GOODWE

HEMS Solution

(Home Energy Management Systems)

White Paper

GOODWE TECHNOLOGIES CO.,LTD.

CONTENTS

01. Introduction

Home energy management systems (HEMS) play a more and more important role in the modern era of the smart grid and smart homes. Households, individually, make a significant impact on global energy use, representing 27.9% of final energy consumption in the EU[1]. For household consumers in the EU, electricity prices per KWh increased by 69% between 2021 and 2022 due to spiking fossil fuels prices[2]. Though showing some decline in recent years, they remain relatively high compared to the global average.

Final energy consumption by sector, EU, 2021
(% of total, based on terajoules)

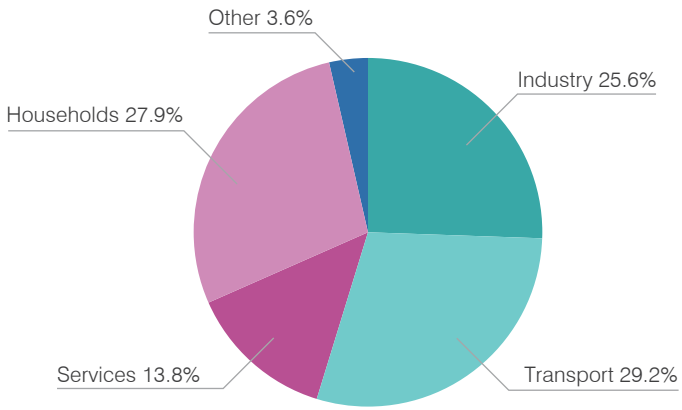


Fig. 1: Final energy consumption by sector, EU, 2021[1]

In addition to cost factors, the following trends are prevalent in the residential energy market:

Electrification of home loads

All utilities now are shifting towards cleaner power sources by using electricity for home loads, especially with the adoption of electric vehicles (EVs) and heat pumps. This shift significantly increases electricity consumption as EVs and heat pumps are "heavy loads".

Dynamic tariff

In order to balance the demand and supply curve without shutting down costly peaker power plants, some utilities are now shifting from fixed residential tariff to dynamic tariff (time-varying rates). In directive 2019/994[3], the European Union mandates member states to ensure all consumers can participate in the energy market with dynamic tariff.

Improve the gird stability

The increasing proportion of renewable energy and electrification of home loads poses a risk to the stability of the electrical grid. Balancing grid supply and demand is becoming more challenging, as shown in Figure 2.

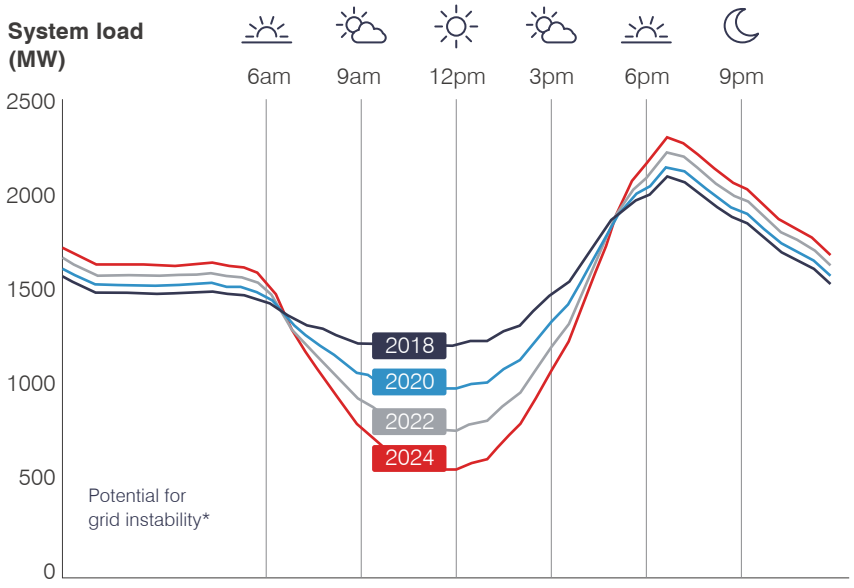


Fig. 2: The electricity duck curve[4]

In this context, HEMS emerge as essential tools, providing users with the means to effectively monitor, regulate, and optimize their energy consumption. HEMS provide insights into energy generation, storage, and consumption, aligning these processes with considerations such as self-generated energy availability and prevailing market rates. The main value that HEMS provides include:

- ***Reducing electricity use and cost***
- ***Revenue stacking by participating in the electricity market or grid service***

This paper delves into the transformative potential of HEMS, elucidating its mechanisms, benefits, and pivotal role in ushering homes into the forefront of the energy revolution.

02. HEMS Architecture

A home energy management system is defined as a system consisting of sensors within home devices via network. To achieve better and more precise management, a HEMS requires the following typical parts:

- **Central Controller** that complements the given objectives and meets user-defined specifications by processing usage data, providing optimization strategies, and forecasting uncertainties.
- **Measuring devices such as Smart meters** that can measure the current, voltage or irradiation.
- **Communication** between central controller, server and each energy device. And user interface that allows the provision of an interface between users and all devices.
- **Smart home applications** equipped with intelligent control and communication modules such as electric vehicles and heat pumps. Or conventional appliances equipped with additional smart control unit like smart plugs.
- **Energy generation and storage system** that includes PV panels, Inverter and Battery.

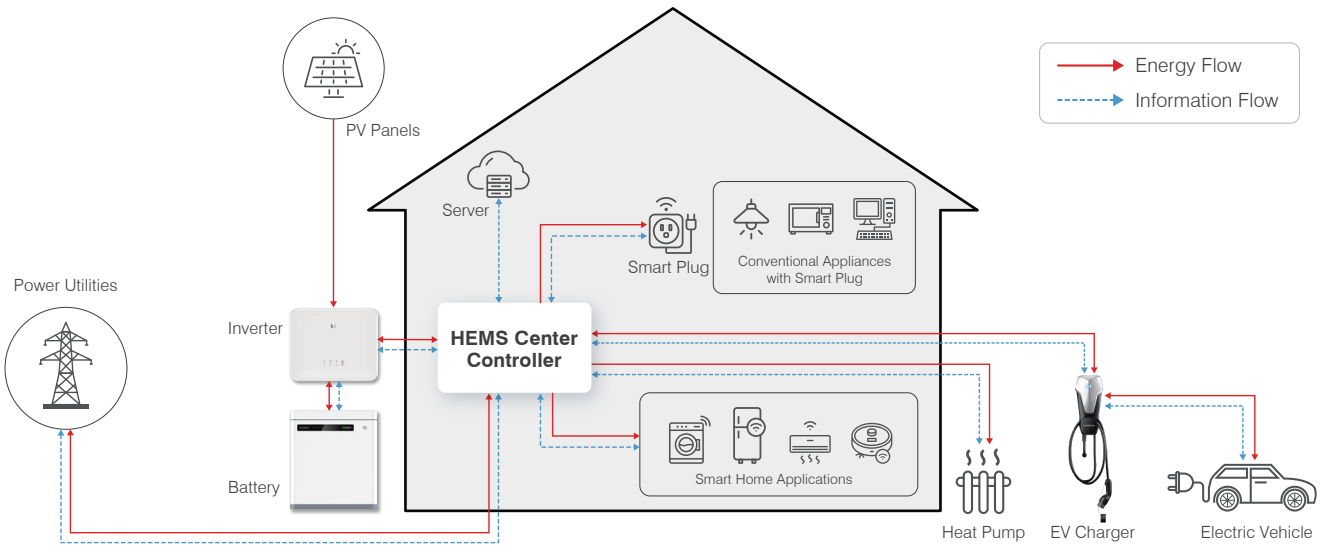


Fig. 3: HEMS Architecture

03. GoodWe HEMS Solution

As a world-leading smart energy solution provider with PV inverters and energy storage solutions as the core, GoodWe sees HEMS value chain as a natural extension of its current activities. By integrating multiple communication protocols in the products, GoodWe provides the flexibility for integrating the third-party service developer to create a HEMS solution in a local way. In addition, GoodWe also provides a flexible Open-Api access, allowing the EMS service providers to access the GoodWe cloud and realize the control of the devices, providing both raw data and processed data forwarding, as well as a control interface.

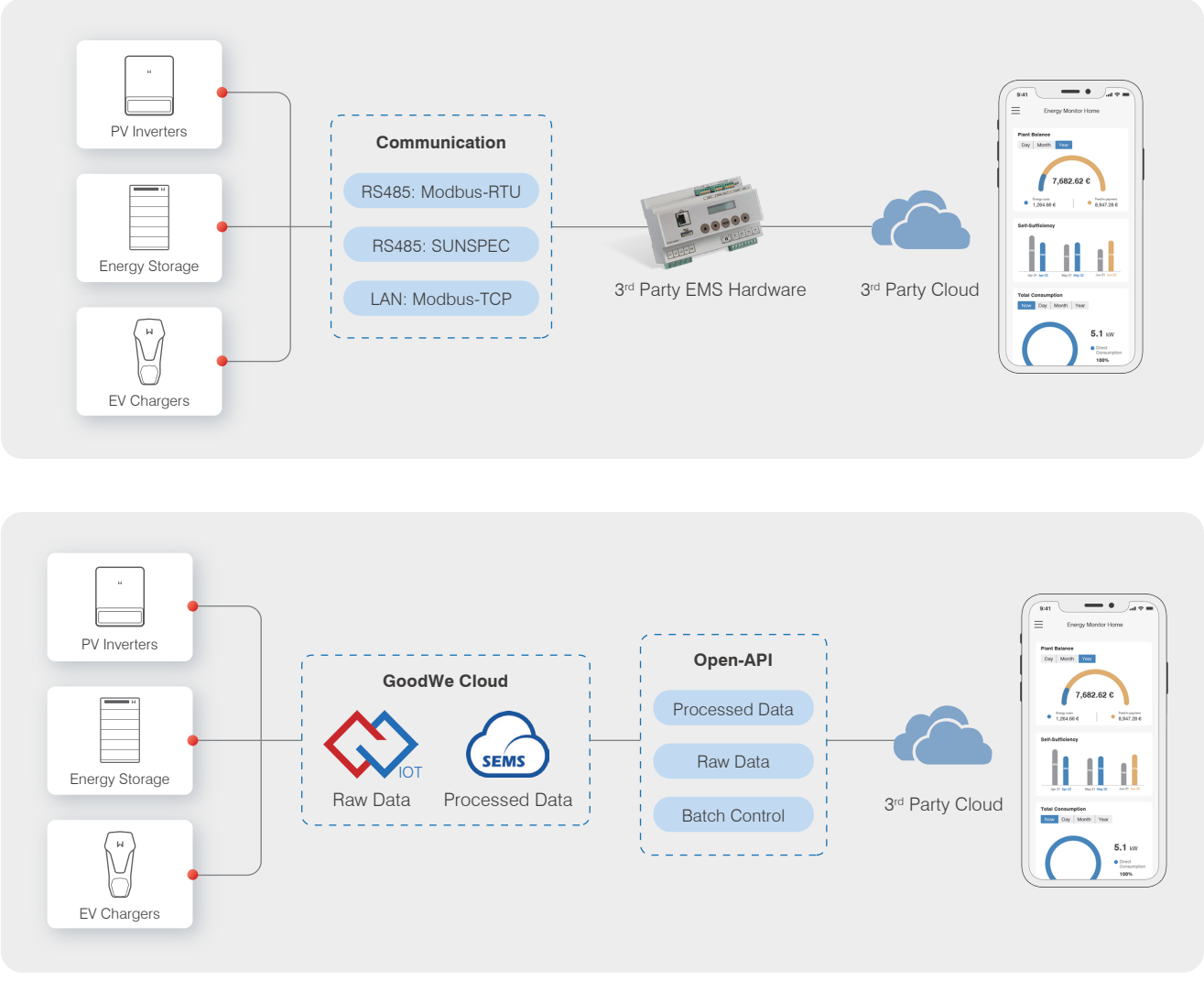


Fig. 4: The HEMS Access Method

However, with technology continuing its rapid evolution, akin to the trend observed in recent years, HEMS are projected to advance through various stages of maturity. Certain service providers have become notably more sophisticated, players such as gridX (Germany), Kiwi Grid (Germany), Smart Fox (Austria), Lifepowr (Belgium) are the forefront of driving the transition towards intelligent HEMS solutions.

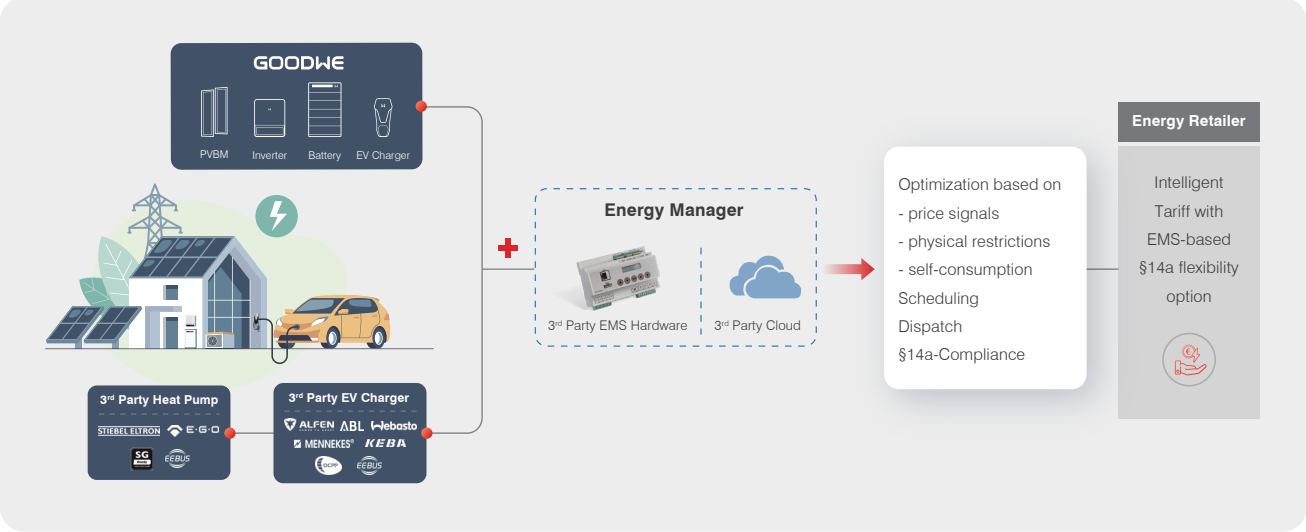


Fig. 5: GoodWe HEMS Solution with 3rd party

The creation of long-term value of GoodWe HEMS solution with Third-Party is to be achieved through the empowerment of flexibility, complemented by the incremental value brought about by energy trading and the avoidance of imbalance costs. We believe the following 4 attributes are best suited to fulfill the market demands:

1. Energy & Cost Saving (Self consumption & Load Management)

Maximizing the utilization of self-generated power to supply the remaining assets within the household, thereby reducing both costs and emissions.

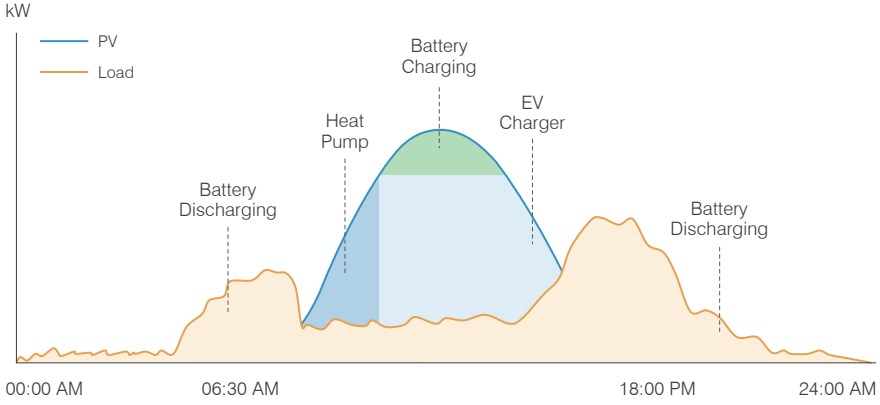


Fig. 6: Maximizing the self-consumption by HEMS

In a residential energy storage system, HEMS can shift the power consumption time of heating and EVs to when the sun is sufficient and store the excess PV power in the battery. Ideally, the entire household's power supply could be fully provided by renewable energy.

2. Revenue stacking (Dynamic tariff & Load management)

Shifting the use of high-power loads and charging the battery when electricity prices are low. Discharging the battery to supply the power and sell excess power when prices are high.

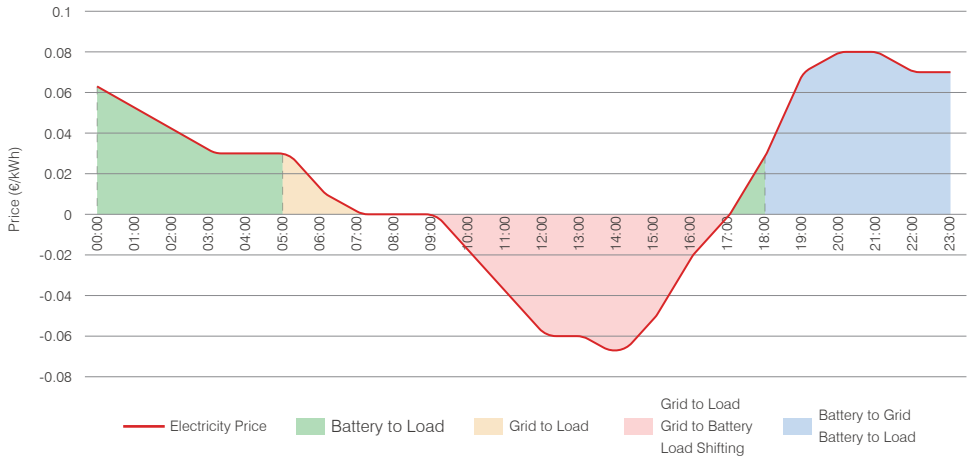
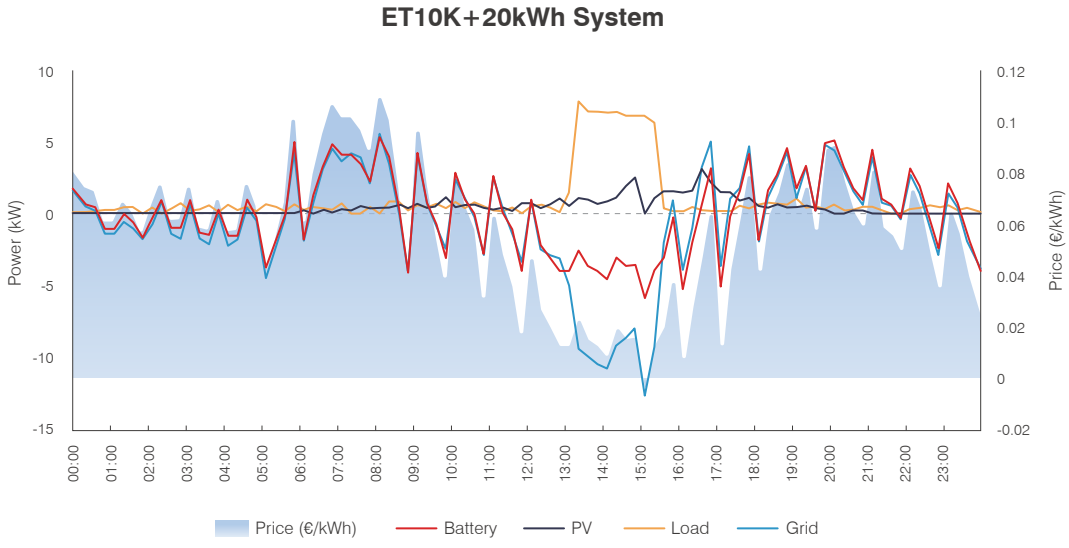


Fig. 7: Concept of HEMS dealing with dynamic tariff

Taking the household load operation from April 9 to 14, 2024 as an example, the following figure shows the optimization logic and results of the HEMS solution, which consist of GoodWe ET10K+20kWh hybrid system and 3rd party EMS gateway.



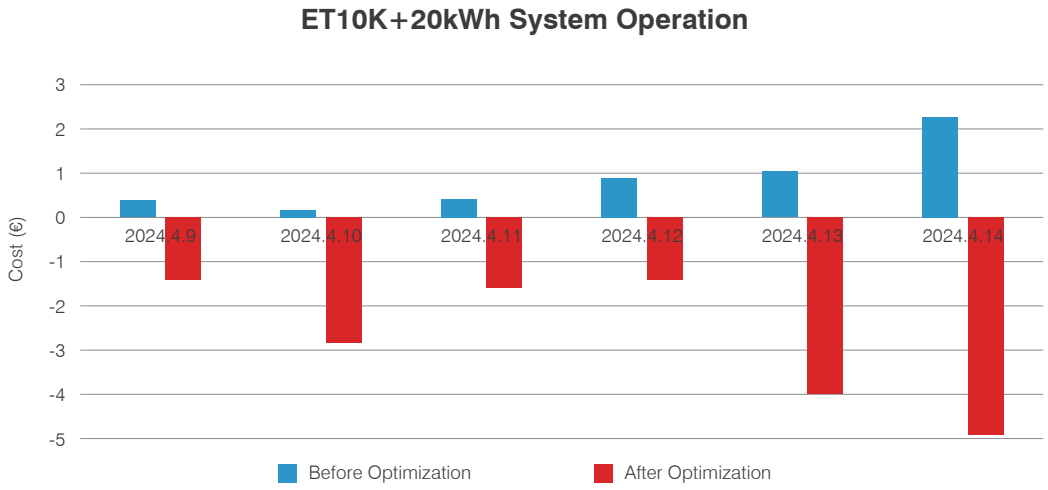


Fig. 8: Logic and effect by adopting HEMS with dynamic tariff

Compared to a traditional energy storage system, adopting the HEMS solution results in savings of 5.16€ in electricity costs and generates 15.5€ in revenue over a 6 days period.

3. Grid Balancing

Aggregating and monetizing the flexibility of multiple energy assets to participate in wholesale markets or support TSOs to keep the grid balanced (e.g., frequency containment reserves and automatic frequency restoration reserves).

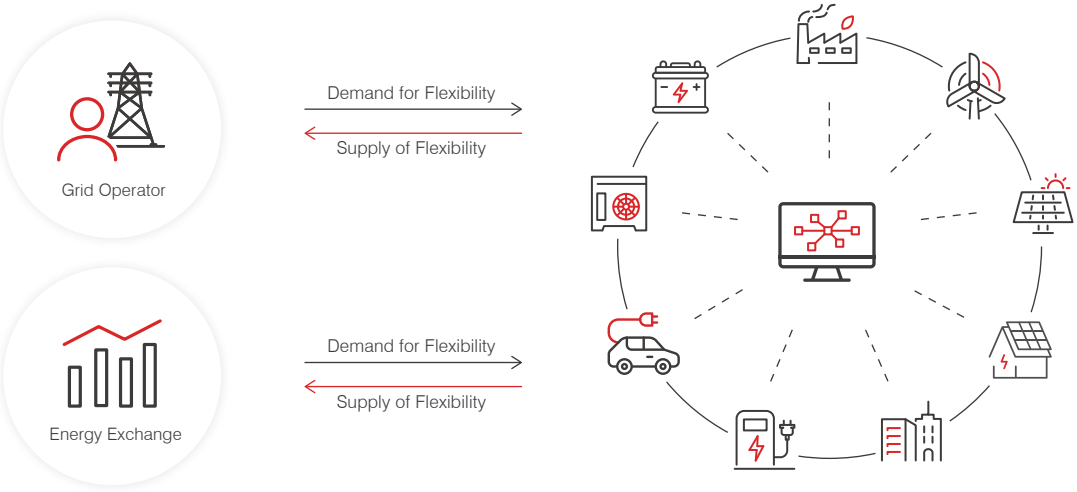


Fig. 9: Virtual Power Plant

4. Imbalance cost avoidance

The Imbalance price reflects a marginal price of balancing energy supply and demand, which typically carries a higher price and variation compared to the retail market. Through the utilization of flexibility inherent in their HEMS customer base, Transmission System Operators (TSOs) have the potential to alleviate a portion of these imbalance costs and generate the revenue.

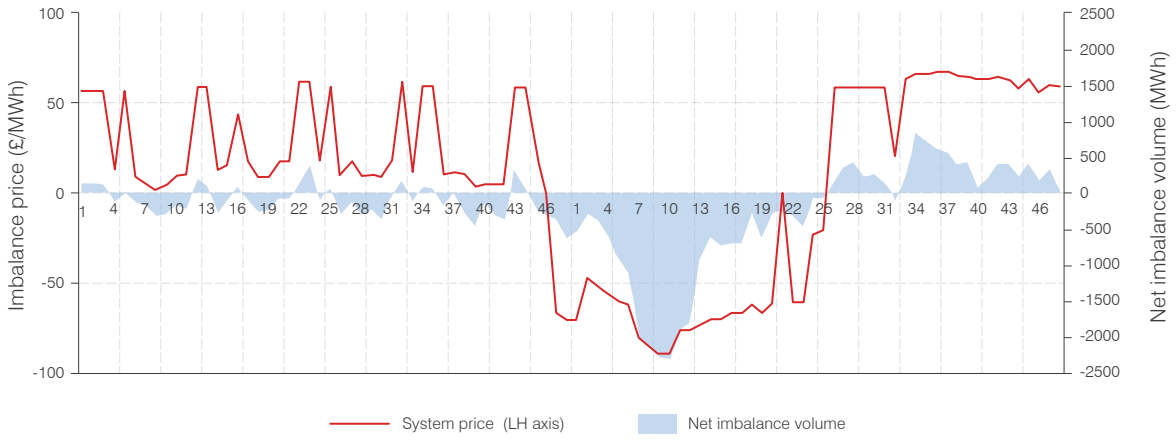


Fig. 10: Imbalance market

04. Conclusion

In today's dynamic energy market, households face frequent and unpredictable price fluctuations while witnessing a rise in electricity-dependent assets such as electric vehicles (EVs) and heat pumps. While some households have started generating their own energy to reduce reliance on external sources, there remains untapped potential for optimization through the analysis of consumption patterns and the utilization of advanced data systems. GoodWe's HEMS solution offers homeowners and utilities the opportunity to engage in environmentally responsible energy practices, leading to cost and energy savings. As we move forward, the evolution of HEMS will continue to empower households to actively manage their energy usage, contributing to a more sustainable and resilient energy future.

Appendix:

GoodWe is currently collaborating with various energy management system manufacturers to develop the HEMS solution. The table below illustrates the compatibility status between GoodWe and some of third-party providers. This compatibility list is regularly updated, with partners like gridX and Kiwi Grid currently undergoing testing phases.

EMS Brand	Compatible GoodWe products Model	Communication	Function
Lifepowr	BT, BH, SBP G2, ET PLUS+, EH, EM On-going: ET 30kW, ES G2	Modbus-TCP Modbus-RTU	Dynamic tariff, Peak shaving(Capacity tariff), Grid balancing, Real-time monitoring, Self consumption, Load management(TOU), Negative price(Curtailment)
Biliq	BT, BH, ET PLUS+ On-going: ET 30kW, EH, ES G2	Modbus-TCP Modbus-RTU	Dynamic tariff, Real-time monitoring, Self consumption, Load management(TOU), Negative price(Curtailment)
Eniris (API)	HT, BT, EH, BH, EM, ES	API	Dynamic tariff, Peak shaving(Capacity tariff), Grid balancing, Real-time monitoring, Self consumption, Load management(TOU), Negative price(Curtailment)
gridX	On-going: ET 30kW	Modbus-TCP Modbus-RTU	Dynamic tariff, Peak shaving(Capacity tariff), Self consumption, Real-time monitoring
Fenecon	ET PLUS+, ET 30kW, BT	Modbus-TCP Modbus-RTU	Dynamic tariff, Peak shaving(Capacity tariff), Self consumption, Load management(TOU), Real-time monitoring
Smart Fox (Dafi)	ET PLUS+, BT, SDT G2, SMT On-going: ET 30kW	Modbus-TCP Modbus-RTU	Self consumption, Real-time monitoring, Load management(TOU)
Solar Log	DNS, DT, MT	Modbus-TCP Modbus-RTU	Grid balancing, Peak shaving(Capacity tariff), Self consumption, Load management(TOU), Real-time monitoring
CheckWatt	ET PLUS+, ET 30kW, BT	Modbus-TCP Modbus-RTU	Dynamic tariff, Real-time monitoring, Grid balancing, Load management(TOU), Self consumption
Qurrent	On-going: ETC, BTC	C&I: Modbus-TCP Res: API	Dynamic tariff, Real-time monitoring, Grid balancing, Load management(TOU), Self consumption
Green Hero	ET PLUS+, ET 30kW, BT	Modbus-TCP Modbus-RTU	Self consumption, Real-time monitoring, Load management(TOU)

EMS Brand	Compatible GoodWe products Model	Communication	Function
AI Power ApS	ET PLUS+, BT, SBP G2, ES G2	API	Dynamic tariff Real-time monitoring Self consumption Load management(TOU)
Öresundskraft	ET PLUS+, ET 30kW, BT	API	Dynamic tariff Real-time monitoring Self consumption Load management(TOU)
Klimmaseade	ET PLUS+		
Kiwigrid	ET 30kW, BT, ES G2 On-going: ET PLUS+	Modbus-TCP SUNSPEC API	Self consumption Real-time monitoring Load management(TOU)
Meteocontrol	SMT, HT, ET PLUS+, XS, SDT G2, DNS	Modbus-TCP Modbus-RTU	
Solar Manager	SDT G2, ET PLUS+, ET 30kW, BT	Modbus-TCP Modbus-RTU	Self consumption Real-time monitoring Load management(TOU)
My PV	ET PLUS+	Modbus-TCP Modbus-RTU	Self consumption Real-time monitoring Load management(TOU)

Reference:

[1] Energy consumption in households - Statistics Explained (europa.eu)

[2] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Electricity_price_statistics#Electricity_prices_for_household_consumers

[3] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32019L0944

[4] https://www.synergy.net.au/Blog/2021/10/Everything-you-need-to-know-about-the-Duck-Curve

GOODWE TECHNOLOGIES CO., LTD.

Add: No. 90 Zijin Rd., New District, Suzhou, 215011, China
Tel: +86 512-69582253
Web: www.goodwe.com

Scan for e-copy