Business Model for Energy Community Developers and Assets Investors

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***Abstract*—Energy community developers are relevant actors for the deployment of energy communities as they can overcome initial investment costs and better navigate complex licensing processes. Their strategy depends on the chosen business model, typically aimed at maximizing their profit while providing tangible benefits to the potential members of the energy communities to encourage their engagement. This works describes strategies for an energy management system adapted to energy community developers whose business model consists in installing, owning and managing energy assets (such as photovoltaic panels and batteries) in its own facilities and in the facilities of those energy community members able and willing to provide them, to sell the locally produced energy for self-consumption in the energy community.**

***Index Terms*— Business Models, Energy Communities, Energy Management Systems, Optimisation.**

I. INTRODUCTION

Energy communities (ECs) are expected to play a crucial role in the decarbonization of the energy system as a complementary tool to utility scale initiatives [1]. However, despite increased research in this field [1], several challenges hinder the widespread deployment of ECs, as their successful design requires a careful balance between objectives, impacts and economic feasibility, and the diverse stakeholders interests [2]. Multiple barriers have been identified in the development of EC, limiting their implementations [3], [4], [5], [6]. Some of these barriers can be mitigated through the active involvement of public administration and large corporations, with the design of suitable business models (BMs) that address the needs of all stakeholders being a key factor. Consequently, public and private entities can play a pivotal role as promoters of energy communities [7], [3]. For example, the results from a case study on a potential renewable EC in Monticello d'Alba, Italy, indicate that the involvement of a third party, while initially necessary for technical aspects, can also provide economic benefits [8]. Another study on Southern California's residential PV market shows that third-party models eliminate upfront costs, reduce risks, and offer immediate savings. Companies lease equipment or sell electricity, simplifying system management [9]. Reference [10] analyses the economic viability of ECs under third-party investment, and the cost distribution among EC members using pricing models such as flat-rate, time-of-use, and segmented pricing. The findings indicate that third-party investments are financially viable when energy prices are competitive, with a 15-year payback period identified as optimal for maximizing profits. The study in [11] analyses a business model in which a third party facilitates access to solar energy without initial investment, offering fixed tariffs. EC members can be hosts (allowing assets to be installed on their properties) or not. Although it protects against market volatility, it faces challenges such as a lack of price transparency and true sense of community, as interactions remain purely transactional.

The reviewed literature includes examples of ECs promoted and managed by third-party developers, that assess the advantages and disadvantages of this BM, its development process, and the benefits obtained with different pricing mechanisms. However, to the best of our knowledge, no studies develop or analyse energy management and allocation methods for this type of BM. Our work proposes an energy management system (EMS) for a BM promoted by an EC developer. The focus is on the energy sharing mechanisms to be adopted, so that the EC developer maximizes its benefits while providing tangible benefits to the EC members to encourage their engagement, which has a direct impact on the EMS algorithm to manage the EC flexible resources. Such BM can be adopted by strong companies as EC developers to overcome members' financial constraints, enhance governance effectiveness, and generate savings for EC members, although typically lower than in more democratic EC.

The rest of the paper is structured as follows. Section II describes the BM, section III the EMS formulation, section IV the cases examples, and section V concludes.

II. EC DEVELOPER BUSINESS MODEL

The EC developer BM identified (Figure 1) corresponds to a promoter that installs energy assets (such as PV panels and batteries) at the facilities of EC members and at its own sites, and manages the EC to maximize its profit, while providing a benefit to the EC members for belonging to the EC.

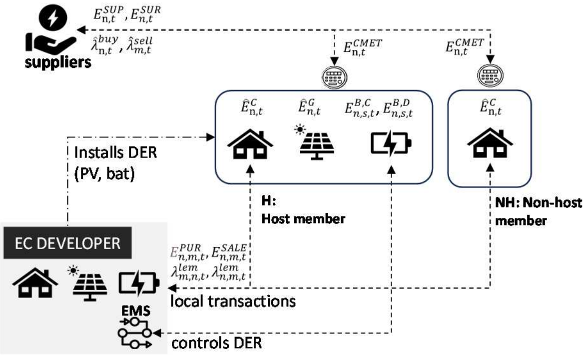

Figure 1. EC developer business model.

In Figure 1 for each time t and EC member n, $E_{n,t}^{SUP}$ and $E_{n,t}^{SUR}$ are the supplied and surplus energies, bought and sold to the grid at prices $\lambda_{n,t}^{buy}$ and $\lambda_{n,t}^{sell}$, respectively; $E_{n,t}^{CMET}$ is n net consumption measured at its smart meter; $\hat{E}_{n,t}^{C}$ and $\hat{E}_{n,t}^{G}$ are the forecasted consumption and generation (considered as inputs); $E_{n,s,t}^{B,C}$ and $E_{n,s,t}^{B,D}$ are the energies charged and discharged by the batteries; $E_{n,m,t}^{SALE}$ the energy sold by member n to m and $E_{n,m,t}^{PUR}$ energy purchased by member n from m.

In this BM, members that provide their facilities for the EC developer to install assets are called host-members, compared to the non-host members that do not have such assets installed. It is common that the EC developer's assets located at host-member facilities become owned by the host members after a pre-agreed period. EC developer profits come from selling the production of its assets to the host and non-host members, and from the final surplus sold to the EC aggregator. Host-members get discounts for providing their facilities to the EC developer. Note that the EC members can also own and operate their own assets behind the meter.

Since the unconstrained maximization of the EC developer profit would lead to allocating all energy first to non-host members who pay a higher price for it, this would disincentivize host-members from belonging to the EC. Therefore, a trade-off is needed between profit maximization and fair energy allocation.

III. ENERGY SHARING AND PROBLEM FORMULATION

A mixed-integer linear programming (MILP) algorithm is proposed to maximize the EC developer profit, or equivalently, minimize its costs:

$$\begin{aligned} min\sum_{t}\Bigg(&\sum_{n\in P}\left(E_{n,t}^{SUP}\cdot\lambda_{n,t}^{buy}-E_{n,t}^{SUR}\cdot\lambda_{n,t}^{sell}\right)+\sum_{n,m\in P}\left(E_{n,m,t}^{SLC}\cdot\hat{\lambda}_{n,m,t}^{grid}\right)\\ &+\sum_{n\in P}\sum_{s\in S}E_{n,s,t}^{B,D}\cdot\hat{\lambda}_{n,s}^{deg}\\ &-\sum_{n\in P}\sum_{m\notin P}\left(E_{n,m,t}^{SALE}\cdot\lambda_{n,m,t}^{lem}\right)\Bigg)\\ &+\widehat{m}\sum_{t}\Bigg(\sum_{n\notin P}\left(E_{n,t}^{SUP}\cdot\lambda_{n,t}^{buy}-E_{n,t}^{SUR}\cdot\lambda_{n,t}^{sell}\right)\\ &+\sum_{n,m\notin P}\left(E_{n,m,t}^{SLC}\cdot\hat{\lambda}_{n,m,t}^{grid}\right)+\sum_{n\notin P}\sum_{s\in S}E_{n,s,t}^{B,D}\cdot\hat{\lambda}_{n,s}^{deg}\Bigg)\end{aligned} \tag{1}$$

The first part of (1) minimizes the EC developer costs, where $n\in P$ refers to those members n with facilities owned by the EC developer, and the second one, multiplied by a small coefficient $\widehat{m}$, minimizes the EC members costs for those that manage their own resources to avoid unconstrainted and unrealistic behaviours. The EC developer part includes the economic balance with the grid, the grid access tariffs $\hat{\lambda}_{n,m,t}^{grid}$ for the energy $E_{n,m,t}^{SLC}$ self-consumed by member n from m, a degradation cost $\hat{\lambda}_{n,s}^{deg}$ to every battery discharge $E_{n,s,t}^{B,D}$ to avoid unprofitable batteries' cycling, and the main source of profit of the EC developer, i.e. the sales $E_{n,m,t}^{SALE}$ from the facilities n belonging to EC developer, to the EC members $m\notin P$ at the local energy prices $\lambda_{n,m,t}^{lem}$, which are different for host and non-host members. The second part of (1) has similar structure except for the local sales term.

Objective function (1) is subject to:

$$E_{n,m,t}^{PUR}=E_{m,n,t}^{SALE} \tag{2}$$

$$E_{n,t}^{CMET}=\hat{E}_{n,t}^{C}-\hat{E}_{n,t}^{G}+\sum_{s\in S}\left(E_{n,s,t}^{B,C}-E_{n,s,t}^{B,D}\right) \tag{3}$$

$$E_{n,t}^{CMET}=E_{n,t}^{SUP}-E_{n,t}^{SUR}+\sum_{m\neq n\in N}\left(E_{n,m,t}^{PUR}-E_{n,m,t}^{SALE}\right) \tag{4}$$

$$E_{n,t}^{CMET}=E_{n,t}^{CMET,c}-E_{n,t}^{CMET,g} \tag{5}$$

$$-\hat{P}_{n}^{CPE,max}\leq\frac{E_{n,t}^{CMET}}{\Delta t}\leq\hat{P}_{n}^{CPE,max} \tag{6}$$

$$E_{n,s,t}^{B}=E_{n,s,t-1}^{B}+\left(E_{n,s,t}^{B,C}\cdot\hat{\eta}_{n,s}^{B,C}-\frac{E_{n,s,t}^{B,D}}{\hat{\eta}_{n,s}^{B,D}}\right) \tag{7}$$

$$\widehat{SOC}_{n,s}^{B,min}\leq SOC_{n,s,t}^{B}=\frac{E_{n,s,t}^{B}}{\hat{E}_{n,s}^{B,N}}\cdot 100\%\leq\widehat{SOC}_{n,s}^{B,max} \tag{8}$$

$$\begin{gathered}\frac{E_{n,s,t}^{B,C}}{\Delta t}\leq\hat{P}_{n,s}^{B,max}\cdot\left(\delta_{n,s,t}^{B,C}\right)\\ \frac{E_{n,s,t}^{B,D}}{\Delta t}\leq\hat{P}_{n,s}^{B,max}\cdot\left(1-\delta_{n,s,t}^{B,C}\right)\end{gathered} \tag{9}$$

$$E_{t}^{AVAIL}=min\left(\sum_{n}E_{n,t}^{CMET,c},\sum_{n}E_{n,t}^{CMET,g}\right) \tag{10}$$

$$\sum_{m}E_{n,m,t}^{PUR}\leq E_{t}^{AVAIL}\cdot\hat{C}_{n,t}^{pr,k} \tag{11}$$

$$\sum_{m}E_{n,m,t}^{PUR}+E_{n,t}^{SUR}\perp\sum_{m}E_{n,m,t}^{SALE}+E_{n,t}^{SUP} \tag{12}$$

$$\sum_{t\in T}\left(\begin{gathered}E_{n,t}^{SUP}\hat{\lambda}_{n,t}^{buy}-E_{n,t}^{SUR}\hat{\lambda}_{n,t}^{sell}+\sum_{s\in S}E_{n,s,t}^{B,D}\cdot\hat{\lambda}_{n,s}^{deg}+\\ \sum_{m\neq n\in N}\left(E_{n,m,t}^{PUR}\cdot\lambda_{m,n,t}^{lem}+E_{n,m,t}^{SLC}\cdot\hat{\lambda}_{n,m,t}^{grid}\right)\end{gathered}\right)\leq\hat{C}_{n}^{ind} \tag{13}$$

Eq. (2) ensures that energy purchased by meter n from meter m ($E_{n,m,t}^{PUR}$) must be sold by meter m to meter n ($E_{m,n,t}^{SALE}$). Eqs. (3) & (4) define $E_{n,t}^{CMET}$ as the net energy consumption of meter n during time t, both by its internal energy balance (3) and its external energy balance (4). Eq. (5) disaggregates $E_{n,t}^{CMET}$ into the positive variables for consumption ($E_{n,t}^{CMET,c}$) and generation ($E_{n,t}^{CMET,g}$). Eq. (6) limits ingoing and outgoing flows in all meters to their respective maximum power $\hat{P}_{n}^{CPE,max}$. Eq. (7) tracks the energy $E_{n,s,t}^{B}$ stored in the battery with charging $\hat{\eta}_{n,s}^{B,C}$ and $\hat{\eta}_{n,s}^{B,D}$; (8) limits battery operation to its maximum $\hat{P}_{n,s}^{B,max}$; (9) limits the battery's state of charge (SOC) $SOC_{n,s,t}^{B}$ computed with the energy and nominal capacity $\hat{E}_{n,s}^{B,N}$. Eq. (10) defines the available energy to be traded within the EC (E_{t}^{AVAIL}) as the minimum of all generation or all consumption. Eq. (11) limits local purchases of meter *m* to the share of available energy multiplied by the allocation coefficients (AC) $\hat{C}_{n,t}^{pr,k}$ selected, explained in the following section, and (12) forbids simultaneous energy sales and purchases by any meter. Non-linear equations (10) & (12) have been linearized using binary variables. Finally, to guarantee that no EC member incurs losses from belonging to the EC, a two stage strategy, similar to the first two steps of [12], is used: the optimal individual cost $\hat{C}_n^{ind}$ of all members is computed with (14) and used in constraint (13).

$$\hat{C}_n^{ind} = min\left(\sum_{t\in T}\left(E_{n,t}^{SUP}\cdot\lambda_{n,t}^{buy} - E_{n,t}^{SUR}\cdot\lambda_{n,t}^{sell} + \sum_{s\in S}E_{n,s,t}^{B,D}\cdot\hat{\lambda}_{n,s}^{deg}\right)\right) \tag{14}$$

Note that (14) is the cost of the EC members behaving individually, exchanging energy only with the grid.

The EC promoter allocates the energy it produces among its own consuming facilities, and then, if there is still local production to allocate, several strategies have been defined and tested for $\hat{C}_{n,t}^{pr,k}$ in (11). The first strategy, (15), (15 is to apply ACs proportional to the consumption of each consuming meter (excluding those belonging to the EC developer):

$$\hat{C}_{n,t}^{prop} = \frac{E_{n,t}^{CMET}}{\sum_{n\notin P}E_{n,t}^{CMET}} \tag{15}$$

The second strategy, (16), applies AC proportional to the consumption of the consuming members weighted by the price they pay (excluding those of the EC developer):

$$\hat{C}_{n,t}^{\lambda prop} = \frac{\hat{\lambda}_{P,n,t}^{lem}\times E_{n,t}^{CMET}}{\sum_{n\in N_C}\hat{\lambda}_{P,n,t}^{lem}\times E_{n,t}^{CMET}} \tag{16}$$

The third strategy, (17), is based on a percentage computed according to the price each EC member pays, which depends on whether they are host (H) or non-host (NH):

$$\hat{C}_{n,t}^{\lambda} = \left\{\begin{matrix}\alpha_{NH,t} = \dfrac{\hat{\lambda}_{P,NH,t}^{lem}}{\hat{\lambda}_{P,NH,t}^{lem}+\hat{\lambda}_{P,H,t}^{lem}}\\ \alpha_{H,t} = \left(1-\alpha_{NH,t}\right)\end{matrix}\right\} \tag{17}$$

Figure 2 shows the last strategy, based on a decision tree built from rules, that includes, as particular cases, the other three strategies, where for each time step *t*, the AC that maximizes the EC developer benefits is selected.

First, it is checked if the energy E_t^{AVAIL} available from the EC developer's meters is equal to or greater than the total consumption of the EC members (both host and non-host). If this condition is met, proportional AC are applied (15). If E_t^{AVAIL} is not enough to meet the EC members consumption ($n \notin P$), the consumption of host ($\sum_{n\in H}E_{n,t}^{C}$) and non-host members ($\sum_{n\in NH}E_{n,t}^{C}$) is computed. If the host members consume more energy than the non-host members, the AC selected are those of (17). If the allocated energy exceeds the consumption of any host or non-host group, the surplus is proportionally redistributed among the members of the respective group experiencing the energy deficit. Conversely, if non-host members consume more energy than host members, the algorithm applies AC as in (16). In cases where a member is allocated more energy than required, the surplus is redistributed among members with deficit using the proportional AC of (15).

A key contribution of the proposed algorithm is its flexibility to define multiple strategies for allocating the EC developer's energy among members. Regardless of the chosen strategy, the final ACs can be calculated as shown in (18):

$$\hat{C}_{n,t}^{k} = \frac{E_{n,m,t}^{PUR}}{\sum_{n\in P,m\notin P}E_{n,m,t}^{PUR}} \tag{18}$$

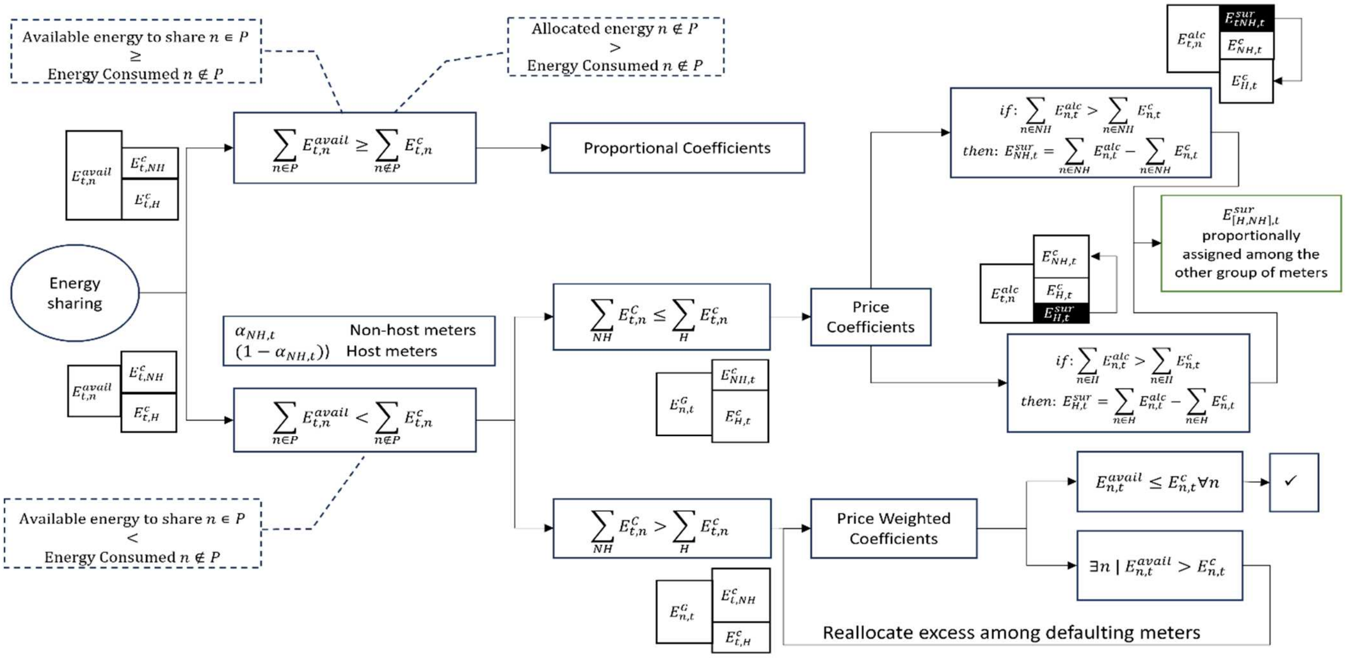

Figure 2. Energy allocation algorithm.

However, forcing the allocation mechanism with (11) and (18), the later computed with (15), (16), (17) or Figure 2 procedure, that depends on $E_{n,t}^{CMET,k}$, leads to non-linear optimization problems. To solve them, the iterative fixed-point algorithm of Figure 3 has been applied. The energy of the EC promoter is first allocated to its own facilities. Then, if there is still energy to allocate, i.e., if it is larger than the EC members consumption, the best allocation is proportional to consumption since it minimizes the surplus energy to be sold back to the grid. If it is lower, any of the AC defined above, including Figure 2 procedure, can be applied. In addition, all the energy allocated is necessarily bought by the consuming member at the predefined prices as defined in the BM.

The AC, fixed as inputs to the optimization problem, lead to a MILP for each iteration based on (1) that computes the batteries schedules. Since these new schedules change the values of $E_{n,t}^{CMET}$, a new allocation can be computed for the next iteration, being $E_{n,t}^{CMET,k}$ and $\hat{C}_{n,t}^{k}$ the values of the metered energy and of the AC of member *n* at iteration *k*, respectively, and OF_t^k the objective function for this same iteration *k*. Then, the root mean squared error (19) for iteration k ($RMSE_k$) considering the AC and the objective function (OF) of two consecutive iterations is:

$$RMSE_k = \sqrt{\sum\nolimits_n \left(\hat{C}_{n,t}^{,k} - \hat{C}_{n,t}^{k-1}\right)^2 + \left(\frac{OF_{n,t}^{k} - OF_{n,t}^{k-1}}{OF_{n,t}^{k=1}}\right)^2} \qquad (19)$$

The stopping criterion is given by comparing this $RMSE_k$ with a predefined threshold, and convergence is reached when the AC and the objective function stabilize.

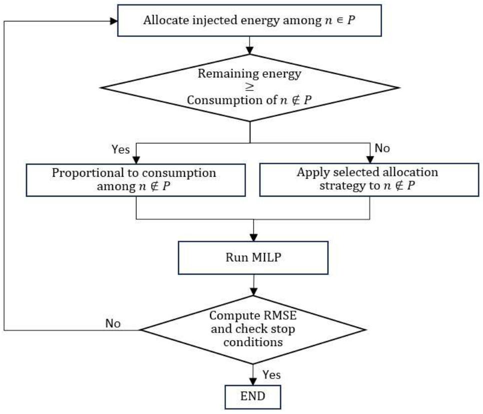

Figure 3. Fixed-point iterative algorithm.

IV. CASE EXAMPLES

An EC with four members, two hosts, MH_1 and MH_2, and two non-hosts, MNH_1 and MNH_2 is simulated. MH_1 has PV panels installed (MP_1) and MH_2 has a battery (MP_2), both of which are owned and managed by the promoter. The community has a 250 kWh-100 kW battery installed in a host facility with efficiencies of 0.9, maximum SOC of 100%, and a degradation cost of 0.0176 €/kWh. A PV panel is installed in another host facility, with its capacity varying depending on the case example. All assets owned by the developer have their own smart meter. Grid purchase prices ($\lambda_{n,t}^{buy}$) vary hourly from 0.077 €/kWh to 0.165 €/kWh and selling prices ($\lambda_{n,t}^{sell}$) from 0.035 €/kWh to 0.074 €/kWh. The self-consumption tariff ($\hat{\lambda}_{n,m,t}^{grid}$) vary hourly from 0.008 to 0.017 €/kWh. Local prices for host members ($\lambda_{P,HM,t}^{lem}$) vary from 0.056 €/kWh to 0.120 €/kWh, and for non-host members ($\lambda_{P,NHM,t}^{lem}$) from 0.066 €/kWh to 0.142 €/kWh. At any given time *t*, the local price for non-host members is higher than that for host members. Detailed prices in Figure 4.

Two case examples, A and B, are considered to analyse the simulations' results, for a 24-hour horizon:

- Case A: the local production is not enough to supply all EC members. We assume a daily PV generation of 167.50 kWh, and (20) holds:

$$\sum_{n\in P} E_{n,t}^{avail} < \sum_{n\notin P} E_{n,t}^{c} \qquad (20)$$

In addition, case A includes subcases *A1* and *A2*:

Subcase A1: non-host members consumption is lower than host members consumption, i.e, (21) holds:

$$\sum_{n\in NH} E_{n,t}^{C} < \sum_{n\in H} E_{n,t}^{C} \qquad (21)$$

Subcase A2: non-host members consumption is larger than host members consumption, i.e, (22) holds.

$$\sum_{n\in NH} E_{n,t}^{C} > \sum_{n\in H} E_{n,t}^{C} \qquad (22)$$

- Case B: the local production meets EC members consumption and there is still EC surplus. We assume a daily PV generation of 1076.5 kWh so that constraint (20) does not hold.

In addition, Case B includes the same two subcases as Case A, *B1* corresponding to (21) and *B2* to (22).

Table I presents the costs of EC meters and those of the EC developer (sum of MP1 and MP2) upon simulations convergence which occurs between 3 and 4 iterations depending on the case study. Green and red colours are for the minimum and maximum costs respectively. The costs $\hat{C}_n^{ind}$ of the members before joining the EC are also included. As Table I shows:

- As expected, the decision tree (Figure 2) performs always better for the EC developer, since the decision tree selects the optimal energy distribution for each member, considering both their consumption and prices. Moreover, if it allocates more energy than they consume, it the excess energy is redistributed among the remaining members, minimizing the sales to the retailer.
- The costs of all members are lower than their costs before joining the EC, as would be expected, given constraint (13).
- The performance of host and non-host members is complementary across various AC when Case A is applied. In A1, coefficients (15) and (16), which are proportional to metered consumptions, provide greater benefits to host

members, which have the higher consumption. Conversely, coefficients (17) and the tree strategy, which for A1 reverts to (17), based on prices, benefit non-host members by allocating more energy to those with higher prices. In A2 non-host member's costs are very similar across most AC methodologies since both (15) and (16) allocate energy considering consumption, and the tree algorithm utilizes (16) as part of the allocation process. However, computing ACs with (17), which only considers price, results in lower incomes for the EC developer. The advantage for having more competitive prices than host members is lost, when the latter have greater consumption. Consequently, in both A1 and A2, allocating less energy to a member results in that member having to purchase energy from retail at a higher price than within the EC, thereby increasing their costs.

- In B, the application of (16) leads to higher costs for host members because, despite the existence of an energy surplus, (16) results in lower allocation than consumption for host members. As a result, they need to purchase energy from retail at a higher price than the local one.

V. CONCLUSIONS

This work presents an energy management system for an energy community, optimizing benefits for developers and cost savings for members. Algorithmic decision-making mechanisms improve efficiency and resource use. Four allocation methods are analysed, including and a decision tree that offers higher benefits for developers while maintaining member savings. To solve the MILP an iterative fixed-point algorithm allows to test all kind of allocation mechanism.

The proposed energy management system is a feasible solution for the development of energy communities, addressing challenges related to financial constraints, governance effectiveness, and technical complexities. The case examples show that the strategic selection of energy allocation coefficients plays a crucial role in optimizing both the developer's profitability who performs the community management tasks while still providing fair benefits to all community members.

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TABLE I. COSTS FOR THE AC METHODOLOGIES TESTED

Case study	Coeffs.	Cost MP_1	Cost MP_2	Cost EC Developer	Cost MNH_1	Cost MNH_2	Cost MH_1	Cost MH_2	$\hat{C}^{ind}_{MNH1}$	$\hat{C}^{ind}_{MNH2}$	$\hat{C}^{ind}_{MH1}$	$\hat{C}^{ind}_{MH2}$
A1	$\hat{C}^{prop,k}_{n,t}$	-6.71	-8.13	-14.84	19.30	20.24	30.94	30.94	19.56	20.52	32.92	32.92
	$\hat{C}^{\lambda prop,k}_{n,t}$	-6.85	-7.99	-14.84	19.30	20.23	31.22	31.24	19.56	20.52	32.92	32.92
	$\hat{C}^{\lambda}_{n,t}$	-8.38	-6.72	-15.1	19.26	20.20	31.44	31.44	19.56	20.52	32.92	32.92
	$\hat{C}^{tree,k}_{n,t}$	-8.42	-6.69	-15.11	19.26	20.20	31.44	31.44	19.56	20.52	32.92	32.92
A2	$\hat{C}^{prop,k}_{n,t}$	-9.58	-6.77	-16.33	32.43	32.43	18.44	19.32	32.92	32.92	19.56	20.52
	$\hat{C}^{\lambda prop,k}_{n,t}$	-9.9	-6.44	-16.34	32.42	32.42	18.61	19.51	32.92	32.92	19.56	20.52
	$\hat{C}^{\lambda}_{n,t}$	-8.45	-7.41	-15.86	32.51	32.51	18.43	19.31	32.92	32.92	19.56	20.52
	$\hat{C}^{tree,k}_{n,t}$	-9.62	-6.75	-16.38	32.42	32.42	18.51	19.40	32.92	32.92	19.56	20.52
B1	$\hat{C}^{prop,k}_{n,t}$	-82.89	-1.67	-84.56	18.91	19.83	27.29	27.29	19.56	20.52	32.92	32.92
	$\hat{C}^{\lambda prop,k}_{n,t}$	-80.62	-3.11	-83.74	18.91	19.83	27.52	27.52	19.56	20.52	32.92	32.92
	$\hat{C}^{\lambda}_{n,t}$	-82.89	-1.67	-84.56	18.91	19.83	27.29	27.29	19.56	20.52	32.92	32.92
	$\hat{C}^{tree,k}_{n,t}$	-82.89	-1.67	-84.56	18.91	19.83	27.29	27.29	19.56	20.52	32.92	32.92
B2	$\hat{C}^{prop,k}_{n,t}$	-86.68	-1.42	-88.1	31.81	31.81	16.22	17.01	32.92	32.92	19.56	20.52
	$\hat{C}^{\lambda prop,k}_{n,t}$	-84.81	-2.36	-87.17	31.81	31.81	16.50	17.30	32.92	32.92	19.56	20.52
	$\hat{C}^{\lambda}_{n,t}$	-86.68	-1.42	-88.1	31.81	31.81	16.22	17.01	32.92	32.92	19.56	20.52
	$\hat{C}^{tree,k}_{n,t}$	-86.68	-1.42	-88.1	31.81	31.81	16.22	17.01	32.92	32.92	19.56	20.52

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APPENDIX

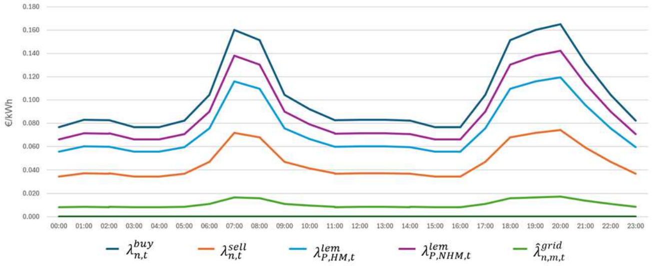

Figure 4.Value of prices.