Engaging picture of case-study, ideally a mixture of people and technology

Chang Mai University P2P Trading Trial

Powerledger, 21/02/2024

Key facts

Location (town + country)	Chiang Mai, Thailand
Duration (start/end dates)	*2023, End date: tbd*
Funding source	
Project lead (organisation)	*Bangchak Corporation Public Company Limited (BCPG)*
Project partners	*Chiang Mai University, Powerledger, Chiang Mai University Electricity Authority (CMUEA), TDED*
No. of participants	*Around 100 (as of Feb 2024)*
Case study type	*{Proof of concept/Technical demonstration}.*

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Case study statistics

Parameter	As designed	As built
No. of participants	*100 (Initially)*	*100 (as of Feb 2024)*
Generation (kWp)	*10 MWp (Initially)*	*12.0 MWp*
Storage (kWh)	*1200*	*1200*
Unit price ($/kWh)	*25 % below retail price*	*25 % below retail price*
Project cost ($)		

Summary of case (~200 words)

The CMU P2P trading project is part of the smart campus platform developed by the Thai Digital Energy Development (TDED) and Chiang Mai University (CMU), in collaboration with several smart grid service providers such as BCPG and Powerledger. This initiative supports CMU's reputation as a pioneering 'green' institution by propelling its carbon neutrality goals. BCPG, CMU, TDED, PEA and Powerledger embraced this opportunity and created a project that realized the trading of solar energy generated across 150 university buildings with rooftop solar, through a blockchain-based P2P energy trading platform. This helps create a 'circular economy' within the university ecosystem by utilizing all solar PV generation on-site. Additionally, the project aims to facilitate the transition of a specific CMU building to operate with net zero greenhouse gas emissions and showcase a business model contribution to the digital utility strategy of the Provincial Electrical Authority (PEA).

The trading community comprises all three CMU campuses, with two being co-located and the third situated 5.7 km away. The trading platform enables the transfer of surplus energy between all university buildings. The project aims to demonstrate the dynamics and benefits of a P2P sharing community within a diverse community such as a university complex.

An additional objective was to demonstrate the advantages and capabilities of the P2P energy trading platform, while also collecting important insights to improve future initiatives. Through this novel approach to energy management, BCPG, CMU and Powerledger seek to transform the energy industry into a more decentralized and efficient system for exchanging energy.

Impact highlights (~4*50 words)

- Impact 1: *To track and visualize electricity generation and load across the university buildings thereby showcasing the total consumption of renewable resources and grid imports. This enables participants and the application host to get insights into their usage patterns and incentivizes increased engagement with the P2P community.*
- Impact 2: *By fostering a sharing economy, the goal is to lower the average electricity costs. This is achieved by enabling the sale of surplus electricity to community peers at*

rates more attractive than standard grid prices. This incentivizes additional participants to join the community and extend benefits.

- Impact 3: *Support of a specific participant (CMU Smart Building) to become a net-zero emitter of GHG. The platform enables the Smart Building to receive the highest share of renewable energy of any building thereby increasing its self-sufficiency with local energy to a maximum extent.*
- Impact 4: *Incentivising the installation of additional renewable energy resources through more beneficial return on investment conditions through the opportunity to sell surplus energy at higher P2P rates rather than usual feed-in rates thereby increasing the overall installed solar PV capacity across the university.*

Project aims and objectives (~250 words)

The project aims to create an automated P2P trading community where all participants benefit from engaging with their peers. The overarching goal is the demonstration of P2P energy trading across participants who belong to one entity but have unique energy-related requirements and together maximize the utilization of DER installations of the prosumers in the project. The project evaluates the specific needs of all participants and provides real-time optimization of energy usage across the campus.

In addition, the platform enhances engagement by presenting load and generation profiles along with trading data through user-friendly interfaces, aiming to motivate participant involvement and fostering a closely connected energy community that satisfies its energy needs from the bottom up rather than relying fully on the backup grid and fossil-dominated electricity.

By leveraging surplus energy among peers and utilizing intuitive interfaces, the platform aims to increase renewable energy awareness and encourage a more interconnected energy community with an agreed allocation of renewable energy between faculties and buildings and real-time tracking.

Altogether, the main objectives include replacing expensive grid electricity with alternative energy sources based on renewables and increasing the self-sufficiency of the community with local energy to a maximum extent. The project's success hinges on creating a comprehensive digital platform that efficiently oversees and analyzes both the energy exchanges and the financial transactions associated with energy generation and consumption within the CMU smart campus.

Mr. Bundit Sapianchai, Former BCPG President and CEO:

"*Our project is about exploring what's possible. It's a microcosm of how the city will operate with clean distributed energy".* Link

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Description of case (≤ 6 pages)

- Market value proposition and key activities: *The value proposition of this project is to utilize peer-to-peer energy trading and blockchain to enable dynamic sharing of electricity between campus buildings of Chiang Mai University enabling participants to receive cost benefits compared to business-as-usual operations. Key activities include the collection of import and export meter readings, which are transferred via a secure remote process into the Powerledger Platform. The platform monitors generation and consumption and creates automated bids and asks for participants. Additionally, bids and asks are matched in an automated manner. The transaction outcomes are communicated to the participants via a customized user interface and transferred to the utility for billing purposes.*
- Financing/funding (who contributed funding and under what terms): *Provided by various project partners, subject to contract terms.*
- Legal structure (co-operative; partnership; social enterprise; etc): *Powerledger is the SaaS provider of the Powerledger Platform to the project host.*
- Timeframes including for project initiation; funding cycles; detailed design; legals and contracts; participant recruitment; trial duration; decommissioning; etc: *The project was initiated in 2018 with solar PV installations taking place in subsequent years. Live trading started in 2023 and it has been ongoing since with some interruptions due to changes to meter readings transfer and trading logic.*
- Stakeholders/project partners involved (organogram): *BCPG as application host and CMU represented by several submeters which are the participants are key stakeholders. The Provincial Electricity Authority (PEA) is the network operator and retailer. Powerledger as SaaS provider provides the technology platform. The Thai Digital Energy Development (TDED) develops a smart campus platform for CMU, which incorporates the Powerledger services.*
- Participant types and characteristics: residents (social housing, private rented, private ownership; socioeconomic status); SMEs (types and loads); social institutions (schools, etc). What were the inclusion/exclusion criteria for participating in the case? *The project involves several university buildings across three campuses (Suan Sak Area, Suan Dok Area, Mae Hia Area).*
- Participant recruitment methods, incentives and protection (opt-in or opt-out; were participants paid to participate; were they exposed to financial losses or other risks; etc): *All participants are part of the same entity (CMU) which simplified the recruitment process. Participants receive financial benefits through reduced electricity bills and have the opportunity to opt out as per the agreed contract details. No adverse side effects on participants are created through the project as all the required infrastructure was already existent (hardware: smart meters) or delivered by stakeholders (software: trading platform, data protocols, cloud storage etc).*
- Participants' role in co-creation of project and objectives (if any): *BCPG had a direct role in the planning, setup and configuration of the solar energy system in CMU. BCPG supplied Powerledger with all the necessary details regarding the on-site setup of the*

solar meters, as well as the method for energy allocation by the solar meters. BCPG also approved the P2P trading logic, aiming to prioritize a specific building at CMU as a key target for achieving Net Zero emission goals.

- Case study functional requirements.
    - Regulatory structure and requirements (beyond compliance with existing law), e.g. constraints imposed by regulatory sandboxes.:
    - *Thailand is advancing regulations that facilitate P2P trading, yet there are limitations on its implementation. There is no FiT for solar surplus and for every transaction that happens via P2P, a separate wheeling charge is imposed which is handled as a fixed charge.*
    - Stakeholder requirements (trial design requirements): *1) Allocate energy with priority for a specific building to contribute to net-zero emissions, 2) transacting energy P2P between buildings, 3) Replicate BAU case for energy balancing with the grid after transacting with preferred energy source.*
    - Technical architecture (representation of assets: generation; storage; control; load types (electric vehicles (EVs); heating, ventilation and air conditioning (HVAC); small and medium-sized enterprises (SMEs); etc): *The generation assets part of this project were multiple individual solar PV systems across various campus buildings with a total capacity of 12 MWp. The solar PV capacity is currently being extended to encompass a total of 15 MW.*
    - *A battery system with an energy capacity of 1.2 MWh is installed onsite. Load requirements of individual buildings are recorded by the main meters and not split into individual load types behind the meter. The generation of solar PV systems is recorded separately.*
    - Data architecture (including data ontology/standards where used): *ISO standards (time stamps, naming conventions,etc…)*
    - Financial model (representation of financial flows and markets): *Powerledger charges the client a standard software license and transaction-based fees. P2P fees are 25% less than the standard grid rates, as decided by CMU/BCPG.*
- Geographical scale: *Local - The project encompasses three CMU campuses. Two of them are colocated, the third is located 5.7 km away.*
- Governance structure (organogram)
- Electricity network ownership (public or private): *The electricity grid is publicly owned by PEA.*
- Management of changes in case study over time (i.e. participants leaving; assets failing; data losses; etc): *The trading group has not undergone changes since inception and will be extended by additional solar PV capacity and additional buildings likely in 2024.*

Outcomes and achievements (~1 page)

Generally, the project is still in an early stage of live trading, the full impact will be investigated at a later stage but some high level contributions have been analyzed.

What outcomes are anticipated from the pilot? *The main outcome anticipated is a contribution to CMU's transition to a smart campus utilizing a maximum of locally generated renewable energy. Additionally, the pilot project was designed to explore how P2P energy trading could assist certain sections of the university in reaching carbon neutrality.*

What outcomes were delivered by the pilot?
By conducting an in-depth analysis of a typical business-as-usual scenario, including the cost of energy from both financial and emissions viewpoints, the pilot demonstrates that carbon neutrality is achievable through P2P trading, resulting in savings in both money and emissions.

What was the primary goal of the project? (please tick one) *

☐ **Grid integration** - e.g. management of grid constraints; balancing of demand and supply; promote/include distributed energy resources (DER) generation; optimisation of energy behaviour to benefit system; aggregation of participant energy loads.

☐ **Environmental benefits** - e.g. promote or include renewable energy (RES) generation.

X **Empowering individuals** - e.g. participants have greater control over preferences; self-sufficiency (autarky); autonomy.

☐ **Local benefits** - e.g. improvement to local economy (job creation etc); independence from other regions; community as focal point for engagement; shared benefits across the community.

☐ **Creating market value** - e.g. economic incentives for participants; access wholesale, balancing and ancillary service markets.

Were there any secondary goals of the project? (please tick as many as apply) *

X **Grid integration** - same description as above

X **Environmental benefits** - same description as above

☐ **Empowering individuals** - same description as above

X **Local benefits** - same description as above

X **Creating market value** - same description as above

☐ If other, please give a brief description

** These questions are compulsory to answer*

Key takeaways

The project aims at creating a market value by providing economic advantages to project participants through reduces rates.

Additionally, it aims at promoting the usage of RES, thereby creating environmental benefits and optimize the usage of surplus energy.

Lastly, it empowers individuals by providing them dedicated access to new energy sources and creates local benefits by reducing the reliance on the wider network.

Obstacles encountered when conducting the pilot (~1 page)

Highlight the obstacles you came across when conducting the pilot. A few examples are mentioned below:

- Regulatory landscape or obtaining regulatory permission
- Recruiting and retaining participants
- Interoperability of systems
- Performance of hardware and software
- Restricted timeline
- Availability of funding
- Ethics and data protection

The main obstacles encountered for the project were of a technical nature.

Flexibility requirements to accommodate with different data structures of software systems of different stakeholders.

Hardware performance: There were multiple issues and blockers that were mitigated throughout the CMU pilot project, that were mostly specific to the technical configuration of the on-site set-up. When the project configuration was initially set up, there was some lack of understanding of how the meters were set up on site.
This caused issues relating to inaccurate trading happening. The system had to go through reconfiguration, to account for the on-site setup, and trading was successfully conducted and validated.

Software performance: Another key obstacle was the inaccuracy of readings at times, multiple intervals of missed readings and different data formats (interval and cumulative) used on both ends. This caused trading to be stopped multiple times, and having readings and transactions deleted so that readings could be reingested again and traded.

Key takeaways

Efficient interfaces between software systems of different stakeholders are a key prerequisite for effective project implementation

Reliable hardware systems are important to depict P2P transaction realistically.

Consistent and accurate meter readings are required to understand participant behaviour and depict their usage and transactions realistically.

Key learnings for other pilots (~250 words)

If you were repeating the pilot project: what would you have done differently, what are your key lessons learned and key takeaways?

Understanding of the on-site setup: Having better documentation, to understand how the on-site configuration was set up, particularly the positioning of meters and their connection to the grid.

Software configuration and interfaces between systems: The issues related to readings transfer and accuracy of readings revealed that the interoperability of systems and functioning of all related infrastructure has to be determined ahead of project implementation to avoid multiple rounds of readings transfer and solution design.

Key takeaways

Determine functioning of key components such as smart meters and readings transfer interfaces.

Discuss and document the setup of participants to understand their connection to other participants and the grid.

Recommendations for policymakers (~400 words)

Please fill in the table below, by including recommendations for policymakers based on your experience of conducting the pilot (in particular obstacles encountered).

What?	Who?	Why- Example from case study?	How?	When?
Investment in adoption of smart meters and DERs	*Central / state government*	*To simplify and accelerate participation in and adoption of P2P trading concepts*	*Direct cash-funding for installation of smart meters and DERs; tax benefit amongst others*	*Prior project inception*
Creation of policy framework supporting the implementation and recognition of P2P concepts as part of energy market regulation	*Central government / state government*	*To streamline the conceptualisation of P2P projects*	*Public consultations, feedback mechanisms and stakeholder workshops*	*Prior project inception*
Implementation of guidelines for customer data protection which enable P2P trading and usage of blockchain	*Central government / state government*	*Ensuring the privacy and security of user data in P2P transactions enhances trust and participation in the system, as seen in successful blockchain applications.*	*Establishing clear data protection standards, regular audits, and secure technology protocols.*	*Prior to or alongside the launch of P2P trading platforms to ensure foundational trust and security measures are in place.*
Educate consumers and businesses about the benefits and	*State governments / Utilities*	*Ensuring customers and businesses are aware of P2P energy trading*	*Through workshops, seminars, online courses, and*	*Initiate prior to and continuously after the introduction of P2P trading platforms to*

operation of P2P energy trading to increase adoption		*thereby increasing interest and participation in projects*	*informational materials distributed across various media platforms.*	*maintain engagement and adapt to evolving market needs.*
Support research and development in blockchain and energy technologies to enhance the scalability and security of P2P platforms	*Central government / state government / academic institutions / private sector partnerships*	*Innovation in technology, particularly blockchain and smart contracts, can enhance the efficiency, security, and scalability of P2P platforms, demonstrated by projects that successfully integrated these solutions.*	*Providing grants, tax incentives for R&D activities, creating innovation hubs, and facilitating public-private partnerships.*	*Ongoing, with a focus on early-stage support to seed innovation and later-stage support to bring successful projects to market.*

Further information/References

- Website: *https://www.powerledger.io/clients/tded-thailand*
- Public data sources: *https://energytag.org/projects/smart-city-at-chiang-mai-university/*
- Other relevant documents