

Product

Book on product development. Metering, Microgrid OS, Batteries, Invertors, Solar panels

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Capability Evaluation Criteria

Attribute	Cost	Interoperability	Long term relationship	Deployment readiness	Build Quality
1	over market price	proprietary standards, risk of vendor lock-in	cannot reliably communicate, needs aggressive follow up and management	timeline unclear or unknown	Questionable may need replacement anytime or unknown durability
3	close to or exactly at market price	use some open and proprietary standards	can communicate reliably but needs incentives to do so	timeline is known but is volatile or longer than what is needed	Acceptable could last 2 to 3 years
5	under market price	fully using open standards	communicates reliably and incentives are already aligned	timeline is known and predictable or within acceptable duration	Durable can last 3 years or more

Microgrid OS

Monitoring and Steering assets on the microgrid

Microgrid OS Evaluation

OS	Cost (money)	Interoperability	long term relationship	Deployment Readiness	Quality
NewSunRoad Stellar					
Remot by Innovex					
Inhemeter					
GxF by LF Energy					
MicroPower Manager					
Hyphae by LF Energy					
Prospect					

New Sun Road Stellar

Stellar seems to have all the capabilities we want from their website but Michael (CTO) confirms that he is not sure that the meters are using are supported 100%. They can likely monitor usage data but may not be able to remote on/off. It is proprietary.

Remot by Innovex

The Innovex team has not been responsive to our email requests for more information about this. Also, their website seems to be frequently down.

Inhemeter

We were not about to get a demo or even an order for meters out of this company. Their meters are known to be good quality but I think they are not interested in working with us because we are

a small new company.

GxF by LF energy

This project is actually a microgrid OS that currently still being open sourced. A number of key components like the GUI for smart metering is not yet open sourced. It is worth watching because it has potential to run for a microgrid because it has smart metering and public lighting capabilities.

MicroPowerManager

This is one looks very promising. Open source and field tested. I think it's ripe for us to take to production and prove it out. It also has an associated battery management capability which makes this community seem like a good fit for NFE.

Hyphae by LF Energy

I think Hyphae has a bold vision for an autonomous microgrid. It currently only has peer to peer battery power interchange capabilities and no metering. Also not get field tested but has some simulation capabilities.

GxF Platform Evaluation

Overview

GxF is an opensource platform (set of capabilities; metering, public lighting) for distribution of power on a grid. It is currently being used by and was donated to the open source community by a Dutch utility company called Alliander.

Links

Here's some useful links from my discovery work on GxF

- [Understanding it's capabilities](#)
- [Official docs](#)
- [Video Overview](#)
- [GxF on M1 Mac](#)
- [Microgrid Management Software](#)

Next Steps

Continue deployment to digital ocean VM

- Start by reviewing all [these packages](#) and understanding which ones you want to deploy or explore whether it makes more sense to rebuild the latest release and deploy packages from that.
- To run the GXF (Grid eXchange Fabric) platform, you generally need only a subset of the packages published in the OSGP GitHub organization—specifically, those that are direct dependencies for the platform's core services and adapters.
- GXF is a modular system, and the required packages depend on your deployment goals. Commonly, the following package types are used:
- Core Platform Packages – These include the main server components, messaging infrastructure, shared libraries, and authentication modules.
 - Protocol Adapters – Depending on your use case, you'll need the adapters that communicate with your field devices (e.g., OSPL, DLMS, IEC61850).
 - Domain and WS Adapters – These provide domain-specific logic and web service endpoints (e.g., smart metering, microgrids, public lighting).
 - Shared Utilities – Supporting packages shared between multiple modules.

Steps to Determine Required Packages

- Review the GxP Deployment Documentation: The official [GxP deployment guide](https://github.com/OSGP/open-smart-grid-platformdocumentation) lists the core components and adapters you need to deploy for a standard platform.
- Match Packages to Components: Identify which packages correspond to those components (e.g., "osgp-adapter-domain-smart-metering", "osgp-adapter-ws-publiclighting", etc.).

Focus on Smart metering Use Case: One of the maintainers tells the application's current design allows you to deploy only the smart metering components, along with some core GxP components. You'll need the following components for smart metering:

- core GxP components:
 - osgp-adapter-domain-admin
 - osgp-adapter-domain-core
 - osgp-adapter-ws-admin
 - osgp-adapter-ws-core
 - osgp-core
 - osgp-logging
- Smart metering specific components
 - osgp-adapter-domain-smartmetering
 - osgp-adapter-ws-smartmetering
 - osgp-protocol-adapter-dlms
 - osgp-throttling-service
 - osgp-secret-management
- Smart metering simulator
 - osgp-simulator-dlms-triggered
 - dlms-device-simulator-starter

These components do not contain any user interface but provide a SOAP interface for communication with the GxP platform. The user interface is currently not part of the open-source implementation.

- We could set up RESTful APIs and build a GUI we can use and contribute back to the community or we can also try to build a UI from the SOAP API available. Open to either, I don't know how much we can do with API only if we don't have a GUI.

Historical Context

From Sander (Maintainer). I recommend you join the [project mailing list](#), introduce yourself (I already did) and use it to ask questions along the way.. I have found it very useful and Sander is very helpful in responding there.



We are currently in the process of creating an open-source containerized solution for deploying and testing GxF. With this solution it will be possible to run GxF locally in k3d - a lightweight wrapper to run k3s (a minimal Kubernetes distribution) in docker - and to run automated tests using cucumber. For this you will need at least 32 GB of RAM, 64 GB is preferable. The solution can be found here: <https://github.com/OSGP/gxf-gitops>. Container images can be found in https://github.com/orgs/OSGP/packages?repo_name=open-smart-grid-platform. Currently the gxf-gitops repository only contains the charts to deploy and test our flexible public lighting solution. The deployment of our smart metering solution is still work in progress.

As a side note, I would like to mention that the current smart metering implementation is specifically tailored to the Dutch market, so it would probably need several changes to make it operable outside of the Netherlands.

In the past we also used to have a distinct microgrids solution available, but as it was no longer used, we removed it from our codebase. However, the old microgrids components can still be found in the GitHub history:

- <https://github.com/OSGP/open-smart-grid-platform/tree/release-5.28.0/osgp/platform/osgp-adapter-domain-microgrids>
- <https://github.com/OSGP/open-smart-grid-platform/tree/release-5.28.0/osgp/platform/osgp-adapter-ws-microgrids>
- <https://github.com/OSGP/open-smart-grid-platform/tree/release-5.28.0/osgp/protocol-adapter-iec61850>
- <https://github.com/OSGP/open-smart-grid-platform/tree/release-5.28.0/integration-tests/cucumber-tests-platform-microgrids>

but they will require some serious dusting off to make them usable again.

Metering

Metering Evalutation

Attribute	Cost (money)	Interoperability	long term relationship	Deployment Readiness	Build Quality
Inhemeter	3	5	3	3	5
Gomelong Meter (no PLC meter with built-in relay)					
Sagewood Meters					
Calin Meter	?	5	5	?	5
Spark Meter	3	1	3	1	5
China Brandless Meter	5	1	3	3	1
iSmart Meter	1	5	3	1	3
Hoptele Meter	3	5	5	5	3

Inhemeter

China/UG based OEM. Edwin Cho is our contact. 0 774 667667, +86 135 3210 1631. 1way Meter boxed FOB 46Usd

Cloud Vending System 100 USD per month up to 1000 meters

Free On Board (FOB)

Which means not including shipping and inland transport and any clearance fees

Sagewood

Sagewood is a UK based logistics supplier. +44 7831 135528 - Manoj

Got some feedback on this one . Here goes... Hi Hilary, all good am still in china snd heading back tomrrow to uk. China was on national holidays from 30 April to today May 5. Now working on it. I

have discussed with the team - Due to small number of meters for the system, we suggest a cloud version so you don't have to invest in hardware. Many endusers are doing this. Meters we can handle but MOQ is around 2000 metres. Or we can manufacture them to vary with other orders. So you don't have to worry about MOQ. Allow me few days and I revert back.

Hoptele

China supplier / OEM. Single phase PLC meter. Wall mount with PLC support and inbuilt relay. DIN rail mount with PLC support but no inbuilt relay. 70 US per meter. No vending system.

Gomelong

China based supplier, has a local distributor in Uganda. Gomelong Meter (no PLC meter with built-in relay). May have none PLC option. Pricing for "digital meter" (probably with no relay) 127k UGX per unit.

Spark Meter

Kenya based. Proprietary system (Meters + AMI). 70 USD per meter. Comes with a DTU that requires line of sight to meters. 1 DTU per 2000 meters max. 600 USD per year per DTU.

Calinmeter

Have a DIN rail PLC with built-in relay. Waiting on quote. May also have AMI

iSmart

Found these ones online. They also have a [PLC with built-in relay](#).

The meter sample fee: 10pcs*600USD/pc; the DCU will need 7500USD/pc; the PC software for testing is 5000USD/pc; the optical head is 300USD/pc; the pilot system will need 30000USD; the technical assistance fee is 1500USD; DHL shipping cost is around 5500USD.

Wired vs Wireless meters

Wireless open standards

Comparison

Protocol	Frequency	Range	Data Rate	Topology	Power Usage
Zigbee	2.4 GHz, 915/868 MHz	Short	Up to 250 kbps	Mesh, Star	Very Low
LoRaWAN	868/915 MHz	Long	0.3-50 kbps	Star	Extremely Low
Wi-SUN	868/915 MHz	Medium to Long	50-300 kbps	Mesh	Low to Medium
Bluetooth LE	2.4 GHz	Short	125 kbps-2 Mbps	Star, Mesh	Very Low
IEEE 802.11ah	Sub-GHz (~900 MHz)	Medium	Up to Mbps	Star, Tree	Low
IEEE 802.15.4	Various	Short-Medium	20-250 kbps	Mesh, Star	Very Low
Thread	2.4 GHz	Short	250 kbps	Mesh	Very Low

Recommended for Residential Microgrid Applications in Uganda:

- **LoRaWAN:** If covering a large geographical area (kilometers), due to its excellent range, penetration, and low power use.
- **Wi-SUN:** For robust, medium-to-large-scale smart metering networks, especially if a mesh topology is desirable.
- **Zigbee/Thread:** Ideal for dense residential areas where devices (meters) are closer together, benefiting from low power and reliable mesh networking.

Wired Open standards

Comparison

Protocol	Standard	OSI Layers	Medium	Topology	Range	Data Rate	Typical Application Areas	Remarks

G3-PLC	ITU-T G.9903	Layers 1-2	Power Lines	Mesh, Star	Up to several km	2.4–35 kbps	Smart grids, AMI, smart meters	Robust, designed for noisy environme nts; supports IPv6, strong security
PRIME	ITU-T G.9904	Layers 1-2	Power Lines	Mesh, Star	Up to several km	21–128 kbps	Smart metering, distributio n automatio n	Optimized for higher- speed PLC, widely used in European smart meter rollouts
IEEE 1901.2 PLC	IEEE 1901.2	Layers 1-2	Power Lines	Mesh, Star	Up to several km	2.4–500 kbps	Smart grids, smart cities	High interopera bility, IPv6 support; ideal for utility and smart city deployme nts
M-Bus (Meter- Bus)	EN 13757	Layers 1-2	Twisted pair cable	Bus	Up to ~1 km	0.3–38.4 kbps	Meter reading (water, heat, gas)	Widely used in Europe; reliable, low-cost wired solution
KNX	ISO/IEC 14543-3	Layers 1-2	Twisted pair cable	Bus, Star, Tree	Up to ~1 km	9.6 kbps	Building automatio n, home control	Open standard for building automatio n, popular in Europe
BACnet MS/TP	ASHRAE 135	Layers 1-2	RS-485 twisted pair	Bus	Up to ~1.2 km	9.6–115.2 kbps	Building automatio n, HVAC controls	Common in building and industrial automatio n; robust, scalable

Ethernet	IEEE 802.3	Layers 1-2	CAT5/CAT 6 cable	Star, Tree	Up to ~100 m	10 Mbps–100 Gbps	Networking backbone, smart buildings	High-speed, standard networking; widely supported across industries
RS-485 (EIA-485)	EIA-485	Layers 1-2	Twisted pair cable	Bus	Up to ~1.2 km	Up to 10 Mbps	Metering, industrial control systems	Simple, robust, widely used for serial data transmission
CAN Bus	ISO 11898	Layers 1-2	Twisted pair cable	Bus	Up to ~1 km	Up to 1 Mbps	Automotive, industrial automation	High reliability, robust error detection, common in harsh environments

Recommended Wired Protocols for Residential Microgrid Metering (Uganda)

- **PLC-based (e.g., G3-PLC or IEEE 1901.2):**
 - Ideal due to existing infrastructure (power lines).
 - Good for scalable, reliable deployments.
- **RS-485:**
 - Robust, simple wiring suitable for smaller clusters.
 - Common for direct-wired connections (local clusters).
- **M-Bus:**
 - Suitable if integrating gas, water, or heat metering alongside electricity

Comparison between wired and wireless

Aspect	Wireless Option (Wi-SUN/LoRaWAN)	Wired Option (G3-PLC, RS-485)	Recommendation
Installation Cost	☐ Lower	☐ Higher (cabling, labor)	Wireless ☐
Maintenance Cost	☐ Moderate (battery replacements)	☐ Low (no batteries required)	Wired ☐
Reliability	☐ Medium (environment dependent)	☐ High (consistent, stable)	Wired ☐

Aspect	Wireless Option (Wi-SUN/LoRaWAN)	Wired Option (G3-PLC, RS-485)	Recommendation
Scalability	✅ High (easy additions)	✅ Moderate to low (harder additions)	Wireless ✅
Range/ Coverage	✅ Good (with repeaters)	✅ Excellent (using PLC)	Wired (PLC) ✅
Security	✅ Good (depends on setup)	✅ Very Good	Wired ✅
Installation Time	✅ Short	✅ Longer	Wireless ✅
Physical disruption	✅ Minimal	✅ High (trenching, wiring)	Wireless ✅

? Recommended Choice: Hybrid or G3-PLC

? Primary Recommendation: G3-PLC (Wired)

Given your scenario (dense apartment blocks with existing electrical infrastructure and meters located closely on the ground floor), **G3-PLC** offers significant advantages:

- **Low Ongoing Maintenance:** No batteries to manage.
- **High Reliability:** Stable signal leveraging existing wiring.
- **Cost-effective (long-term):** Minimal ongoing costs after initial installation.
- **Robust & secure:** Highly suited for apartment complexes.

? Alternate Recommendation: Hybrid (PLC Backbone + Wireless Endpoints)

If flexibility or future expansions matter, consider a hybrid setup:

- Use **G3-PLC** within each block to connect meters reliably to a local gateway.
- Connect block gateways to a central system via wireless (**Wi-SUN or LoRaWAN**). This reduces physical disruption between buildings while maintaining the reliability within each block.

This hybrid method provides the best of both worlds—flexibility and low maintenance.

Links

[Chatgpt detailed thread](#)

Metering

CalinMeter

We got the API docs [here](#)

Storage

Batteries and invertor

Cost Analysis: Procurement and Shipment of 60kWh LFP BYD Batteries from China to Uganda

1. Executive Summary:

This report provides a comprehensive cost estimate for purchasing and shipping a 60kWh Lithium Iron Phosphate (LFP) battery pack manufactured by BYD from China to Uganda. The analysis encompasses the estimated purchase price in China, various shipping options and their associated costs, and the import duties and taxes applicable in Uganda. The total estimated cost is subject to considerable variation depending on factors such as the prevailing market price of batteries, the chosen shipping method (sea or air freight), and the specific import duties levied by the Ugandan authorities at the time of import. This report outlines a potential cost range to aid businesses in Uganda in their procurement planning and financial forecasting for such a significant component.

2. Introduction:

BYD (Build Your Dreams) stands as a prominent global manufacturer of rechargeable batteries, including Lithium-ion and LFP chemistries, with a significant presence in the electric vehicle and energy storage sectors.¹ The company's LFP batteries are particularly recognized for their enhanced safety features and cost-effectiveness, making them a preferred choice for a wide array of applications, from electric vehicles to stationary energy storage systems.¹ Given BYD's established position in the battery market, this report aims to provide a detailed cost analysis for an entity in Uganda seeking to procure a 60kWh LFP battery pack from this leading Chinese manufacturer. This analysis will delve into the primary cost drivers, including the initial purchase price of the batteries in China, the logistical expenses associated with shipping to Uganda, and the governmental levies in the form of taxes and duties imposed by both countries. Understanding these components is crucial for accurate budgeting and informed decision-making for any organization undertaking such an international procurement.

3. Estimated Purchase Cost of 60kWh BYD LFP Batteries in China:

The landscape of lithium-ion battery pricing in China has been characterized by a notable downward trend, primarily influenced by decreasing raw material costs and heightened competition among manufacturers.⁴ This trend is particularly evident in the pricing of LFP batteries, which generally exhibit a more competitive cost structure compared to Nickel Cobalt Manganese (NCM) batteries.⁶ Recent industry reports suggest that the price of LFP battery cells in China, which stood at approximately \$70 per kilowatt-hour (kWh) in the near past, was anticipated to undergo substantial reductions throughout 2024, with further potential decreases projected for 2025.⁴ Some forecasts even indicated the possibility of LFP cell prices falling below \$56/kWh by mid-2024 and potentially reaching as low as \$36/kWh by 2025.⁴

Examining online marketplaces such as Alibaba and Made-in-China reveals a variety of BYD LFP battery products listed by different suppliers, with prices varying based on factors like capacity and the specific vendor.¹⁶ Given these fluctuating market conditions and supplier-specific pricing, it becomes apparent that a precise, fixed purchase price is difficult to ascertain. Instead, a more realistic approach involves considering a price range based on the available data.

Based on the per kWh price ranges identified in the research, the estimated purchase cost for a 60kWh BYD LFP battery pack in 2024 can be projected. Utilizing the lower end of the price spectrum at around \$49/kWh¹² and the higher end at approximately \$70/kWh⁴, the following cost range can be estimated:

Table 1: Estimated Purchase Cost Range of 60kWh BYD LFP Batteries in China (2024)

Price per kWh (USD)	Estimated Cost for 60kWh Pack (USD)
Low Estimate: 49	2,940
Mid Estimate: 60	3,600
High Estimate: 70	4,200

This suggests that the purchase cost for a 60kWh BYD LFP battery pack could range from approximately \$2,940 to \$4,200 based on 2024 price levels. It is important to note that potential price reductions anticipated for 2025 could further lower these estimates.

For sourcing these batteries, platforms like Alibaba and Made-in-China serve as potential avenues, hosting numerous suppliers and distributors of BYD batteries.¹⁶ Several specific companies have been identified as offering BYD battery products.¹⁶ Additionally, BYD itself operates an energy storage division, which could be a direct point of contact for procurement.²⁵ While online platforms offer a broad selection of suppliers, engaging directly with BYD or their officially recognized distributors might provide enhanced assurance regarding product quality and potentially more favorable pricing terms, especially for substantial orders like a 60kWh battery pack.

4. Shipping Cost Analysis: China to Uganda:

Transporting a large and heavy item like a 60kWh battery pack from China to Uganda necessitates careful consideration of the available shipping methods, each with its own implications for cost and transit time. Sea freight generally emerges as the more economical option for such substantial cargo.³⁷ Within sea freight, two primary options exist: Less than Container Load (LCL) for smaller shipments that don't fill an entire container, and Full Container Load (FCL) for larger volumes.³⁷ The typical transit time for sea freight from China to Uganda ranges from 5 to 8 weeks.³⁸

Conversely, air freight offers a significantly faster transit time, typically between 7 to 10 days for standard air freight and 2 to 4 days for express services.³⁸ However, this speed comes at a considerably higher cost compared to sea freight.³⁷

Estimating the precise shipping costs requires considering the weight and volume of the 60kWh LFP battery pack. Research suggests that a battery pack of this capacity can vary in weight depending on the manufacturer and design, ranging from approximately 438kg for a Tesla Model 3 battery⁴⁰ to over 700kg for a Delong battery pack.⁴¹

Based on these weight figures, the estimated cost for air freight, which is typically calculated per kilogram, can be projected. Using a cost range of \$7.5 to \$10 per kg³⁷, the air freight cost for a 60kWh battery pack could range from \$3,285 (438kg * \$7.5/kg) to \$7,120 (712kg * \$10/kg).

For sea freight, the cost is often determined by volume, particularly for LCL shipments, with rates ranging from \$150 to \$190 per cubic meter.³⁷ While the exact volume of a 60kWh battery pack was not explicitly available in the research, its substantial size likely makes an FCL shipment (using a 20-foot container) a more practical approach. The cost for an FCL 20-foot container from China to Uganda is estimated to be between \$4,000 and \$6,000.³⁷

Table 2: Estimated Shipping Cost Comparison (Sea vs. Air Freight)

Shipping Method	Cost Metric	Estimated Cost (USD)	Transit Time
Sea Freight (LCL)	\$150 - \$190 / m ³	Requires Volume Data	5 - 8 weeks
Sea Freight (FCL 20ft)	Per Container	\$4,000 - \$6,000	5 - 8 weeks
Air Freight	\$7.5 - \$10 / kg	\$3,285 - \$7,120	7 - 10 days (Std)

The selection of the shipping method will have a significant impact on the total cost. Sea freight offers substantial cost savings but necessitates a longer lead time, while air freight provides speed at a considerable premium.

Engaging a freight forwarder is a common practice for international shipments to manage the complexities of logistics and customs procedures.³⁷ These services typically involve additional fees covering documentation, customs clearance in China, and overall shipment coordination. Furthermore, it is important to anticipate potential surcharges such as fuel adjustments, port handling fees, and other miscellaneous charges that can add to the base shipping costs. Therefore, when budgeting for the shipment, an allowance for freight forwarder fees and these potential unforeseen surcharges should be included to ensure a more accurate overall cost estimation.

5. Tax and Duty Implications:

Navigating the tax and duty implications in both China and Uganda is a critical aspect of the overall cost analysis.

In China, the research material does not explicitly mention specific export taxes levied on batteries. While standard export procedures and minor administrative fees might be applicable, significant export duties on this commodity appear unlikely based on the provided information. Nevertheless, it is prudent to verify this with the chosen supplier or a freight forwarder based in China to preempt any unexpected charges at the point of export.

Uganda, on the other hand, has specific import duties and taxes that will apply to the incoming battery pack. Notably, Uganda recently imposed a 25% import duty on electric vehicles, hybrid vehicles, and electric motorcycles.⁴⁸ While batteries are not explicitly listed in this category, their fundamental role as a core component in both electric vehicles and energy storage systems strongly suggests that they are highly likely to be subject to this new import duty. Under the East Africa Customs Union (EACU) common external tariff, most finished products attract a 25% duty, further supporting the likelihood of this tariff applying to the battery pack.⁵⁰ This import duty is expected to be a significant contributor to the overall cost of importing the 60kWh LFP battery pack.

In addition to import duties, Uganda levies a Value Added Tax (VAT) at a standard rate of 18%.⁵⁰ This VAT is typically calculated on the Cost, Insurance, and Freight (CIF) value of the imported goods, which includes the purchase price, shipping costs, and the import duty itself.⁵² Therefore, the 18% VAT will be applied on top of the combined cost of the battery, its shipment, and the 25% import duty, leading to a further increase in the total expenditure.

Other relevant taxes in Uganda include a 1.5% infrastructure tax on imports, designed to fund railway infrastructure development.⁵⁰ Additionally, a 15% withholding tax may be applicable to imported goods and services, although the specific applicability to batteries warrants confirmation with the Ugandan tax authorities.⁵⁰ While these taxes are individually lower than the import duty and VAT, they will collectively contribute to the overall tax burden associated with the import.

It is important to highlight that the Ugandan government offers potential tax exemptions and incentives for local manufacturers involved in the electric vehicle sector. Entities manufacturing electric vehicles, electric batteries, or charging equipment, and meeting specific criteria such as employing at least 80% Ugandan citizens, utilizing at least 80% locally sourced raw materials (where available), and meeting minimum investment thresholds, might be exempt from the 25% import duty and stamp duty.⁴⁸ If the importing entity qualifies under these provisions, they could potentially realize significant reductions in the final cost.

To provide an estimated range for the import duties and taxes in Uganda, the following table illustrates the potential breakdown based on the low and high estimates for the purchase cost and shipping (using sea freight

as the lower shipping cost):

Table 3: Breakdown of Estimated Ugandan Import Duties and Taxes (Based on Sea Freight)

Item	Low Estimate (USD)	High Estimate (USD)
Estimated Value of Goods (Purchase + Shipping)	6,940	10,200
Import Duty (25% of Estimated Value)	1,735	2,550
VAT (18% of (Estimated Value + Import Duty))	1,561.20	2,295
Infrastructure Tax (1.5% of Estimated Value)	104.10	153
Potential Withholding Tax (15% of Estimated Value)	1,041	1,530
Total Estimated Taxes and Duties	4,441.30	6,528

Note: The "Estimated Value of Goods" in the Low Estimate scenario uses the low purchase cost (\$2,940) + the low end of the FCL sea freight cost (\$4,000). The High Estimate uses the high purchase cost (\$4,200) + the high end of the FCL sea freight cost (\$6,000).

6. Total Estimated Cost and Breakdown:

Consolidating the estimated purchase cost, shipping cost (considering both sea and air freight for a comprehensive range), and the total estimated taxes and duties, we can arrive at an overall cost projection:

Table 4: Consolidated Total Estimated Cost Range

Cost Component	Low Estimate (USD)	High Estimate (USD)
Estimated Purchase Cost	2,940	4,200
Estimated Shipping Cost (Sea Freight)	4,000	6,000
Estimated Shipping Cost (Air Freight)	3,285	7,120
Estimated Taxes and Duties	4,441.30	6,528
Total Estimated Cost (Sea Freight)	11,381.30	16,728
Total Estimated Cost (Air Freight)	10,666.30	17,848

The total estimated cost for purchasing and shipping a 60kWh LFP BYD battery pack from China to Uganda could range significantly, potentially from approximately \$10,666.30 (low purchase cost + low air freight + low taxes/duties) to \$17,848 (high purchase cost + high air freight + high taxes/duties). If sea freight is chosen, the range would be approximately \$11,381.30 to \$16,728.

7. Key Considerations and Recommendations:

For any entity in Uganda looking to undertake this procurement, several key considerations and recommendations should be taken into account:

- **Supplier Negotiation:** Actively engage in negotiations with potential battery suppliers in China to secure the most competitive purchase price, especially when dealing with larger order volumes.
- **Incoterms:** Clearly define and agree upon the Incoterms with the chosen supplier. These terms dictate the responsibilities and costs associated with transportation and delivery, including who bears the risk

at different stages of the shipping process.

- **Shipping Insurance:** Secure adequate shipping insurance to protect against potential damage or loss of the valuable cargo during its transit from China to Uganda.
- **Quality Control:** Implement stringent quality control measures in China, preferably through on-site inspections before shipment, to ensure the battery pack meets the required technical specifications and quality standards.
- **Customs Clearance in Uganda:** Partner with a reputable and experienced customs broker in Uganda. Their expertise will be invaluable in navigating the import clearance procedures, ensuring compliance with all Ugandan regulations, and potentially expediting the process.
- **Verification of Import Duties and Taxes:** It is strongly recommended to directly contact the Uganda Revenue Authority (URA) or consult with a qualified tax professional in Uganda. This step is crucial to obtain the most up-to-date and accurate information regarding import duties, VAT rates, and the applicability of any potential exemptions for battery imports. The information provided in this report is based on currently available data but is subject to change.
- **Exploring Local Suppliers:** While the focus of this report is on importing from China, it might be worthwhile to briefly explore the possibility of sourcing similar batteries from local suppliers within Uganda or the broader East African region. However, the availability and cost-effectiveness of BYD LFP batteries through these channels may be limited.
- **Long-Term Cost Analysis:** When evaluating the overall cost, consider the long-term benefits associated with LFP batteries, such as their extended lifespan, high cycle life, and potentially lower maintenance requirements compared to other battery chemistries. These factors can contribute to a more favorable total cost of ownership over the operational life of the battery pack.

By carefully considering these recommendations and conducting thorough due diligence, the procuring entity in Uganda can better navigate the complexities and costs associated with importing a 60kWh LFP BYD battery pack from China.

Vending

Billing and Payment System evalutation

Attribute	Cost (money)	Interoperability	long term relationship	Deployment Readiness	Quality
Pesapal	1	3	5	5	5
Jumia Pay					
Pegasus					
Kitegateway	3	3	5	3	3
Stripe Atlas					
Flutterwave					
Stanbic	3	3	5	3	3

Pesapal

In Brief: Pesapal is a Payment Service Provider that enables various forms of Payment options for business in one platform. Through our Online and Point of Sale Payments services, we ensure customers have a variety of options, and your team can monitor all transactions coming through in one web-based merchant dashboard.

ONLINE PRODUCTS:

Payment Link

We provide a personalised payments page link that enables your clients to pay you both on and off the website. It accepts Visa, Mastercard, AMEX and mobile money payments. For example,

<https://payments.pesapal.com/wildwaterslodge>

Benefits:

- Saves Time & Cost: Rids off the time and resources of having to register orders & bookings manually.
- Drive Sales 24/7: Push for sales all day as long as you are open without fear of overbookings
- Reduce risk on Fraud: All payments are posted in real-time reducing risk of handling payments manually
- You can run promotions on social media pages using links that will direct guests to place direct bookings to any property as well as to complete payment. i.e.

<https://payments.pesapal.com/wildwaterslodge>

Find Below examples of some of the properties and the links that we have Integrated the online booking engine.

- Arcadia Lodges - <https://arcadialodges.reserveport.com/>
- Imperial Hotels - <https://imperialhotels.reserveport.com/>
- BMK House - <https://bmkhouse.reserveport.com/>

B)Point of sale machine

cid:b75f8c5e-18fd-4b37-bd97-65a8b3c42067

Distinct features

- Fast set up and training in 24 hours
- Accept VISA , MasterCard & Mobile Money payments
- Process MTN Mobile Money payments
- Customer receives physical receipts for Mobile Money and card payments, you also retain the merchant copies to help in reconciliations.
- Stable connection with both 4G + Wi-Fi

- Virtual Cards from Booking.com & Expedia can be charged
- Tap and Go feature
- Next day settlement
- Settlement to any Bank in Uganda
- Very competitive transaction fees .
- Access real-time reports
- Branded receipt with your company logo
- Integrate with any 3rd party POS system
- Mitigate fraud and human error during reconciliation

C) Payment Link

We provide a personalised payments page link that enables your clients to pay you both on and off the website. It accepts Visa, Mastercard, AMEX and mobile money payments. For example,

<https://payments.pesapal.com/wildwaterslodge>

Rates and costs

- Card rate per transaction- 2.5%
- mobile money per transaction is 2%
- Online Rate per transaction- 3.5%
- Payment page set up-No cost

Documents required to be submitted

- Certificate of incorporation
- Form 20
- Form 1
- TIN certificate
- IDs for the directors as per the form 20
- Cancelled cheque leaf or Bank statement/ Bank letter confirming bank details
- Completed signup form [Pesapal Sign Up Form new.pdf](#)

Questions from Aaron

Rates and Costs: In your current workflow, are these costs paid by customers (transparently) or charged to the merchant (hidden from the customer)? I pay my Yaka bill with MTN mobile money and when I pay for a token of 200k UGX, I am charged a 4150 UGX. I would like an approach where fees are transparent to the customer and not hidden. [Customers are charged for every transaction they make see attached tariff Tariff .png. In addition, merchant is charged commission of 3.5% per transaction](#)

Payment links/Page: There's two options I would like to discuss here. There examples you shared for the lodges are one option. I would like to know if I can have the option of NFE appearing among the Pay Utility options on [this page](#). Is that option available to us? [This is not an available option, we can engage our developers on this.](#)

Timelines for payment settlement: I would like to understand what your current average timelines are for settling funds to Merchants and Customers in the following cases

- Depositing funds on Merchant accounts after completion of a customer transaction. Let me know if these differ depending on the payment method the customer uses. Understanding these will help my team plan what our cashflow expectations if we decide to work with Pesapal. [Settlement to merchant accounts takes 24hrs,we have developed this to have real time settlements to any bank or mobile money](#)
- Refunding customers for transactions done in error or overpayment. How long before a customer receives their fund on their original form of payment when NFE initiates a refund through PesaPal. [Reversals to customers take effect from the time we are notified](#)

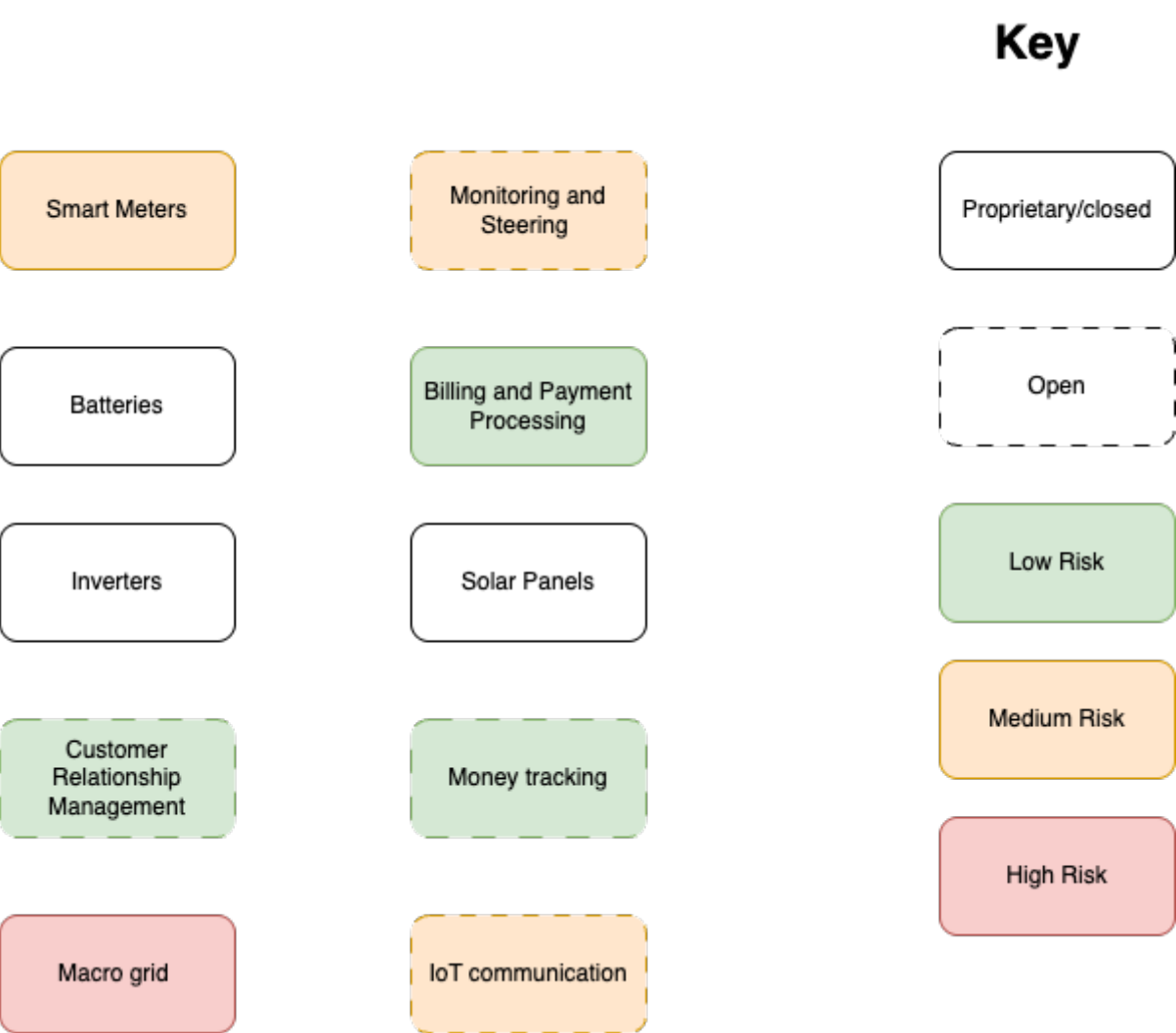
Documents required to be submitted: We are able to provide all these documents. I think you forgot to attach the sign-up form. [See attached the sign up form](#)

Lastly, in full transparency, this decision for our payments partner is still pending. We are currently evaluating other providers like Jumia Pay, Pegasus and setting up direct integrations with Telcos and Banks. We are aiming to make a decision on this by end of this week. [Can we run a test account as you evaluate on the providers, this will give us the real feel.](#)

Microgrid Capability Map

Microgrid Capabilities

This diagram shows the distinct capabilities the microgrid will have and the level of freedom each capabilities for each capability's current implementation offers the community the microgrid is serving. The diagram also show Aaron's understanding of the level of risk to the model associated with each capability given what we know about it. The capabilities without a risk profile assigned are not targeted to go live yet.



Smart Meters

Based on our evaluation [here](#), we'll likely use Calinmeter's [CA168-S](#).

Monitoring and Steering

This is still under evaluation [here](#) but we are leaning towards using EnAccess's [MicroPowerManager](#)

Billing and Payment Processing

We'd be going postpaid using [Pesapal](#), see evaluation [here](#).

Customer Relationship Management

Expo CRM seems like a good option because we have [one running](#) as part of what Federated Computer offers us. And yes, it's open source but we are yet to test it.

Money Tracking

All money will be tracked via Open Collective's Platform. [NFE fiscal host](#) has already been set up.

Macrogrid Connection

Our connection to the UEDCL main grid will be metered by a proprietary meter controlled by UEDCL, we may need to connect an addition meter infront of it that we control.

IoT Communication

As per [this](#) report, we are leaning towards wireless communication via an open standard (LoraWAN)

Microgrids 101

[This page](#) and [Wikipedia](#) go into great detail to describe the concept of a microgrid. I would like to expand on that. During one of the weekly LF Energy Hyphae community checkin calls. When I explained that the initial phase for NFE's pilot microgrid will only include sub-metering a handful of homes. My colleague commented that "Oh, so it won't really be a microgrid yet". That statement stuck with me because I infant think it would be a microgrid. Which brings us to the question I would like to address in this article. What do I mean when I say "microgrid".

Why definitions matter

Definitions generally matter because they help us communicate more clearly about the problem and how we are solving it. If we can agree on what we when when we say "microgrid" or "battery" then it makes it simpler to have conversations about which use-cases make sense for Hyphae's autonomous microgrid idea to address.

First principles

The term *microgrid* is a compound term. It consists of two terms *micro* and *grid*. I will start with the assertion that a microgrid is first a *grid*. If we are agreed there (pun not intended), then let's move on to define what we mean by *grid*.

A grid, in it's most primitive form, is really a set of at least two energy assets, connected, usually by physical energy conducting medium like a wire for a purpose. Let's look at the picture below.



The energy asset on the left (battery) is producing energy and the asset to the right is consuming energy. The two assets have been connected for a purpose and I think that's actually an a very simple example of a grid. Now this grid can include more than 2 assets and in the real world, there's often 100s of assets connected to a grid but for the sake of defining the term, I think this example will serve us well.

If you are still with me, let's move on to the preceding term, the *micro* term. This term adds a layer of meaning to the Grid term. I propose that the distiction between Micro and Macro is really about scope of monitoring and steering for the "owner(s)" of the grid. If the scope is considered small by the owner and exists within the context of a larger grid, then we have ourselves a *microgrid*.

Energy Assets

These exist in various forms but here's an oversimplified list [Energy Asset Taxonomy.csv](#). I share it here to example one's imagination on the kind of things that can exist on a microgrid.

Supply-Side Assets (Energy Producers)

These generate or inject energy into the system.

Subtype	Example Assets	Notes
Renewable Generators	Solar panels, wind turbines	Often variable in output
Non-renewable Generators	Diesel gensets, gas turbines	Firm or dispatchable supply
Co-generation Units	CHP systems	Produce electricity + heat

Demand-Side Assets (Energy Consumers)

These draw energy from the system.

Subtype	Example Assets	Notes
Residential Loads	Lighting, HVAC, appliances	Often flexible for DR programs
Industrial Loads	Motors, manufacturing equipment	Usually larger and more steady
Electric Vehicles	While charging	Can also act as supply (see V2G)

Storage Assets (Bidirectional)

These can both store (consume) and release (supply) energy.

Subtype	Example Assets	Notes
Battery Storage	Lithium-ion, lead-acid	Fast response, scalable
Mechanical Storage	Flywheels, pumped hydro	Used in larger systems
Thermal Storage	Ice storage, molten salt	Stores heat, not electricity

Hybrid/Prosumer Assets

Assets that both consume and produce energy as part of normal operation.

Subtype	Example Assets	Notes
Solar + Battery Systems	Rooftop PV with integrated battery	Common in homes & businesses
EVs with V2G	Electric Vehicles (bi-directional)	Vehicle-to-grid capable
Smart Appliances	Can adjust operation dynamically	May support DR/load shifting

Monitoring & Steering Assets (Support Infrastructure)

These don't directly consume or produce energy, but enable management.

Subtype	Example Assets	Notes
Smart Meters	Energy meters with comms	Enable billing, monitoring
IoT Sensors	Voltage, temperature, fault sensors	Support system diagnostics
Controllers/EMS	Inverters, EMS, SCADA systems	Coordinate and control flow

Monitoring and Steering the microgrid

This capabilities represent what the purpose for a microgrid can be. In the example of NFE's first phase of microgrid deployment. The purpose can be thought of as 3 part;

- for the owner (of the microgrid) to monitor energy consumptions patterns to inform additions of supply side assets like batteries in future so that energy can be more reliable for the community
- for the owner and consumers to bulk purchase electricity there by making it more affordable.
- for the owner and consumers to evolve the their experience of transacting on the grid. Prepaid vs postpaid vs credits to consumers.

The point here being that these capabilities of monitoring and steering (the assets) on the grid are a means to achieve a variety of purposes for the grid owner and other grid stakeholders.

The Autonomous Microgrid

This is what I think can be the vision for project [Hyphae](#), to be able to simply define a start and end state for grid attributes we care about and have Hyphae monitor and steer the grid to the end state. For example, the end state could be 90% reliability for all demand side assets on the grid. Hyphae can then make sure that energy is being drawn or stored or cut off from some assets so that we can maintain a reliability of 90%.

That's what I imagine an autonomous microgrid should be capable of doing. There may be aspects of grid operations that will require manual human intervention like replacing a malfunctioning asset or making a payment for a bill but the more you think about it, the more you recognize that almost every aspect has potential to be automated to make the grid completely autonomous.

Levels of Microgrid Autonomy

I am thinking about how we can borrow from [the 6 levels for Self driving cars](#) to define levels for Microgrids..

TBD