue to maintain and improve the services and apps.

Q2 2019

- BD team expands into different state
- Onboard 3-4 more utilities into the consortium
- Establish Legal & Policy division, Business Development division, Engineering division, Marketing & PR division, HR division.
- Hire senior machine learning expert, establish R&D team.

- Acquire 100,000 users
- Hire for the 4 divisions

Q3 2019

- Selective Sourcing generally available
- Demand Response generally available
- Established NAD dominance in 4 states
- Recruit 10 more utilities to join the NAD consortium
- System licensing to partner companies in UAE & South Africa

7.4. PHASE 4: Q4 2019 AND BEYOND

Over the long term, NAD will saturate utility companies' network in most regions in the U.S. and help each region to push for more green energy (solar, hydro, or wind) adoption. The NAD Network will be used by millions of market participants to trade power. At this point, the market will be mature enough to facilitate massive selective sourcing orders and OTC orders.

While NAD will still mainly focus on the U.S. market, it will begin targeting foreign markets and contribute to the global community.

8. CONCLUSIONS

We expect that with the expansion of NAD's coverage in the electricity market, eventually any entity, whether individual households, farms, utility companies, traditional electricity generators, or any other participants in the current electric market, will join the NAD Network.

The NAD Network is designed without additional hardware but leverage more of utilities existing infrastructure, and keeps US dollars as the currency for daily electricity or kWhs trading. These efforts keep disruption to consumer behavior to a minimum while offering the numerous additional benefits. Only Selective Sourcing will require the Eden token to access, but the feature will use the already popular Ethereum and provide a very simple and intuitive user interface.

Entry into the market will be easy for all participants (both buyers and sellers). Many more sellers of electricity, especially individual producers, are likely to emerge in the market given the low barrier to entry. We expect that a much larger number of market participants will intensify competition, which will result in a more efficient market, fair price of electricity, better quality of service, and more options for end consumers.

9. TEAM

9.1. KEY TEAM MEMBERS

9.1.1. THOMAS SUN

Tom is a long time Blockchain and cryptocurrency enthusiast and investor. Prior to NAD Grid, he was a senior software engineer at Twitter and led the internal interactive query project in the space of distributed computing. Since graduating with a B.S. in Electrical Engineering from the University of Illinois at Urbana-Champaign, Tom has worked in Goldman Sachs' equity trading department, Yahoo ads platform org.

9.1.2. GUSTAVO COLLANTES

Gustavo was a Sr. Technical Specialist in ICF, a global consulting and technology services company with a market cap of $1B. He is an experienced scientist and manager with interests in both technology and social sides of innovation. Prior positions include Research Director for the UC Davis Policy Institute for Energy, Economics, and the Environment, co-Founder and CEO of Logios, a small company dedicated to consulting and technology development in the renewable energy space, Senior Technical Advisor to the State of Washington and Chair of the Washington State Electric Vehicle Task Force, and Fellow at the Harvard Kennedy School. Gustavo enjoys the application of interdisciplinary rigorous approaches to address complex problems of high social and environmental impact. He is also an experienced leader, having developed and directed initiatives involving stakeholders at the state and national levels. He is a nationally recognized expert in transportation electrification, who led the planning and implementation of the first regional network of fast charging stations in the United States. Gustavo earned his M.Sc. on Aerospace Engineering from the Israel Institute of Technology, Technion and his Ph.D. in Transportation Technology and Policy from UC Davis. He has lived and worked in four different continents.

9.1.3. RUI ZHANG

Rui is an experienced legal and policy specialist skilled in structuring transactions, negotiating contracts, ensuring regulatory compliance, and providing policy analysis. Rui has counseled Blockchain-tech projects on business and regulatory issues, including White Paper release, public token sale, private funding, etc. Rui has served as corporate counsel in the headquarter of CITIC, one of the largest financial service companies in China for four years. Rui, who graduated from the Harvard Kennedy School of Government and the Cornell Law School, possesses a strong background in both law and policy. During her time at Harvard, Rui counseled Alibaba's research team on its U.S. investment strategy.

9.1.4. XIAOYAO QIAN

Xiaoyao is a Blockchain evangelist. He discovered Ethereum in early 2015 and has since dedicated a lot of efforts in creating Blockchain tools. He created the presto-ethereum project -- an analytic tool that allows you to run SQL queries on Ethereum data. Presto-ethereum was shared and stayed at rank #3 on Hacker News for the entirety of its first day of publication. Xiaoyao is currently a Computer Science M.S. student at the University of Illinois at Urbana-Champaign, with a focus in distributed systems and decentralized systems. Before this, he acquired a B.S degree in Computer Science from the University of Illinois at Urbana-Champaign and worked as a software engineer at Yahoo, leading the Flurry realtime metrics API development work.

9.1.5. HERVAL FREIRE

Herval is a serial founder, angel investor and software engineer with almost two decades of experience in the field. His achievements include building and architecting infrastructure for huge scales in some of the largest internet services (Twitter, SoundCloud and a few others as a consultant), as well as mission-critical enterprise systems (track & trace systems for multiple governments, derivative & stock trading systems). He currently leads the engineering team on Twitter's Infrastructure Site Reliability Engineering organization, and is a crypto investor since 2014.

9.2. ADVISORS

9.2.1. TAMER ROUSAN

Tamer is a leading strategist and expert in power and energy systems. He accelerated through the engineering, supervisory, and managerial ranks at Ameren Corp, while leading some of Ameren's most innovative and technologically advanced projects. In 2016, Tamer headed the design, engineering, and construction of Ameren's Utility-Scale Microgrid, the most advanced Microgrid in North America to date. Tamer has expertise in Self-healing networks, Smart Grid, Distribution Automation, Energy Efficiency, and DER Integration. Tamer holds B.S. and M.S. degrees in Electrical Engineering from the University of Illinois at Urbana-Champaign. He is the recipient of EPRI's 2014 Technology Transfer award.

9.2.2. LYDIA KREFTA

Lydia Krefta is Principal Product Manager, Grid Integration and Innovation, at Pacific Gas and Electric Company (PG&E). Lydia is leading in projects of Blockchain applications for energy and EV charging protocols and so far has managed two use cases to test Blockchain technology within the energy/utility industry while building out a long-term strategic plan for Blockchain applications for distributed energy. Prior to her current role, Lydia worked on corporate strategy, business intelligence, asset knowledge and integrity management at PG&E. Before joining PG&E, Lydia has worked for DreamWorks Animation, Tuition. Io, Norththrop Grumman Corporation, and Watt Disney Imagineering. Lydia received her MBA degree from

UCLA Anderson School of Management, and her B.S. in Engineering Science from Penn State University.

9.2.3. OREN SCHETRIT

Oren Schetrit was co-founder and CEO of whisker labs, a company developing the world's first peel-and-stick energy sensing technology. Earth Networks, a global leader in weather and environmental technology services, acquired whisker labs in October 2016. Oren now serves as Vice President of product management, leading development of sensing technology and software services. Prior to co-founding Whisker Labs, Oren led research and development

projects focused on internet-enabled building automation and energy analytics software at the Lawrence Berkeley National Lab. Oren received his MBA from Berkeley-Haas (academic achievement award - valedictorian), and bachelors in mechanical engineering and civil engineering (double major) from UC Davis.

9.2.4. DEV SHENOY

Dr. Dev Shenoy is currently Chief Engineer with Allegheny Science and Technology, a contractor to the U.S. Department of Energy (DOE). Prior to that, Dev served as Chief Engineer at DOE HQ. Dev is a co-author of DOE's 2015 QTR (Quadrennial Technology Review) that serves as blueprint for DOE's energy technology investments. Prior to joining DOE, he served as a Senior Advisor at the Manufacturing and Industrial Base Policy (MIBP) Office within the Office of the Secretary of Defense (OSD). In that role he co-led a Telecom initiative with the White House Office of Science and Technology Policy (OSTP) to explore U.S. opportunities to strengthen the supply chain for optical networks and wireless equipment. Prior to serving at the Pentagon, Dev was a Program Manager at the Defense Advanced Research Projects Agency (DARPA), where he developed and managed over $100 M in cutting-edge technology programs for defense and commercial applications. Dev has served on panels related to Machine Learning/Intelligence for the National Academy of Sciences and the Synergy forum. Dev also served on a panel hosted by Information Technology and Innovation Foundation (ITIF) on behalf of the Senate Manufacturing Caucus, to discuss Policy Implications for Manufacturing Jobs.

9.2.5. TIM TULLY

Tim Tully is the Chief Technology Officer at Splunk, a public company with a market cap of 9.38 billion dollars, where he collaboratively leads the evolution of technology across the company's entire product portfolio. He actively leads Splunk's architecture team of technologists and technology owners to define technical blueprints, roadmaps, and principles that drive day-to-day design decisions. Tim is an expert in machine learning and software architecture and infrastructure.

Prior to Splunk, Tim led the Flurry engineering group with responsibilities spanning the mobile developer suite, including Flurry Analytics and Yahoo App Publishing, and began at the

company as Distinguished Engineer / Architect for Yahoo's big data platform. Tim rose quickly through the ranks at Yahoo! to VP of Engineering, and eventually serving a total of 14 years at the company. Prior to coming to Yahoo, he held software engineering roles at Pillar Data Systems, iScale, Inc., and Sun Microsystems. He serves as a technical advisor to OpenGov, Inc., and EmbraceHer, a women's health care start-up. He holds three patents and received his B.S. in EECS from UC Davis, and his M.S. from Carnegie Mellon University.

9.2.6. MATT LECAR

Matt Lecar serves as Principal at Pacific Gas and Electric Company (PG&E). Matt is a veteran utility industry expert with a 20 year track record in venture capital, new product development,

international business development, and management consulting for utilities, investors, and start-ups. Matt recently rejoined PG&E in the ISO/FERC Relations team, where he is focused on the interaction of wholesale markets with distributed resources. Other areas of experience include renewable integration, microgrid design, distribution automation, and demand side technology (AMI, Demand Response, Home Area Networking, Business/Industrial Automation, Energy Efficiency, distributed renewables, plug-in vehicles, etc.). Matt received his Master in Public Policy degree from Harvard Kennedy School of Government, and B.A. in Physics and Political Science from University of California, Berkeley.

10. RISKS DISCLOSURE

This document does not constitute an offer or solicitation to sell shares or securities in NAD Grid Corp. None of the information or analysis presented is intended to form the basis for any investment decision. This document does not constitute investment advice or solicitation for investment in any security. This document should not be construed as an offer for sale or subscription of any security.

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Eden Token is a cryptographic token that represents access to Selective Sourcing service on NAD platform once fully developed. Eden Token is not a security and this is not an offer to sell security. Eden Token is not an investment and should not be purchased as an investment. At the time of this writing, Eden Token 1) cannot be traded for goods or services; 2) has no known use outside the NAD network; and 3) cannot be traded on any known exchanges. There is no guarantee that Eden Tokens will increase in value.

If you purchase Eden Tokens, you certify that you are doing so merely out of the intention to source electricity (kWh) on NAD platform through smart Selective Sourcing service once fully developed, or to participate in the NAD community. You certify that you are not purchasing Eden Tokens for any investment or other financial reasons.