GREENTECH

WHITEPAPER

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SOLMAG

A PIONEERING DECENTRALIZED SOLAR ECOSYSTEM
CONNECTING GLOBAL ENERGY SOURCES.

ENERGIZE. EVERYWHERE.

WWW.SOLMAG.IO

October 25, 2023
The Solmag Team

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INTRODUCTION

Solmag, the Decentralized Global **Energy Data** Platform.

Through Solmag, you can seamlessly monitor energy production, demand, and pricing from anywhere in the world.

It's a marketplace where surplus renewable energy becomes a valuable commodity, incentivizing the growth of clean power sources.

With smart trading tools and advanced algorithms, Solmag optimizes energy transactions, unlocking the full potential of your energy resources while contributing to a greener planet.

At its core, Solmag serves as a beacon of innovation, allowing individuals, communities, and businesses to access, share, and make informed decisions based on real-time data from a myriad of global energy sources. By decentralizing energy data and trading, Solmag brings *transparency* and *accessibility* to the forefront, empowering users to play an active role in the future of energy.

The end-to-end service proposed by Solmag takes the idea of **peer to peer energy networks** to the next level offering the entire suite of tools to finance, grow and sell clean produced energy between Solmag members.

Incorporating *blockchain technology* into Solmag ensures the reliability, security, and efficiency of the platform while reinforcing its commitment to decentralization, transparency, and sustainability in the energy sector.

Solmag is committed to emphasizing the people's power and building an ecosystem for energy independence.

ABSTRACT

"The foundation of Solmag's proposed model originates from the recognition that we cannot sustain continued growth and societal progress without addressing the fundamental flaws in our existing societal framework. While our focus has been primarily on individual growth, the planet's temperature continues to rise, jeopardizing the sustainability of life for both current and future generations. As a collective, it is imperative that we introspect and take immediate action to rectify the actions that have brought us to this critical point. In an ideal scenario, every individual would possess the knowledge and means to contribute to the cause. However, acknowledging that such utopian conditions are far from reality, Solmag offers a straightforward approach for everyone to participate actively in the movement aimed at reshaping the values that have led us to this juncture. To prevent the new system from succumbing to its own internal disorder, Solmag advocates for the creation of a four-tiered system. This system serves as the foundation for establishing an infrastructure that can be effectively documented and centralized, subsequently facilitating various layers of interaction among ecosystem users. These interactions encompass energy exchange and the purchase of energy tokens, allowing users to meet their energy requirements. Furthermore, this system accounts for the evolution and diversification of consumer types within the network over time, effectively adapting to the ever-changing needs of the community."

INFRASTRUCTURE, INTERACTION, CONSUMER, COMMUNITY.

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VISION

ENERGIZING FUTURE

We envision a future where every person, regardless of their background or location, embraces the incredible potential of having a Digital Energy Wallet (DEW) in their hands.

Solmag emerges as a testament to humanity's indomitable spirit and their insatiable quest for a brighter future. It symbolizes the fusion of technology and nature, as solar panels harness the sun's life-giving energy while the blockchain empowers individuals to participate actively in this revolutionary energy network.

Within this visionary concept, Solmag becomes a beacon of hope, inspiring unity and collaboration among nations and peoples. It sparks a global movement towards a sustainable future, where the limitations of energy scarcity and environmental degradation fade into obscurity.

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MISSION

ZERO TO NETZERO

We are on a mission to revolutionize the energy industry by creating a sustainable and **decentralized solar ecosystem** that empowers individuals and communities worldwide to generate, share, and benefit from clean energy.

The following steps will contribute to the successful realization of Solmag's mission:

- Poduct Development and Enhancement
- User Engagement and Community Building
- Global Expansion
- Technology Integration
- Education and Advocacy

At its core, Solmag is dedicated to empowering individuals and communities worldwide to harness the power of the sun. Our Mission it's a call to action for a future where solar power unites, where prosumers across the globe come together in a quest for sustainable energy.

Solmag's mission extends beyond energy. It's about fostering a community of environmental stewards through gamification and education. It's about aggregating sustainable power through a decentralized energy cloud.

The Solmag Ecosystem mission embodies the principles of sustainability, unity, and empowerment. It's a mission that speaks to our responsibility to our planet and future generations. As we journey through the challenges of climate change, Solmag's mission lights the way toward a greener and more resilient world.

PIONEERING SUSTAINABLE ENERGY

FOSTERING UNITY

AND DRIVING ENVIRONMENTAL INNOVATION.

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MOTIVATION AS A SOURCE

The world is facing a critical juncture in its history, as the consequences of climate change become increasingly severe, as set out in the **Paris Climate Agreement** [1]. **The Green Deal Industry Plan** [2] is putting Europe's net-zero industry in the lead, providing faster access to funding, a predictable and simplified regulatory environment, and open trade for resilient supply chains. By raising the EU's ambition on reducing greenhouse gas emissions to at least **55%** below **1990** levels by **2030**, the plan sets a bold and necessary target for decarbonizing the EU economy. This is not only helping to limit global temperature rise but also will create new opportunities for sustainable growth and job creation.

One key component of the effort to decarbonize our energy systems is the rapid deployment of renewable energy sources such as solar power. Solar energy is clean, abundant, and increasingly cost-competitive with fossil fuels. However, the current energy system is centralized, with power generated by large-scale power plants and distributed through a grid of transmission lines. This model is highly inefficient, vulnerable to disruption, and contributes to carbon emissions.

To address these challenges, a decentralized energy network map that connects solar panel prosumers is needed. By creating a Green Prosumers Community, we can harness the power of solar energy and enable individuals and communities to take control of their energy production and consumption. This will reduce reliance on centralized power systems, promote energy independence, and reduce carbon emissions.

JOIN THE SOLAR ENERGY MAP.

Become part of Industry 4.0

The Fourth Industrial Revolution emphasis the digital technologies and decentralized systems, provides an ideal opportunity to create a strong energy network. [3].

Contribute to the technological advancement

The Kardashev scale, which measures a civilization's level of technological advancement based on its energy consumption, indicates that we are currently at a level 0.73 civilization. By creating a decentralized energy network, we can take a significant step towards advancing to higher levels of civilization and achieving a sustainable future [4].

FOSTER ENVIRONMENTAL SUSTAINABILITY.

Minimize Carbon Emissions.

By leveraging solar energy, individuals and businesses can make a substantial impact in mitigating climate change by reducing carbon emissions and promoting a more sustainable and low-carbon energy system [7].

Promote sustainability

Using blockchain technology and community-driven participation, this market empowers individuals and businesses to actively contribute to a greener and more sustainable energy ecosystem.

WORLD ENERGY **TRILEMMA**

Solmag strives to incorporate individuals into the energy landscape while addressing the intricate challenges presented by the energy trilemma. It actively contributes to the cultivation of precisely balanced energy systems [9]. The World Energy Trilemma Index, issued annually, assesses the effectiveness of national energy systems in each of the three dimensions comprising the trilemma.

Figure 1: World Energy Trilemma

UPGRADING FROM LEGACY TO MODERN WEB2 & WEB3 SYSTEMS

The **Solmag Ecosystem** introduced an overarching layer that covers a significant portion of the tools within the energy network.

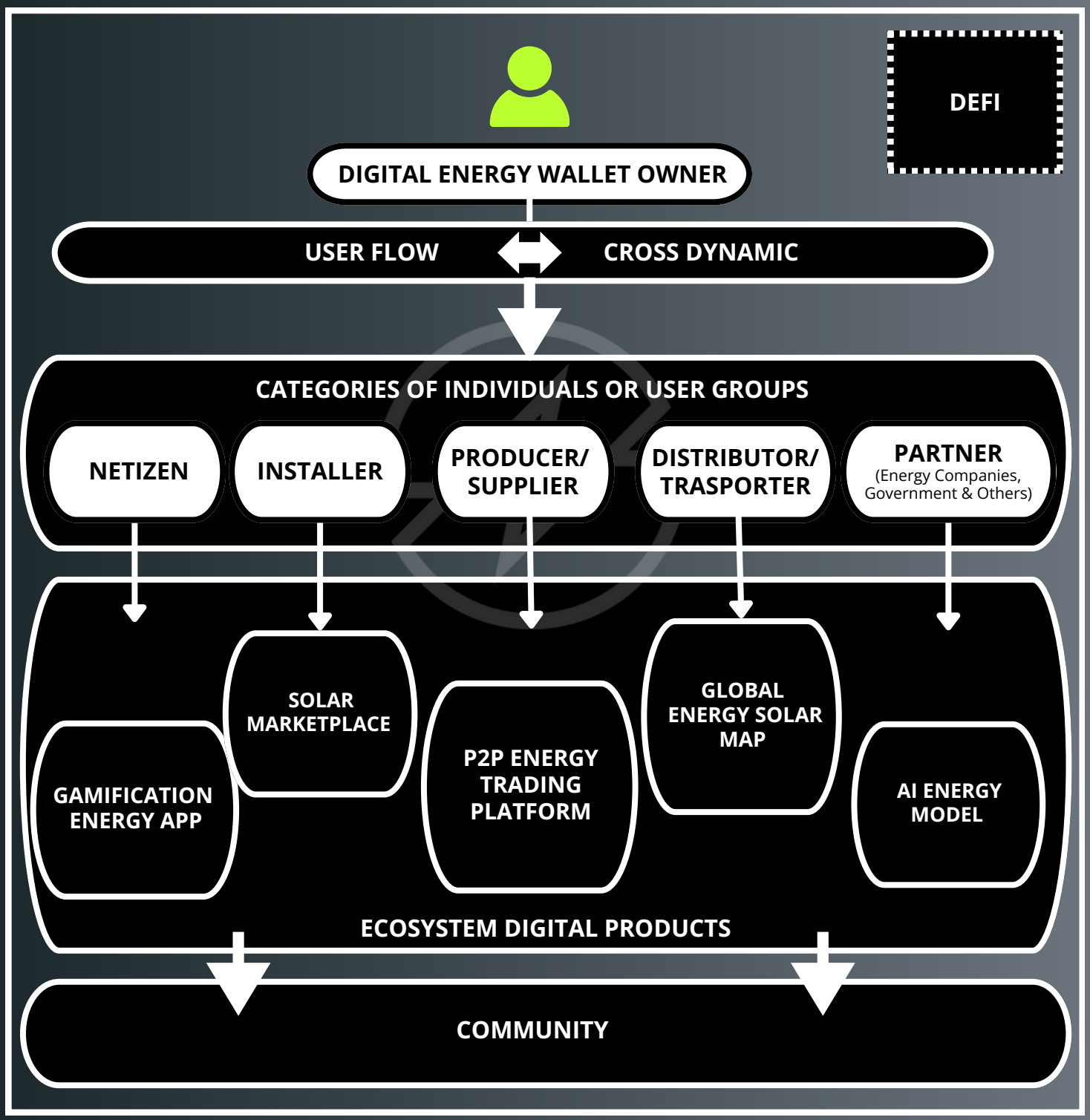

Figure 2: Solmag Ecosystem

NAVIGATING THE MARKET LANDSCAPE WITH PRECISION.

The current state of the prosumers market

- Limited access to information and expertise which can lead to regulatory barriers and policies
- Prosumers may face technical challenges related to installation and use of the solar panels, maintenance and integration of renewable energy system to the grid
- The public awareness for the potential of prosumers to contribute to a more sustainable energy system
- Where to find financing and cost issues

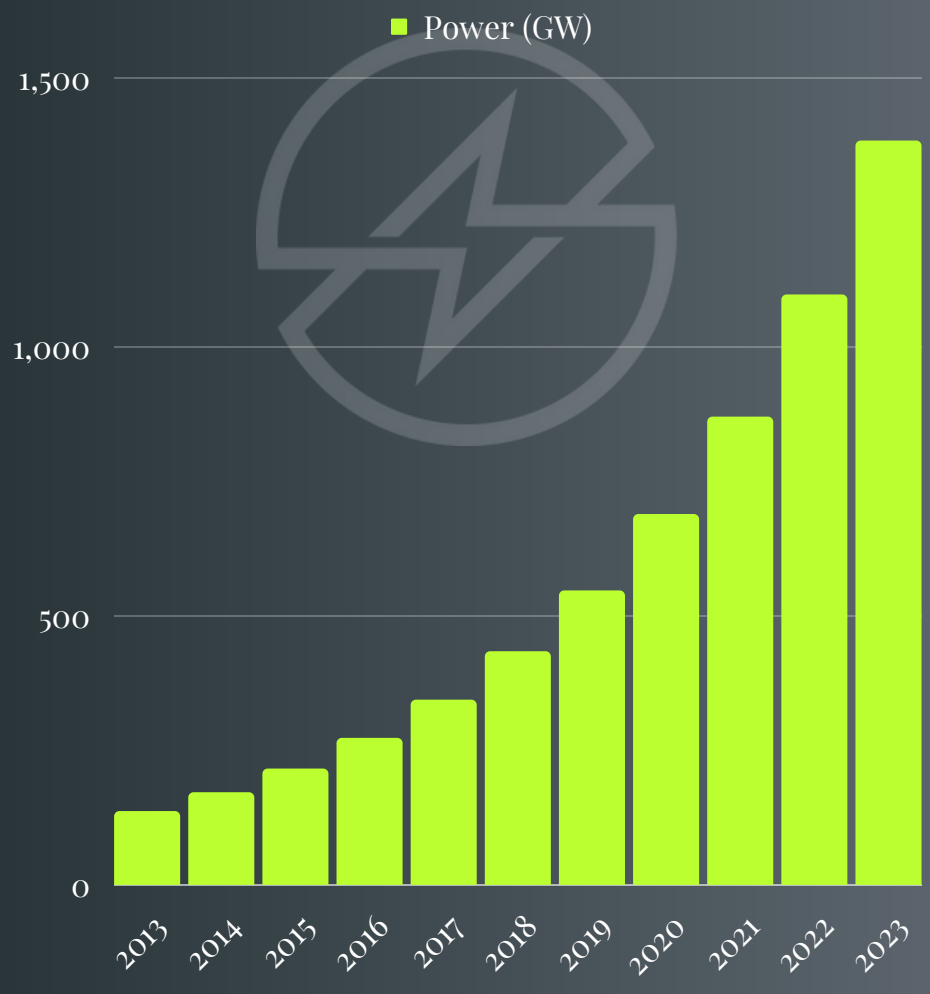

Figure 3: Evolution of the solar energy intalled in the world

Furthermore, solar energy production has experienced a significant increase in the past ten years, corresponding to the growth in capacity. Presently, the production level has exceeded x10 compared to its 2013 value [14].

From a total TW solar fleet today, the world could be installing 1 TW of solar annually by the end of the decade – hitting up to 800 GW per year already in 2027. [15]

CHANGING COUNT OF PROSUMERS ACROSS EUROPE

Solar energy represents an affordable, environmentally friendly, adaptable, and scalable source of power. Currently, it stands as one of the most cost-effective renewable energy options available, rendering it highly accessible for households throughout Europe. In 2020, solar energy accounted for 5.2% of the European Union's overall electricity generation. Considering the prevailing market patterns, it holds the capability to fulfill as much as 20% of the EU's electricity requirements by 2040 [10].

For instance, in the Netherlands, the number of photovoltaic (PV) prosumers surged from under 500,000 in 2015 to over 1 million in 2020. Similarly, Portugal witnessed an increase from 3,000 to over 30,000 PV prosumers in 2019. In Poland, the number of prosumers expanded from 51,000 in 2018 to 847,000 in 2021, boasting an installed capacity of nearly 6 GW, as reported by URE in 2022.

ORGANIZING PROSUMERS INTO ELECTRICITY TRADING COMMUNITIES

Costs to attain electricity transfer limitations and self-sufficiency goals

This study investigates and compares the costs incurred by individual households and households organized in electricity trading communities in seeking to attain greater independence from the centralized electricity system. This independence is investigated with respect to:

(i) the potential to reduce the electricity transfer capacity to and from the centralized system and
(ii) the potential to increase self-sufficiency. An optimization model is designed to analyze the investment and operation of residential photovoltaic battery systems.

The model is then applied to different cases in a region of southern Sweden for year 2030. Utilizing measured electricity demand data for Swedish households, we show that with a reduced electricity transfer capacity to the centralized system, already a community of five residential prosumers can supply the household demand at lower cost than can prosumers acting individually. [16]

The advantages of forming an electricity trading community among residential prosumers become more pronounced when there is a limitation on electricity transfer capacity, as opposed to a primary focus on achieving complete self-sufficiency. It is essential to take into account the localized utilization of photovoltaic-generated electricity and its influence on the net trading dynamics with the centralized system when assessing the implications of a significant prosumer presence on the electricity grid.

SOLMAG ECOSYSTEM PRODUCTS

ALL THE PRODUCTS ARE IN A CONTINUOUS STATE OF DEVELOPMENT.

We will provide a concise summary here, followed by a more detailed description for each point in subsequent sections. We will aggregate all the Solmag Ecosystem products into the main project. - **Solmag.io**

Solar Marketplace - Solmag.eu

A solar marketplace serves as a pivotal platform that connects two crucial stakeholders in the renewable energy ecosystem: professional installers and prospective prosumers or producers. This marketplace is designed to streamline and facilitate the process of transitioning to solar energy by providing a well-structured environment for these two parties to engage in mutually beneficial transactions and collaborations.

Global Energy Solar Map - Map.solmag.io

A global prosumers map is a representation of individuals, businesses, and organizations worldwide who actively participate in the production and consumption of energy. This map provides information on prosumers' locations, energy generation methods, consumption patterns, and their involvement in energy trading or sharing, offering insights into the global distributed energy landscape.

Peer to peer Energy Trading Plattform - (Coming Soon)

A Peer-to-Peer Energy Trading Platform is an innovative digital system that facilitates the direct exchange of surplus energy between individual users within a local energy network. It allows prosumers, those who both produce and consume energy, to sell their excess energy to other participants, or even buy energy as needed, all without the traditional intermediary of a central utility company. This platform typically employs blockchain or smart contract technology to ensure secure, transparent, and automated transactions. By enabling users to trade energy locally, it fosters a more decentralized and sustainable energy ecosystem while providing economic benefits to participants and promoting the use of renewable energy sources.

Gamification Energy App - (Coming Soon)

A Gamification Energy App is a mobile or web application designed to engage and motivate users to manage their energy consumption more efficiently through the integration of game-like elements. These apps leverage principles of gamification, such as challenges, rewards, competitions, and interactive features, to make energy conservation and sustainable practices more engaging and fun. Users can set energy-saving goals, track their usage, earn rewards or points, and compete with friends or peers in a virtual environment. Gamification Energy Apps not only raise awareness about energy efficiency but also encourage users to adopt greener habits, ultimately contributing to a more sustainable and eco-friendly lifestyle.

AI Energy MODEL - Trained for Energy Data - (Coming Soon)

An AI model trained for energy data is a sophisticated computational system designed to analyze and interpret vast amounts of data related to energy production, consumption, and distribution. This specialized model is trained using machine learning techniques to recognize patterns, make predictions, and extract valuable insights from diverse energy datasets. Its primary purpose is to enhance decision-making processes within the energy sector by providing accurate and actionable information. This AI model is capable of optimizing energy resource management, predicting demand, identifying inefficiencies, and recommending strategies for improved energy efficiency and sustainability. It plays a pivotal role in the modern energy landscape, offering data-driven solutions for more effective and sustainable energy use.

ECOSYSTEM LINKAGES

INTERCONNECTED SOLAR

In the illustration below, we depict the Ecosystem's data integration and Products interconnectivity.

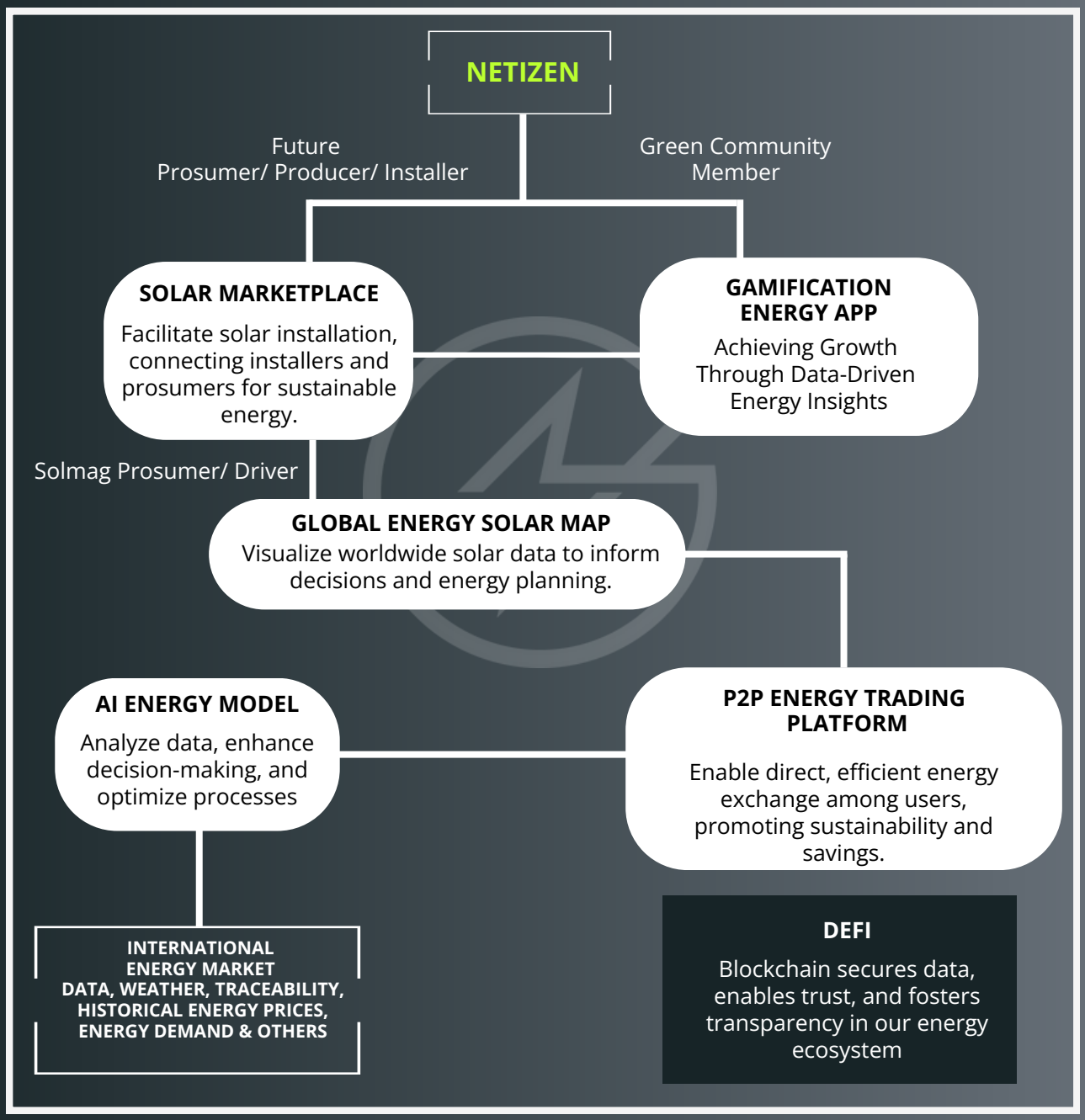

Figure 4: Decentralized Solar Ecosystem

PRODUCT NR. 1

SOLAR MARKETPLACE – ECOSYSTEM **ENGINE**

A Solar marketplace in our ecosystem is a necessary product because it is the prosumer or producer creator.

Access to Trusted Installers: The solar marketplace acts as a hub where individuals or businesses looking to adopt solar technology can access a network of trusted and certified solar panel installers. These installers are thoroughly vetted to ensure they meet industry standards and possess the necessary qualifications and expertise.

Comprehensive Information: The marketplace provides comprehensive information about various installers, including their credentials, customer reviews, project portfolios, and pricing structures. This transparency empowers consumers to make informed decisions when selecting an installer.

Customized Solutions: Future prosumers or producers can outline their specific energy needs and preferences, and the marketplace's advanced algorithms can match them with installers capable of providing tailored solar solutions. Whether it's for residential, commercial, or industrial applications, the marketplace connects customers with installers who can meet their unique requirements.

Competitive Bidding: The marketplace may facilitate a competitive bidding process, where installers submit proposals and quotes for potential projects. This fosters a competitive environment that often results in cost-effective solutions for customers.

Financing and Incentives: The platform may also offer information and assistance regarding financing options and available incentives, including government rebates and tax credits, to make solar adoption more financially attractive.

Project Management: The marketplace can include project management tools to oversee the progress of solar installations, including timelines, milestones, and quality assurance checks, ensuring a smooth and successful transition to solar energy.

Energy Market Integration: We can foresee a future where it seamlessly integrates with local or regional energy markets. This integration will empower prosumers to sell excess energy back to the grid or engage in peer-to-peer energy trading, thus creating additional revenue streams.

Customer Support: Customer support services are typically available to address queries, provide technical assistance, and resolve any issues that may arise during the transition to solar energy.

PRODUCT NR. 2

GLOBAL ENERGY SOLAR MAP – ECOSYSTEM **CORE**

A Global Solar Energy Map is a comprehensive data platform that aggregates diverse energy-related information from various sources across the world.

Its primary goal is to facilitate and promote peer-to-peer energy trading. This map integrates data from different models and sources, offering a dynamic and insightful overview of solar energy resources on a global scale.

Key components of this map include:

Installation Data: The map incorporates details about solar panel installations, including their capacity, location, and technology used. This data helps users identify potential energy producers within their vicinity.

Energy Production Models: It uses advanced energy production models to estimate the electricity generated by solar installations under varying conditions, such as weather, time of day, and panel orientation.

Grid and Transmission Data: The map integrates information about the electricity grid infrastructure and transmission lines, enabling users to understand how energy can be transferred and traded locally.

Regulatory and Pricing Information: It includes data related to energy regulations and pricing structures, allowing users to grasp the legal framework and potential economic benefits of peer-to-peer energy trading in different regions.

User Profiles: Users, including prosumers, are encouraged to create profiles and list their energy generation and consumption preferences, facilitating the identification of potential trading partners.

Peer-to-Peer Trading Features: The map integrates **product nr. 3** for users to interact, negotiate, and execute energy trading agreements securely and transparently.

Real-Time Monitoring: It offers real-time monitoring of solar energy production, consumption, and trading activities, ensuring users stay informed about their energy transactions.

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Visualization Tools: The map employs data visualization techniques, including interactive maps and charts, to make the information accessible and comprehensible for users.

Sustainability Metrics: It may also display environmental and sustainability metrics, such as carbon emissions reductions and energy savings, showcasing the positive impact of solar energy trading.

Figure 5: Global Map

By aggregating and presenting these diverse data sources and models, the Global Solar Energy Map serves as a valuable tool for individuals, communities, and businesses interested in participating in peer-to-peer solar energy trading.

DB SYSTEM ARHITECTURE

DATA EXTRACTION FOR GLOBAL ENERGY SOLAR MAP

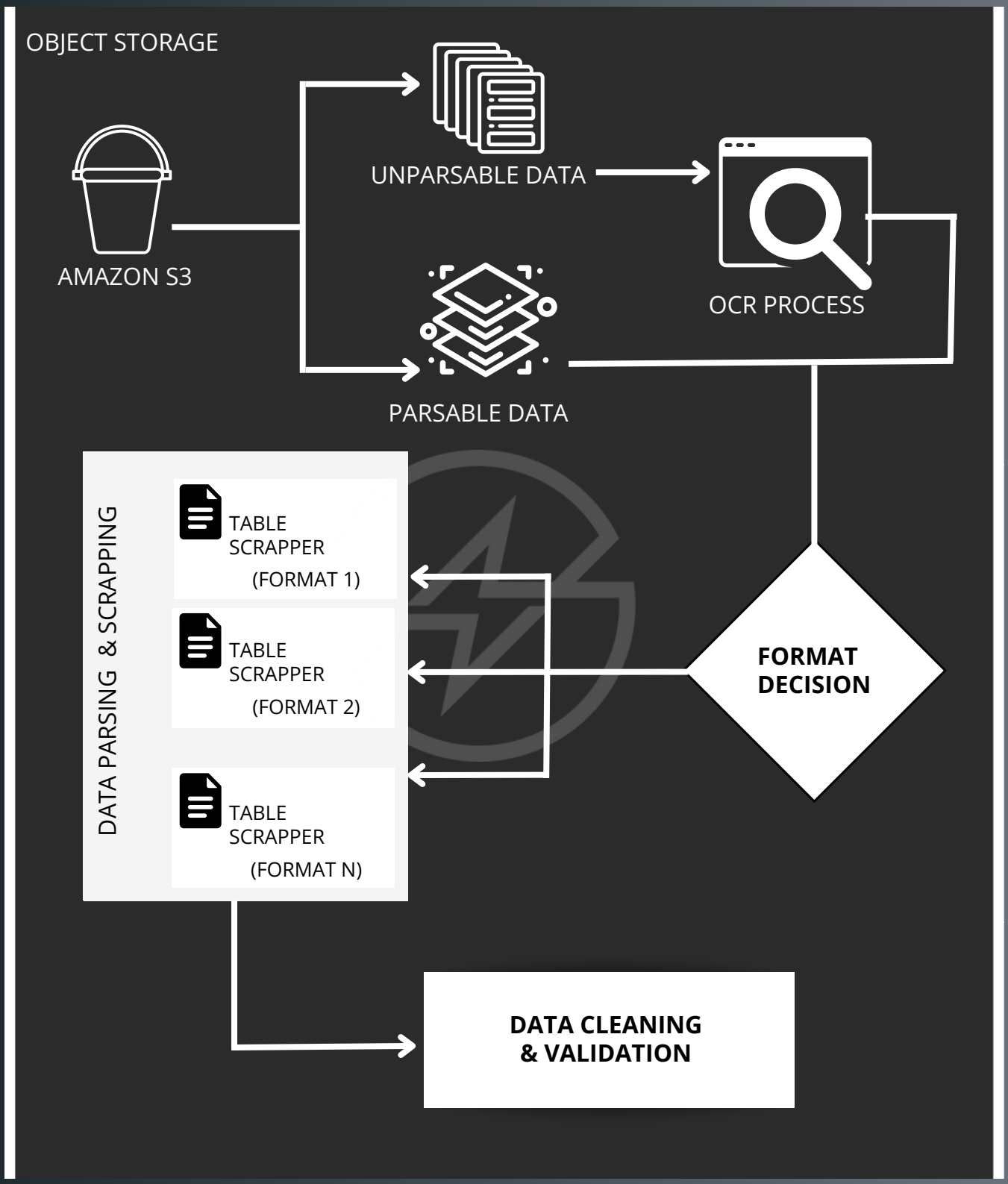

Figure 6: Prosumers Data Parsing

PRODUCT NR. 3

PEER TO PEER ENERGY TRADING PLATFORM

We believe that we need a paradigm shift and that the stars have aligned.

We believe that Peer to Peer (P2P) energy trading has the potential to be one of the key catalysts for change and transformation towards the future of the electricity market, system and infrastructure.

On the one hand, there is a unique opportunity caused by the convergence of several technologies: smart meter deployment, blockchain technology, Peer to Peer and social platforms and advancements in artificial intelligence. On the other hand there is inadequate adoption of distributed renewable energy, increasing challenges for the complex role of the Transmission System Operator (TSO) and Distribution System Operators (DSOs)

As we have seen in other industries, it is likely that consumers will push for the disruption that will follow and impact the business models of Energy Retailers and grid operators as well as government regulation and policy. Consumers, commercial and industrial businesses are the main focus of this discussion. Energy Retailers and Grid Operators are discussed more indirectly.

We will also discuss what we believe consumers and businesses can do to prepare and how Solmag can help set out on the journey with the right AI and Data capabilities.

In the traditional centralized energy system, electricity is almost entirely centrally generated and co-located in the proximity of industrial sites. This is for good reason, to match production and consumption as much as possible and therefore optimize the transport across the network. From central production sites, a vast capillary network extends that transports electricity over hundreds of kilometers to smaller consumers. Consumers have access to the liberalized market strictly through eligible counterparts. Finally the electricity network is maintained as mentioned earlier by the TSO and the DSOs. [17]

To present how P2P energy trading works and its interaction in the current energy system, it is necessary to highlight the vital role that Balance Responsible Parties (BRP) play in ensuring a safe power supply.

Power outages will occur if the amount of electricity demanded diverges outside of a narrow tolerance bandwidth from the amount of electricity supplied. That's why BRPs are responsible for forecasting and matching, every day, at **15 minute** intervals how much electricity their clients will take from the grid, and how much electricity will be put on the grid by the assets they, or their clients hold.

Powerledger's technology is used by prosumers with rooftop solar in Da Nang and Quang Nam provinces in central Vietnam to sell electricity directly to consumers.

The aim is to demonstrate how technology can be used to reduce energy costs with improved price transparency by establishing a local energy market.

Vietnam has become a major producer of solar power – the world's tenth largest – but this increase in renewables has created imbalances for the grid which has resulted in intermittency issues. [18]

We see three main set-ups to engage in P2P energy trading:

- In the 'GridFlow' configuration, consumers remain connected to the central grid while independently managing price and volume risks through direct purchase or sale of electricity to other peers. As we'll explore in more detail later, this approach offers several advantages. These include minimal upfront investment requirements for peer-to-peer traders, cost savings by avoiding premiums charged by Energy Retailers, increased awareness and control over consumption profiles (such as peak shaving), a guaranteed source of green energy, and reduced exposure to market fluctuations, as observed in the events of the fall of 2021. It's worth noting that, presently, large industrial players are entering into Power Purchase Agreements (PPAs) with significant wind parks to directly source green energy. While not representative of typical peer-to-peer trading on a dedicated platform, these instances exemplify the growing trend of direct transactions in the market.

- In the 'semigrid' configuration, participants establish a microgrid to manage a portion of their combined energy requirements while maintaining a connection to the central grid to cover the remaining capacity. A notable illustration of this model is the Schoonschip Amsterdam microgrid. In this community-run microgrid, residents engage in electricity trading within the microgrid, while retaining grid connectivity for backup purposes. This arrangement encourages participants to balance their energy profiles and lessens the necessity for significant central grid investments.

Although the initial investment costs for stakeholders in this model are somewhat higher compared to the 'Gridflow' Trading setup, the resulting savings are considerably greater. An emerging trend is the deployment of 'semigrid' within industrial clusters. For instance, P2P platforms have been established in international shipping ports, including the Port of Rotterdam and the Port of San Diego. From 2026, upcoming European legislation will enable our countries to address and manage this evolving energy landscape. Currently, our primary option is to donate surplus energy. Nevertheless, our role is to provide the technological infrastructure for facilitating individual contracts and agreements pertaining to data and energy transfer.

- AutoGrid: in this set-up several participants create a private electricity network that is fully self-sufficient, not connected to the central electricity network and parties transact through a P2P platform. In this case the investments for participants in the initiative, as well as the associated savings, are higher than the other two set-ups. However, given the current cost of energy storage and maturity of micro-grid technology, it seems unlikely that this will be the prevalent set-up. It is more likely that consumers will first explore Gridflow trading and semigrid set-ups in the years to come, until sufficient maturity is reached for this set-up to flourish.

In the realm of energy economics, it's important to recognize that the percentage distribution of costs can be a fluid and dynamic concept, heavily influenced by geographic location and the energy sources in play.

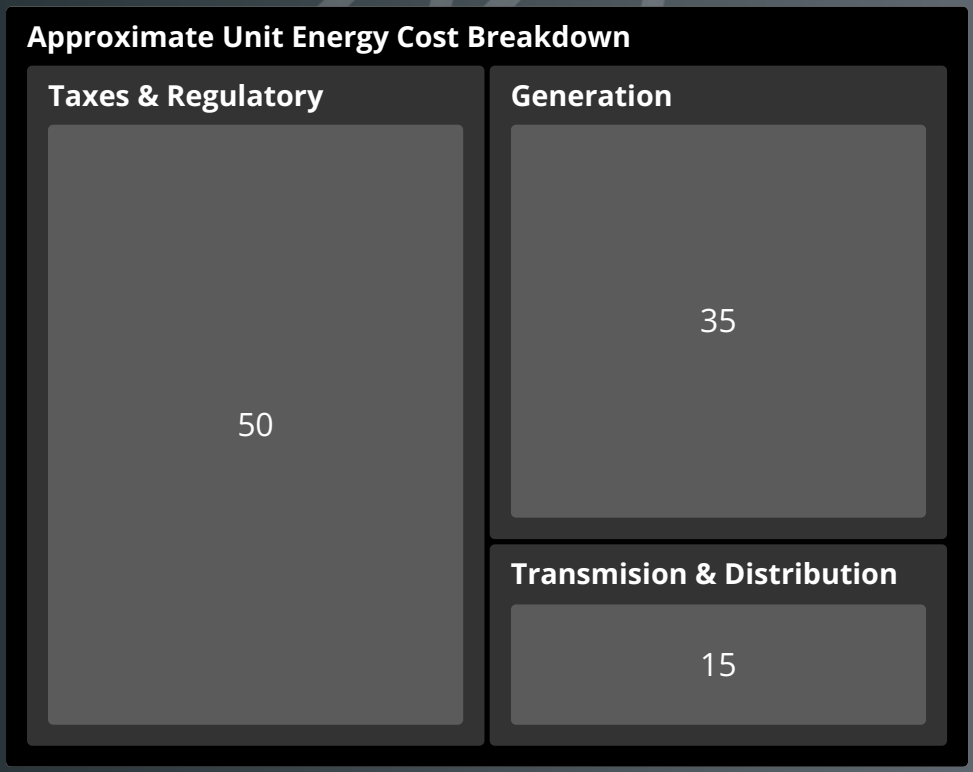

Figure 7: Energy Cost

Gridflow

Trading participants proactively assume responsibility for price and volume risk management, leading to potential savings on the premium typically charged by Energy Retailers.

Volume risk management entails the handling of uncertainties regarding the quantity of energy to be consumed or generated. Initially, this may appear intricate; however, the amalgamation of smart metering technologies and AI algorithms offers accessible means for developing the necessary analytical capabilities. Price risk management, conversely, pertains to the management of uncertainties regarding the price at which electricity can be purchased or sold, given the fluctuations occurring throughout the day, week, and seasons. Though this may seem intricate as well, intelligent automation can facilitate the implementation of hedging and purchasing strategies, rendering the management of price risk a manageable process.

Beyond financial advantages, the development of capabilities for price and volume risk management unveils an array of non-financial benefits. A consumer, cognizant of their consumption patterns, may opt to instigate behavioral changes that result in peak shaving and strategic energy purchasing during periods of lower pricing. Moreover, consumers can procure 100% locally produced renewable energy, contributing to sustainability objectives.

For organizations, corporations, and industrial clusters considering this setup, Solmag's AI and data practice stands ready to assist in assessing the financial value and environmental impact of 'Gridflow' Trading. Moreover, we can assist in building the analytical capabilities required for effective risk management.
Mathematically, the relationship between volume risk management (VRM), price risk management (PRM), and potential cost savings (CS) can be expressed as follows:

CS = VRM + PRM

In this equation, CS represents the total cost savings achievable, while VRM and PRM denote the impact of volume risk management and price risk management, respectively. Our approach leverages AI algorithms to optimize VRM and PRM, thus enhancing overall cost savings and sustainability.

Semigrid

Self-organized clusters that establish fully or semigrids present a promising solution to address congestion challenges, expedite the energy transition, and unlock financial resources. Recent instances of microgrid implementations have demonstrated energy cost reductions ranging from 5% to 15%. The viability of a P2P microgrid is further bolstered when integrated with energy storage, enabling efficient peak shaving and potentially magnifying cost savings by approximately 50%. For industrial clusters, the potential for additional savings is even more substantial, as they can secure longer-term contracts at more favorable pricing.

AutoGrid

In the context of a microgrid, a collective operates as a fully self-sustaining entity, independent of any central grid connection. While participants in this setup can reap the highest financial benefits, they must also bear the most substantial investment costs. Given the current state of technological advancement and maturity, this configuration stands as the most intricate. The gradual emergence of partly-independent grids represents a probable transitional phase toward a future where fully independent microgrids are poised to play a significant role in shaping the energy landscape.

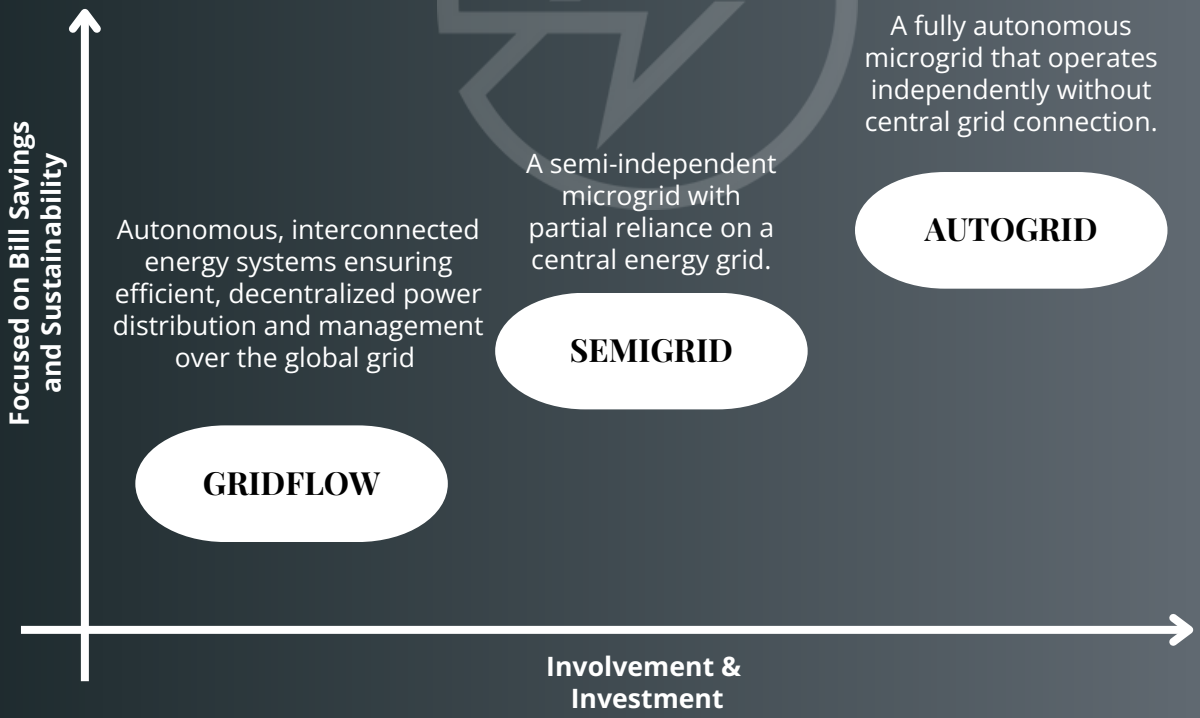

Figure 8: Types of P2P Trading

TRADING STRATEGY OPTIMIZATION FOR A PROSUMER IN CONTINUOUS DOUBLE AUCTION-BASED PEER-TO-PEER MARKET: A PREDICTION-INTEGRATION MODEL

With increasing prosumers employed with flexible resources, advanced demand-side management has become of great importance. To this end, integrating demand-side flexible resources into electricity markets is a significant trend for smart energy systems. The continuous double auction (CDA) market is viewed as a promising P2P (peer to peer) market mechanism to enable interactions among demand side prosumers and consumers in distribution grids.

To achieve optimal operations and maximize profits, **prosumers** in the electricity market must act as **price makers** to simultaneously optimize their operations and trading strategies. [19]

Nevertheless, modeling the CDA-based market is challenging due to its information-driven clearing process and the unpredictable bidding behaviors of participants. To encourage prosumer engagement in the CDA market, this study introduces an innovative approach known as the Prediction-Integration Strategy Optimization (PISO) model. The model incorporates a surrogate market prediction system based on the Extreme Learning Machine (ELM), which leverages historical transaction data to understand the dynamic relationship between prosumer bidding strategies and market responses.

Description of the market prediction model

Given the historical transaction data of M training samples **{[λt , PtCDA] , Ft }M** , the construction of the market predictor is the training process of ELM. λt and PtCDA denote the bidding price and quantity in trading cycle t, respectively. Ft represents this participant's selling profit when acting as a supplier or purchasing cost when acting as a consumer in cycle t.

Designing microgrid energy markets

Blockchains, as emerging information technology, offer new opportunities for decentralized market designs and provide transparent and user-friendly applications that allow energy consumers to participate in the decision on who produces their energy and by which technology it is generated. Microgrids, which are a geographically limited group of multiple generation loads and energy resources, can also increase the reliability of supply as they offer the potential to provide energy in case of power outages of the superordinate grid. [20]

Designing microgrid energy markets

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In the course of our ongoing development for the peer-to-peer trading platform, it becomes imperative to incorporate algorithmic trading strategies. This strategic inclusion is critical for enhancing the efficiency, reliability, and competitiveness of the platform, positioning it as a robust solution within the evolving energy landscape.

Algorithmic Trading Strategies

Any strategy for algorithmic trading requires an identified opportunity that is profitable in terms of improved earnings or cost reduction. The following are common trading strategies used in algo-trading

Trend-Following Strategies

The most common algorithmic trading strategies follow trends in moving averages, channel breakouts, price level movements, and related technical indicators.

Arbitrage Opportunities

Buying a dual-listed stock at a lower price in one market and simultaneously selling it at a higher price in another market offers the price differential as risk-free profit or arbitrage.

Mathematical Model-Based Strategies

Proven mathematical models, like the delta-neutral trading strategy, allow trading on a combination of options and the underlying security.

Volume-Weighted Average Price (VWAP)

Volume-weighted average price strategy breaks up a large order and releases dynamically determined smaller chunks of the order to the market using stock-specific historical volume profiles.

Percentage of Volume (POV)

Time-weighted average price strategy breaks up a large order and releases dynamically determined smaller chunks of the order to the market using evenly divided time slots between a start and end time. [21]

PRODUCT NR. 4

GAMIFICATION ENERGY APP

As the prosumer community continues to expand, encompassing individuals without technical backgrounds, we're encouraging all online users to virtually cultivate an ecosystem that directly relates to real-life experiences.

In the intricate game of sustainable living, the pillows are clear: Energy production, electric vehicle ownership, carbon footprint, energy efficiency, and community engagement. These are the fundamental building blocks that, when strategically aligned, pave the path towards a greener, more resilient future.

We are guided by the following key factors for development.

User-Friendly Interface: The app boasts an intuitive and user-friendly interface, ensuring that users can easily navigate and access its various features.

Energy Challenges: Gamification Energy Apps often include energy-related challenges and goals. Users can set and track their goals, such as reducing energy consumption or increasing renewable energy use.

Points and Rewards: To motivate users, the app awards points or virtual rewards for completing energy-saving tasks. These points can be used to unlock virtual badges, customized avatars, or even redeem real-world rewards, like discounts on energy bills or eco-friendly products.

Real-Time Monitoring: Gamification Energy Apps often offer real-time monitoring of energy usage, enabling users to see the immediate impact of their actions on consumption.

Social Interaction: Users can connect with friends and compete in energy-saving challenges or share their achievements on social media platforms. This fosters a sense of community and encourages healthy competition.

Education: The app provides educational content on energy conservation, renewable energy sources, and sustainability. Users can learn about the environmental benefits of energy conservation and make more informed choices.

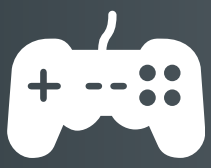
Customization: Users can tailor the app to their preferences, setting energy-saving goals and challenges that align with their specific circumstances and objectives.

Progress Tracking: The app tracks and visualizes users' progress, showing them how they're contributing to energy conservation and sustainability over time.

Sustainability Tips: Gamification Energy Apps often provide tips and recommendations on how users can make more sustainable choices in their daily lives, both inside and outside the home.

In Playing for the Planet's survey of over 400,000 gamers, 68% of respondents said they wanted to engage more on environmental issues, while 70% were open to climate-themed content in their games. [22]

Taking into account that 94% of Generation Alpha (2010+), 90% of Generation Z (1995 - 2009), and 82% of Millennials (1980-1994) are deeply engaged in gaming.



PRODUCT NR. 5

AI ENERGY MODEL – TRAINED FOR ENERGY DATA

As we gather an increasing amount of data from the global energy ecosystem, our plan includes training an AI model to gain a comprehensive understanding of the entire energy sector, enabling more effective utilization.

Through our data gathering process, we are committed to achieving and continually enhancing optimization in the following areas:

Multi-Source Data Integration: The model will be designed to integrate and process data from diverse sources, including IoT devices, energy consumption records, and weather data.

Anomaly Detection: Incorporating algorithms for detecting irregular patterns or potential issues within the energy system to enhance security and reliability.

Energy Forecasting: Providing predictive capabilities to estimate energy demand and supply fluctuations, enabling better resource allocation.

Load Balancing: Implementing load-balancing algorithms to optimize energy distribution and reduce wastage.

We employ a **geometric deep learning** algorithm for load balancing, similar to the approach utilized by Waze.

The primary purpose of this algorithm is to compute the most efficient route cost.

Energy Efficiency Recommendations: Developing algorithms to suggest energy-efficient practices and behaviors for both consumers and industrial users.

Renewable Energy Integration: Enabling the model to manage and optimize the integration of renewable energy sources into the grid.

Predictive Maintenance: Using AI to predict equipment failures and recommend maintenance schedules, reducing downtime.

Market Analysis: The model will analyze energy market trends to support strategic decision-making and investment in the energy sector.

Grid Resilience: Enhancing grid resilience by modeling and simulating various failure scenarios and recovery strategies.

Real-time Monitoring: Enabling real-time monitoring of energy infrastructure for immediate response to issues or changes in demand.

As a burgeoning market and given the inevitable shift towards solar energy as a primary global source, it's imperative that we refine our algorithm based on P2P transactions within the network to enhance its efficiency.

Our primary objective in evolving the algorithm is to inspire the community to engage, enabling us to align with the most crucial and pressing needs.

Geometrical Deep Learning

Deep learning architectures are typically composed of a number of layers, that are combined together to form the overall model architecture. Often combinations of layers are then repeated. Geometric deep learning models typically include the following types of layers.

Linear equivariant layers: The core component of geometric deep learning models is linear layers, such as convolutions, that are equivariant to some symmetry transformation. The linear transform itself needs to be constructed for the geometric category considered, e.g. a convolution on the sphere and graph are difficult, although there are often many analogies.

Non-linear equivariant layers: To ensure deep learning models have sufficient representational power, they must exhibit non-linearity (otherwise they could only represent simple linear mappings). Non-linear layers must be introduced to achieve this, while also preserving equivariance. The canonical way to introduce non-linearity in an equivariant manner it to do so via pointwise non-linear activation functions (e.g. ReLUs), although other forms of non-linearity tailored specifically to the underlying geometry are sometimes considered . [23]

Local averaging: Most geometric deep learning models also include a form of local averaging, such as max pooling layers in CNNs. Such operations impose local invariances at certain scales, ensuring stability and leading to multi-scale, hierarchical representations by stacking multiple blocks of layers.

Global averaging: To impose global invariances in geometric deep learning models, global averging layers are often employed, such as global pooling layers in CNNs.

Geometric deep learning is a topical and rapidly evolving field, where much progress has been made. However, many unsolved questions remain, not only in models themselves but also around scalability and practical application. We will address these issuses in upcoming articles, showing how solving such issues is critical to unlocking the remarkable potential of deep learning for a host of new applications.

Figure 9: The AI Scheme [24]

BLOCKCHAIN ARHITECTURE

TRUST. FOUNDATIONAL PRINCIPLE THAT HOLDS ALL RELATIONSHIPS.

Executive summary

A blockchain-enhanced system consists of various components that work together to provide a seamless experience for end-users while ensuring that administrators can configure and manage the system effectively. The main components of the system include:

- A web application where users can utilize their own in-browser wallets (eg. Metamask) to interact with the Solmag Ecosystem.
- A suite of smart contracts implementing the logic of:
- SOLMAG Token (ERC-20 / BEP-20)
- SOLMAG NFT Token (ERC-721)
- Governance Contract (for contracts above)

High Level overview

Solmag Marketplace:

- Immerse yourself in a thriving Solmag Marketplace, where you can not only engage in electricity transactions through energy sources (prosumers and charging stations) using SOLMAG tokens but also explore a diverse range of real-world assets, including these energy sources. These assets are readily available for trade within the marketplace.

Global Prosumers and Producers Map:

- Navigate the expansive world of energy prosumers and producers via our Global Prosumers Map. Get a bird's-eye view of energy sources, including prosumers and charging stations, and energy generators worldwide, all interconnected within the Solmag Ecosystem. Discover opportunities for collaboration and trading on a global scale.

Peer-to-Peer Energy Trading Platform:

- Delve into the exciting realm of peer-to-peer energy trading. Utilize the Solmag Ecosystem to securely trade electricity with fellow members, whether they are consumers or energy producers. With the SOLMAG token at the heart of this platform, you can engage in transparent and efficient energy transactions.

Gamification Energy App:

- Energize your experience with our gamification energy app. Earn rewards, level up, and embark on energy-related challenges. Transform the way you interact with energy by gamifying your journey within the ecosystem. This app injects fun and motivation into the world of sustainable energy.

Prosumers and producers, once granted KYC approval, become esteemed NFT token holders, entitling them to:

- Ownership Rights: Gain exclusive ownership rights over energy sources, symbolized by NFTs, which are securely recorded on the blockchain.
- Energy Service Provider: Unlock the potential to provide electric vehicle charging services and electricity generation services, receiving payments in SOLMAG Tokens based on a calculated rate. Share your energy with the world and benefit from it.
- Explore Energy Sources: Conveniently explore the network of energy sources, both geographically through a map interface and through user-friendly web and mobile applications. Stay connected and engaged wherever you go.

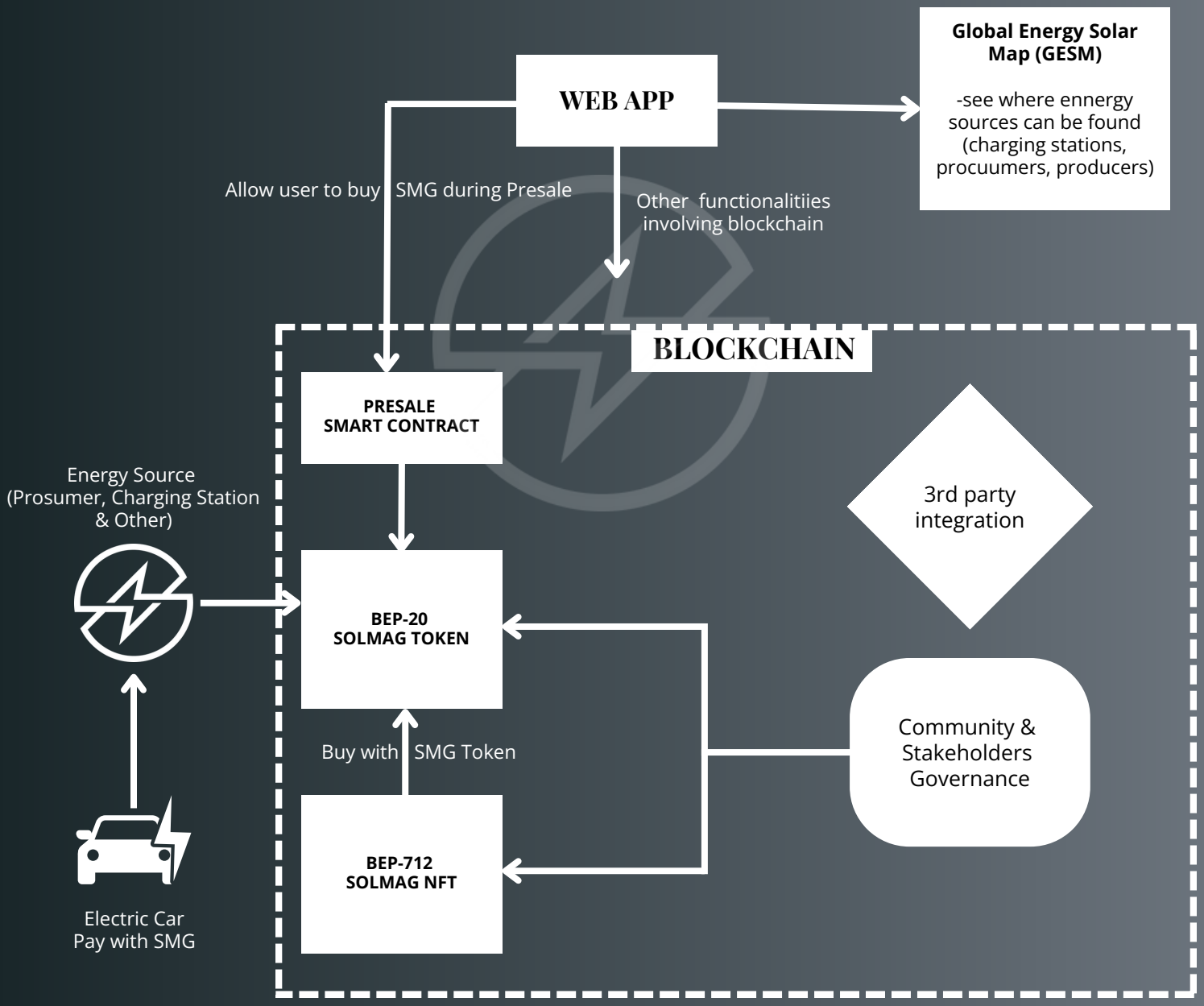


Figure 10: Blockchain Architecture

We are using different Smart Contracts

● Modularity: Using separate smart contracts for NFTs and cryptocurrency tokens provides clear modularity. Each contract can be optimized for its specific purpose, which can make development, testing, and maintenance more manageable.
● Customization: NFTs often have unique attributes and behaviors specific to their use cases (e.g., artwork, in-game items). By using separate contracts, we can tailor the NFT contract's logic and data structures to suit those unique attributes.
● Clarity: From a design perspective, keeping NFTs and cryptocurrency tokens separate can help maintain clarity in terms of contract functions, events, and storage layouts.
● Upgrades: upgrading one type of token without affecting the other, separate contracts allow for more granular control over upgrades.

Gas Fees
● The average gas fee for BNB as of 29.08.2023 is 5.525 Gwei BNB (0.00000124 USD) compared to 37.97 Gwei ETH (0.000065 USD) for Ethereum.
● The Binance Smart Chain (BSC) offers cheaper gas fees compared to Ethereum, making it an attractive choice for launching a token. While Ethereum has transitioned to a Proof of Stake (PoS) consensus mechanism, which aims to improve scalability and reduce energy consumption, BSC's consensus mechanism allows for faster block generation (every 3s compared to 12-15s) and lower gas fees (as shown above).

Integrations

1.Cryptocurrency Exchanges: Getting a token listed on cryptocurrency exchanges allows users to trade it against other cryptocurrencies. This provides liquidity and exposure to a broader audience.
2. Decentralized Exchanges (DEXs): Integrating with DEXs like Uniswap, SushiSwap, or PancakeSwap allows users to trade the token in a decentralized and automated manner directly from their wallets.
3. Payment Gateways: Integrate the token into platforms that offer payment processing services, enabling merchants to accept the token as a form of payment for goods and services.
4. Wallet Integrations: Collaborate with wallet providers (like MetaMask or Trust Wallet) to ensure that the token is supported and displayed correctly within their interfaces.
5. NFT Marketplaces: ERC-20 tokens can be used to facilitate transactions on NFT (Non-Fungible Token) marketplaces, providing a utility token for buying, selling, or bidding on NFTs.
6. Staking and Governance: Use the token for staking within a governance system, allowing holders to participate in decision-making processes related to the project.
7. Cross-Chain Bridges: Utilize cross-chain protocols to bridge our ERC-20 token to other blockchains, expanding its usability beyond the current blockchain.

DEVELOPMENT PARTICULARS

Smart contract testing

Involves systematically checking and verifying the performance, security, and functionality of self-executing digital contracts that run on blockchain platforms like Ethereum. It's important for:

- Ensuring correct functionality: Testing confirms that smart contracts work as intended, preventing unexpected issues.
- Enhancing security: Thorough testing helps identify and fix vulnerabilities that could lead to financial losses or breaches.
- Maintaining data integrity: Testing ensures data accuracy and prevents unauthorized access.
- Optimizing performance: It helps make contracts efficient, reducing costs and execution times.
- Enabling interactions: Testing ensures seamless communication between contracts and external systems.
- Complying with regulations: Contracts can be tested for adherence to legal requirements.
- Preventing losses: Effective testing prevents bugs that could lead to substantial financial losses.

Smart contract upgradeability

Upgrading smart contracts is a complex process, particularly due to the immutable nature of blockchain and the necessity for smooth transitions. This complexity is intertwined with governance, as decisions about upgrades often involve stakeholders.

Challenges encompass maintaining data compatibility, verifying security and functionality, managing user experience, addressing potential disruptions and costs, and aligning with established standards. Navigating these intricacies necessitates strategic planning, thorough testing, and transparent communication. Effective governance mechanisms are crucial for involving stakeholders and ensuring that upgrades align with the community's interests while maintaining trust and system integrity.

Pre-sale

A Basic BEP-20 smart contract includes the following:

Functions

constructor(name_, symbol_) - initialize name and symbol

External function (can be called by users / contracts on the blockchain)

name() - return token name: “Solmag”
symbol() - return token symbol: “SMG”
decimals() - return decimals (1 to 8)
totalSupply() – return total supply
balanceOf(account) - return account balance
transfer(to, amount) - transfer amount of token to address
allowance(owner, spender) - returns the remaining number of tokens that spender will be allowed to spend on behalf of owner through transferFrom
approve(spender, amount) - sets amount as the allowance of spender over the caller’s tokens
transferFrom(from, to, amount) - moves amount tokens from from to to using the allowance mechanism. amount is then deducted from the caller’s allowance
increaseAllowance(spender, addedValue) - increase allowance by value
decreaseAllowance(spender, subtractedValue) - decrease allowance by value

Internal functions (can not be called from outside the contract):

_transfer(from, to, amount)
_mint(account, amount)
_burn(account, amount)
_approve(owner, spender, amount)
_spendAllowance(owner, spender, amount)

Hook that is called after any transfer of tokens. This includes minting and burning

_beforeTokenTransfer(from, to, amount)
_afterTokenTransfer(from, to, amount)

Events - logged onto the blockchain, making it possible for apps to listen for them

Transfer(from, to, value)
Approval(owner, spender, value)

Presale Smart contract

A presale is implemented through the use of another smart contract that could be in the form of multiple rounds with varying prices for the token. Upon contributing to a round a user is given the corresponding SOLMAG token amount using the allowance function described above (allowing smart contract to transfer a maximum of given allowance of tokens) using OpenZeppelin's AllowanceCrowdsale.

A round would function as such:
1. Activate Round:
● The presale owner activates a specific presale round by specifying the start and end times, token price, allocation limit, and other parameters for that round.
2. Round Start:
● When the start time of the presale round arrives, participants can begin contributing using BNB.
3. Participant Interaction:
● Participants who want to take part in the presale round use their BSC wallet and interact with the presale contract's user interface or directly through transactions.
4. Sending BNB:
● Participants initiate a transaction from their BSC wallet to the presale contract's BNB address.
● The transaction includes the amount of BNB they want to contribute.
5. Validation and Allocation:
● The presale contract receives the BNB and validates the contribution based on factors such as the presale round's status and allocation limits.
● If the validation is successful, the contract proceeds to allocate presale tokens to the participant based on the token price and the contributed BNB amount.
6. Token Allocation:
● The presale contract calculates the number of presale tokens the participant will receive based on the contributed BNB and the specified token price.
● The contract updates the participant's token balance and records the contribution.
7. BNB Handling:
● The BNB contributed by participants is held in the presale contract's balance until the end of the round.
8. End of Round:
● When the end time of the presale round is reached, participants can no longer contribute to that round.
9. Tokens Distributed:
● At the end of the presale round, participants' token balances are finalized, and the presale contract no longer accepts contributions for that round.
10. Completion:
● Participants who successfully contributed during the round now have presale tokens in their BSC wallets.
Alternatively, we can "force" the presale acquisitions into staking as an initial measure.

TOKENOMICS

INITIAL DISTRIBUTION OFFER

Our project will consist of **1,000,000,000 SMG** tokens and is scheduled for a complete release within the next four years, commencing in **Q1 2024**.

Our initial launch involves a private sale offering **50,000,000 SMG** Tokens at a base price of **$0.01** per token.

Through our inaugural release, our objective is to establish a community of **10,000 members.**

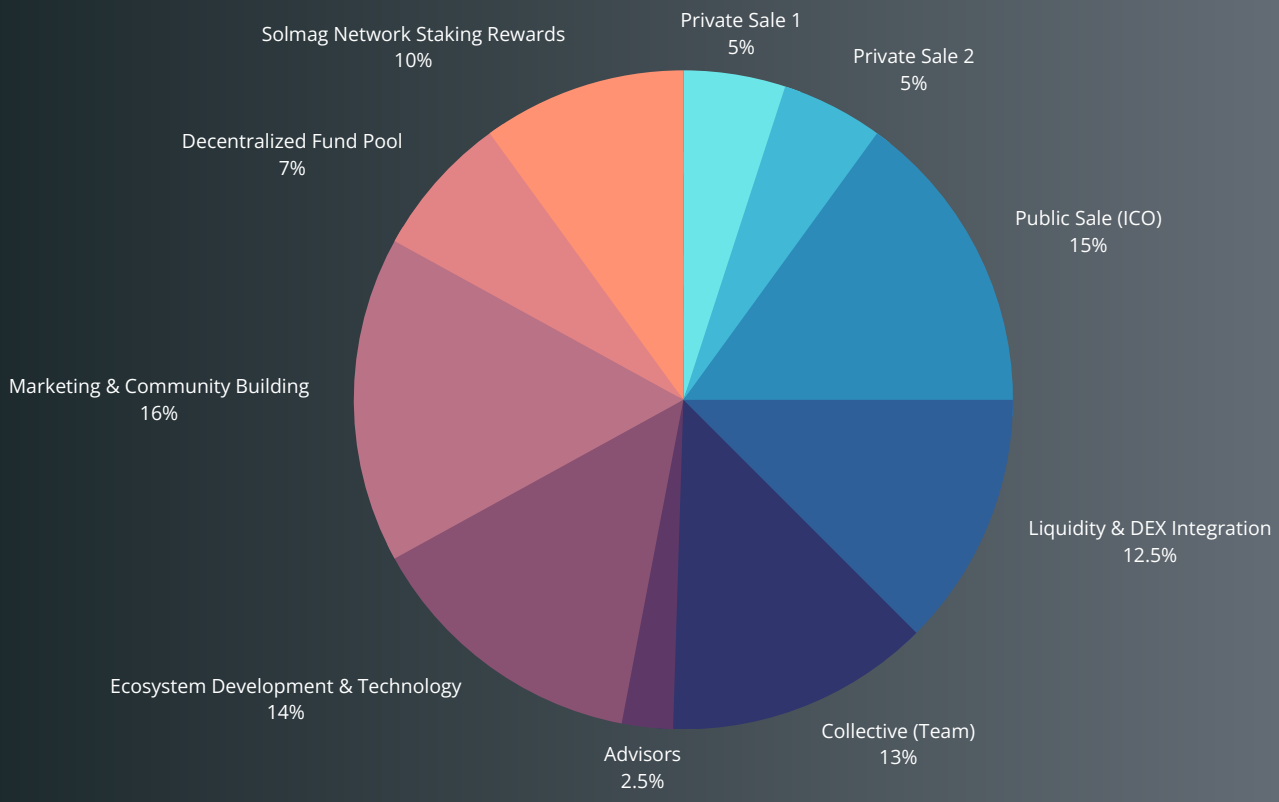


Figure 11: Solmag Tokenomics

Before the **ICO**, our strategy includes a second private launch in the third quarter, offering tokens at a bace price of **$0.03**, maintaining the same quantity as in the first private sale.

The private-sale of tokens will be executed in **10 phases**. Each phase will be open for a maximum of **14 days**. Each stage will experience an incremental increase of $0.0015.

ENERGY SOURCES INTEGRATION PLAN

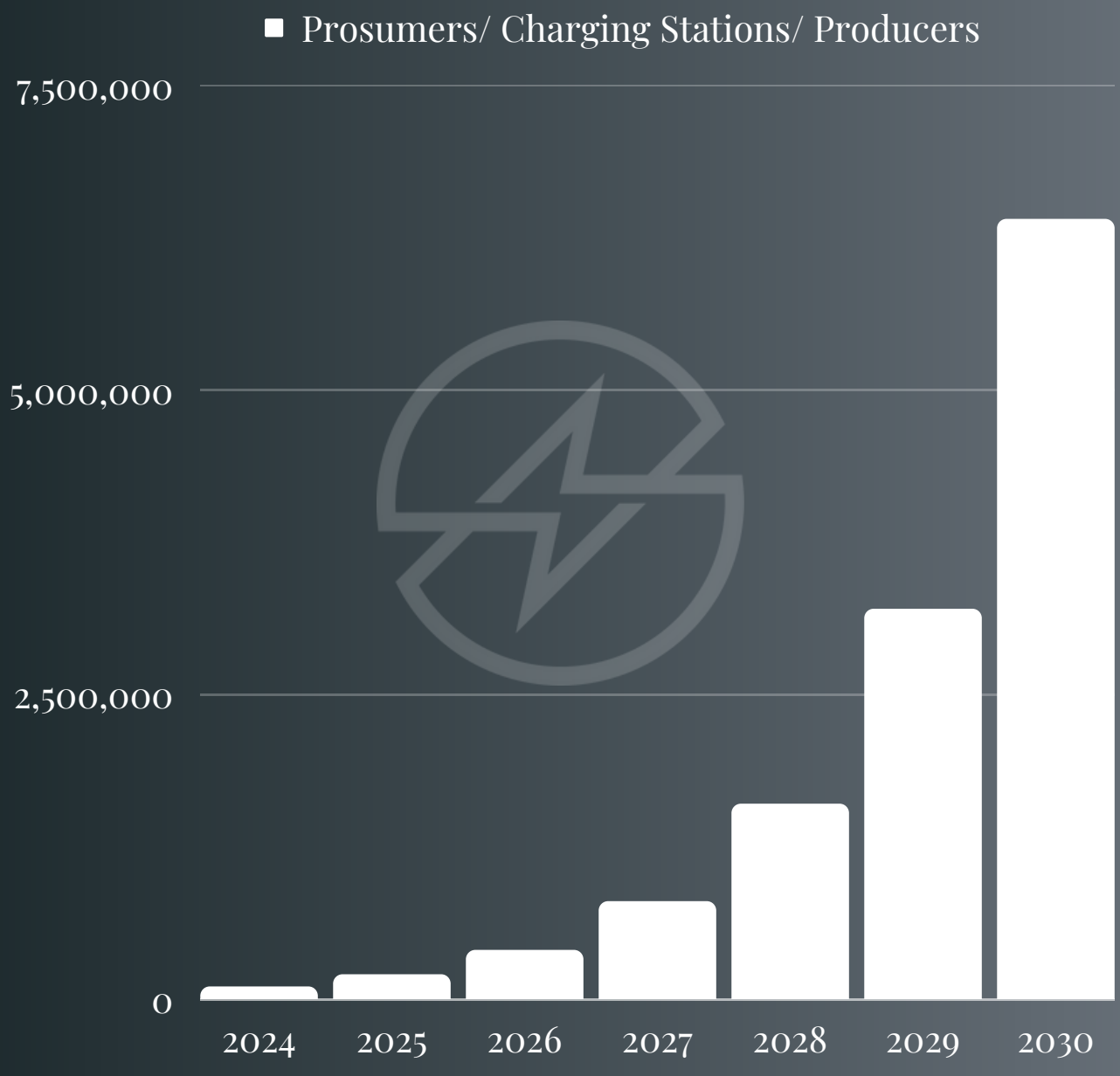


Figure 12: Energy Sources

Vesting Period

The project as a whole will feature a 4-year vesting structure, which is designed to ensure the project's long-term sustainability and continuous operation. In this vesting plan, the initial 64% of the total assets will have a 12-month cliff vesting period. Following that, the remaining 36% will have a 1% monthly vesting over the subsequent 36 months.

This private sale system will promote the intrinsic and extrinsic values of the ecosystem to early investors, who will in turn become the long term holders of the future.

Inflationary

For the initial four years, all SMG Tokens generated by our ecosystem products will be allocated as staking rewards. After this period, with the ecosystem operating at full capacity, the distribution of SMG tokens will transition to investors and various Ecosystem Tokenomics departments, excluding the DEX.

This model will facilitate the expansion of the ecosystem while ensuring its secure and sustained operation.

Deflationary

With a set fee of **0.2%** on each **MWH** traded through our P2P Energy Trading Platform, we anticipate burning **1 SMG** for every **100 MWH** exchanged.

Full Tokenomics Plan - here

ICO

In the preparatory phase leading up to the ICO, we meticulously devised a comprehensive plan to ensure our project's success:

Conceptualization and Documentation: Our first step involved conceiving the ICO and crafting a detailed whitepaper that outlined our project's vision, objectives, and technical specifics.

Legal Compliance: To ensure regulatory adherence, we engaged with legal experts, defining the ICO's legal structure and compliance strategies.

Team Formation: A highly skilled team, comprising experts in blockchain development, marketing, legal, and business development, was carefully assembled.

Smart Contracts and Security: The development and rigorous security auditing of smart contracts were priorities, guaranteeing the integrity of our technical foundation.

Tokenomics: We meticulously charted our tokenomics, specifying token supply, distribution mechanisms, and pricing strategies, all while designing attractive bonuses and discounts for early investors.

Robust Security Measures: Cybersecurity was a paramount concern. We implemented formidable security protocols to protect the ICO against digital threats.

Marketing and Community Engagement: We strategically designed marketing campaigns and community-building initiatives to generate awareness and cultivate interest.

ENERGY TRADING PLAN

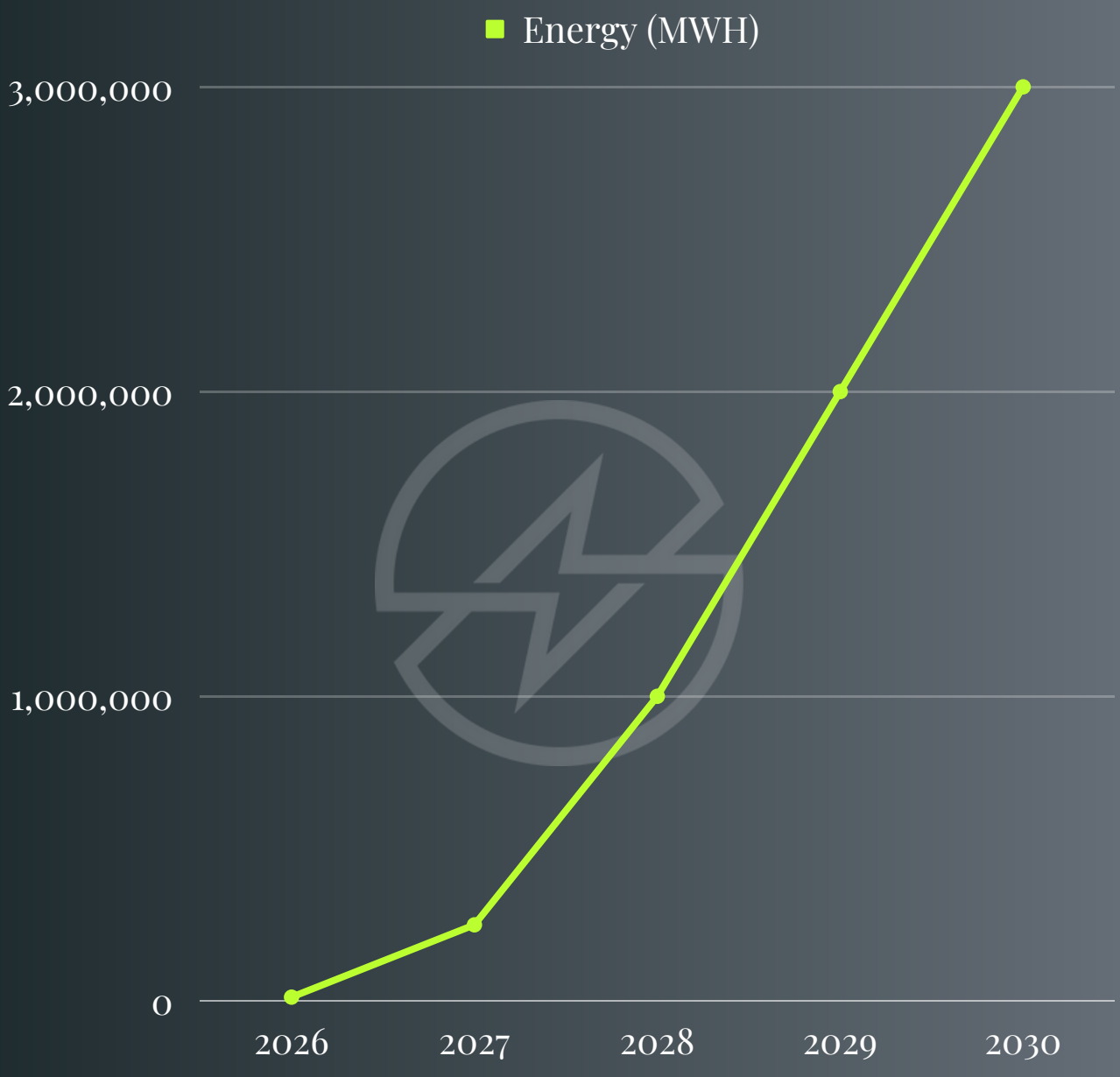


Figure 13: Energy Traded to 2030

ROADMAP

Q4 2023

SOLAR MARKETPLACE

GLOBAL ENERGY SOLAR MAP

Q1 2024

Q4 2024

PEER TO PEER ENERGY TRADING PLATTFORM

GAMIFICATION ENERGY APP

Q1 2025

Q3 2025

AI ENERGY MODEL

COMMUNITY GROWTH

Phase 1: Seeding the community

At the outset of our project's seed phase in the Web3 community, our primary emphasis lies in selecting a couple of central channels that act as focal points for our members to connect. Simultaneously, our dedicated community team assumes a pivotal role, providing assistance, nurturing engagement, and seamlessly integrating authentic conversations about our project and its merits.

Our primary communication channels consist of **Twitter** and **LinkedIn**.

Phase 2: Cultivating growth

In the growth cultivation phase, also known as the scaling phase, the focus lies on increasing membership while keeping the community engaged. It typically entails expanding your community tech stack to a few additional channels such as a forum, knowledge base, learning management system, or customer engagement platform. [25]

As we progress through the growth phase, the ongoing data collection empowers our community team to assess the reach and effectiveness of our project.

Phase 3: Demonstrating community impact

After our community program demonstrates its effectiveness in driving growth and maintaining engagement, our next step is to assess its tangible benefits for our project. This includes evaluating its impact on critical factors like product adoption and revenue generation.

TERMINOLOGY AND CORRESPONDING DEFINITIONS IN USE.

'AutoGrid' = A grid term designed to operate autonomously, generating and managing their energy without reliance on external power sources or the central grid.

'GridFlow' = A term referring to an energy network approach where participants actively manage price and volume risk independently. In this setup, consumers take charge of their energy sourcing and trading, bypassing the traditional Energy Retailers.

'ICO' = ICO stands for "Initial Coin Offering." It's a fundraising method used by cryptocurrency and blockchain-related projects to raise capital.

'Netizen' = A user whose gaming profile is determined by a combination of factors, including energy production, electric vehicle ownership (EVs), carbon footprint, energy efficiency rating, and community engagement within the gaming platform.

'Prosumer' = A hybrid term combining "producer" and "consumer," referring to an individual or entity that both generates and consumes goods or services, often within the context of energy production, where they generate their electricity while also utilizing energy resources from the grid when needed.

'**Semigrid**' = A term referring to an energy network that operates as an integrated energy system, combining both self-sufficiency and connection to the central grid. In a semigrid, a portion of the energy requirements is managed independently within the microgrid, often through renewable sources like solar or wind, while the remaining capacity is supplemented through the central grid.

OVERALL CONCLUSIONS

Solmag is an innovative and promising Solar Ecosystem designed to revolutionize the way we harness and interact with solar energy on a global scale. With a comprehensive suite of products, it stands as a pivotal bridge between various energy sources, particularly focusing on solar power.

The Solar Marketplace within Solmag empowers users by providing a centralized hub for buying and selling solar energy, promoting sustainability and enhancing energy security. Simultaneously, the Global Energy Solar Map offers real-time insights into solar energy generation across the world, facilitating informed decisions and global collaboration.

Furthermore, the Peer-to-Peer Energy Trading Platform not only enables individuals to trade surplus solar energy but also fosters community resilience. The Gamification Energy App introduces an element of fun and competition, incentivizing sustainable energy consumption and habits. Lastly, the AI Energy Model optimizes energy production and consumption, fostering efficiency and reducing environmental impact.

Solmag's comprehensive suite of products presents a groundbreaking approach to connect global energy sources, particularly solar. By offering a multifaceted platform that combines user empowerment, data-driven insights, collaborative trading, gamification, and AI-driven optimization, Solmag promises to play a pivotal role in shaping the future of sustainable and interconnected energy ecosystems. It is not just a technological advancement; it's a path toward a greener, more efficient, and sustainable global energy future.

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“A CIVILIZATION'S LEVEL OF TECHNOLOGICAL ADVANCEMENT CAN BE CLASSIFIED BASED ON ITS ABILITY TO HARNESS AND USE ENERGY.”

-NIKOLAI KARDASHEV-