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Modelling and Optimization of Power Allocation and Benefit Sharing in a Local Energy Community

Alyssa Diva Mustika, Rémy Rigo-Mariani, Vincent Debusschere,
and Amaury Pachurka

Abstract This paper proposes a strategy for the resources management and power allocation in an energy community. Especially, the fairness of the benefit sharing is assessed thanks to a metric introduced as a monthly net energy price (in c€/kWh) from the viewpoint of each individual and computed as the individual bill over the consumed energy. The community management decouples the operational (i.e., power dispatch) from the settlement phase (i.e., monthly community billing). In particular, the investigated billing approach is based on an optimization process with an additional constraint to limit the gap between the maximum and minimum identified prices over all the community members. This study then provides a new method to better address individual's need in the community. The results show a narrow range of the individual energy price and 11.5% collective bill reduction compared to a case where the members act individually.

1 Introduction

Energy communities (EC) have been emerging in the past years as an alternative to integrate renewable energies in parallel with microgrids. An EC typically consists in several end-users located in a close geographical range, and are either traditional consumers or prosumers (i.e., end-users that can act as producers or consumers thanks to individual assets [1]). In France, the geographical limitation between two consumers is set at 2 km and the maximum cumulative installed generation is 3 MW

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[2]. EC in Denmark, Finland, and Sweden are only allowed through private grids [3].

The management of an EC includes the actual operation of local production and/or storage (i.e., through an energy management strategy (EMS)), and an allocation rule for the community energy to each member. There are many options to allocate the collective energy and each method presents characteristics that are able to suit EC with different preferences. The main objective is to define how the overall community generation is contractually distributed among participants over a given period of time (e.g., on a monthly basis for billing purposes). Contreras-Ocaña et al. [4] proposed for instance a minimum variance of the annual energy allocation among the different members that fulfill a predefined benefit shared between investors and consumers. Peer-to-peer trading has been also investigated with contractual connections between prosumers and an energy sharing coordinator (i.e., no connection between individuals and the main grid) [5]. In [6], a deviation from the allocation rules relative to the pre-agreed values between the community manager and members could be allowed within a tolerance aiming at minimizing the community bill.

A common aspect of EC that are also being looked into is the fairness of the allocation. To ensure some fairness between members, the application of game theory has been showing promising results to develop a cooperative framework [7, 8]. However, the computational time could be unacceptable since every possible combinations of community needs to be run in order to compute the marginal value/benefit brought by every single member. The investigation of energy allocation that is based on optimization process is still an open subject, with a rapidly growing literature.

Providing this context, this study presents a new energy allocation strategy that is based on individual energy price (in c€/kWh) perspective and aims at limiting the gap between the values among the community members. This topic is identified as being of importance to energy community managers in the sense of providing more options of allocation strategy that would consider every member's viewpoint. Note that, prior to the allocation is computed (at a monthly basis), the management of the community flexible resources (i.e., the storage systems here) is performed with an optimization-based EMS. This management targets a maximum self-sufficiency ratio (SSR) at the community level (i.e., minimum import from the upstream grid) indiscriminately from any economical aspect. Next, the settlement phase is taken place where the contribution of the paper lies on the proposed metric in terms of net energy price from individual perspective to compute the energy allocation rules.

The rest of this paper is organized as follows. Section 2 introduces the collective self-consumption (i.e., the production that can be consumed locally thanks to the heterogeneous profiles in the community) and describes the energy allocation concept. Section 3 presents the proposed methodology for an EMS that maximizes SSR and three options of energy allocation keys. The use case is then described in Sect. 4 where results are analyzed in terms of energy flows and benefit at both community and individual levels. Finally, Sect. 5 concludes this paper on the main

2 Collective Self-Consumption

Rather than acting individually, collective self-consumption is an interesting concept in EC that allows members to collectively aggregate the consumption and production profiles with the aim of increasing the ratio of self-consumption (SCR) i.e., the amount of local production that can be absorbed by the load [9].

In the French context, the organization of an EC comprises of several stakeholders: community members, community manager (also called PMO for *personne morale organisatrice* or moral organizing entity in English), the distribution system operator (DSO) that manages the distribution grid, and lastly the suppliers that compensate the surplus or deficit of the local energy (i.e., the sell/purchase any community deficit/surplus energy).

The PMO is a legal entity in charge of organizing the internal community as well as dealing with external parties. The main French DSO, Enedis, specifies that the PMO needs to define the keys of repartition (KoR) at a monthly basis for billing purposes, to be further used to compute the amount of energy flows between the community and the grid. Those keys define the amount of overall community generation that is allocated to each member. It is obvious that KoR presents a great role for bill calculation at the community level as well as benefit distribution at the individual level (i.e., bill for each member).

The typical architecture model of an EC, as presented in Fig. 1, shows that the physical energy flow measured at the meter level ($P_{n,t}^{meter+}$, $P_{n,t}^{meter-}$) can be contractually partitioned into two components: the community flows ($P_{n,t}^{com+}$, $P_{n,t}^{com-}$) and the grid flows ($P_{n,t}^{gd+}$, $P_{n,t}^{gd-}$). The positive (+) and negative (-) superscript indicates import and export of energy, respectively. Each member may own private assets such as solar PV, stationary (batteries) and/or mobile (electric vehicles, EV) storage to fulfill household demand with +/- superscript representing the charge/discharge conditions. There is no physical grid connection

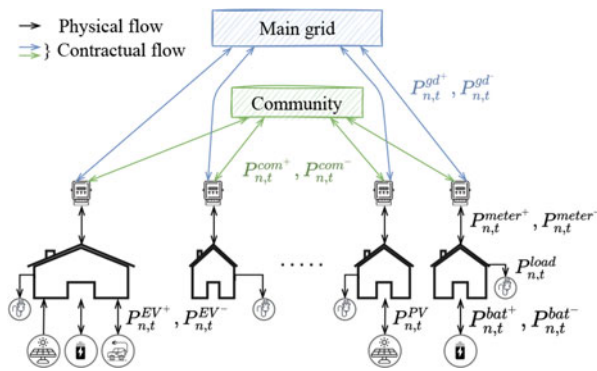


Fig. 1 Model architecture of the energy community

between the members within the energy community here (i.e., energy is exchanged between members and the community through a virtual community hub).

2.1 Energy Allocation and Bill Computation

The collective production at the community level is distributed among the members through an allocation rule and coefficients denoted as *keys of repartition* (KoR). This metric is defined on a monthly basis and can be static (i.e., the ratio is constant over time) or dynamic (i.e., varies each 30 min for instance) with a value in percent. Obviously, the sum of the KoR over all community members cannot exceed 100% as in (1). The community production is the summation of the net production measured at the house meter of each individual as expressed in (2). The power allocated to each individual is then obtained per time step thanks to the predefined KoR with (3).

$$\sum_{n \in N} \lambda_{n,t} \leq 100\% \quad (1)$$

$$P_{coll,t}^{prod} = \sum_{n \in \mathcal{N}} P_{n,t}^{meter-} \quad (2)$$

$$P_{n,t}^{alloc} = \lambda_{n,t} \times P_{coll,t}^{prod} \quad (3)$$

In some cases, and depending on the KoR values, the allocated energy may be higher than what a member needs (i.e., his consumption) thus the actual energy import from the community is calculated using (4). On the contrary, if the community energy is not enough to fulfill the demand, the deficit is supplied by the grid as computed in (5).

$$P_{n,t}^{com+} = \min \left(P_{n,t}^{alloc}, P_{n,t}^{meter+} \right) \quad (4)$$

$$P_{n,t}^{gd+} = P_{n,t}^{meter+} - P_{n,t}^{com+} \quad (5)$$

All the energy taken from the community is computed with (6). Then, we can obtain the collective surplus as the difference between collective production and self-consumed energy from the community as in (7). This collective surplus is then assigned to each producer based on the prorata of individual production, which represents the energy exported to the grid, (8). Finally, the net production exported to the community is computed with (9).

$$P_{coll,t}^{selfcons} = \sum_{n \in \mathcal{N}} P_{n,t}^{com+} \quad (6)$$

$$P_{coll,t}^{surplus} = P_{coll,t}^{prod} - P_{coll,t}^{self\ cons} \quad (7)$$

$$P_{n,t}^{gd^-} = \frac{P_{n,t}^{meter^-}}{P_{coll,t}^{prod}} \times P_{coll,t}^{surplus} \quad (8)$$

$$P_{n,t}^{com^-} = P_{n,t}^{meter^-} - P_{n,t}^{gd^-} \quad (9)$$

The monthly individual bill (B_n) ultimately comprises of the community (B_n^{com}) and the grid (B_n^{gd}) as in (10). While payment to the community (11) depends on the internal community tariff ($\pi_n^{buy,comm}$, $\pi_n^{sell,comm}$) and the amount of energy import/export ($\sum_{t \in \mathcal{T}} P_{n,t}^{com^+}$, $\sum_{t \in \mathcal{T}} P_{n,t}^{com^-}$), the grid bill comprises also the subscription fee ($\Pi_n^{subs,gd}$) as in (12) in addition to the suppliers energy rates ($\pi_n^{buy,gd}$, $\pi_n^{sell,gd}$). Therefore, the collective bill (B_{coll}) is computed as the summation of all the individual bills with (13).

$$B_n = B_n^{com} + B_n^{gd} \quad (10)$$

$$B_n^{com} = \left(\pi_n^{buy,com} \sum_{t \in \mathcal{T}} P_{n,t}^{com^+} - \pi_n^{sell,com} \sum_{t \in \mathcal{T}} P_{n,t}^{com^-} \right) \Delta t \quad (11)$$

$$B_n^{gd} = \Pi_n^{subs,gd} + \left(\pi_n^{buy,gd} \sum_{t \in \mathcal{T}} P_{n,t}^{gd^+} - \pi_n^{sell,gd} \sum_{t \in \mathcal{T}} P_{n,t}^{gd^-} \right) \Delta t \quad (12)$$

$$B_{coll} = \sum_{n \in \mathcal{N}} B_n \quad (13)$$

3 Management Method of an Energy Community

As shown in Fig. 2, the EC management in this work relies on a decoupling between the operational phase (i.e., energy management strategy (EMS)) and the settlement (i.e., KoR and monthly billing). The first stage is then defined as an EMS for the overall community through an optimization model that maximizes the SSR over a given time horizon. In an operational phase, such optimization shall be integrated in a predictive control approach. In this paper, the optimization is performed somewhat a posteriori on a monthly basis with deterministic profiles. The EMS results in the optimal operation of storage units and all the power flows measured at the households' meter. At the second stage, the allocation rules distribute the community production to each member (i.e., through KoR). In this paper, we investigate three options of KoR: a static version, the default method proposed by the French DSO, and an optimization-based strategy that considers individual per unit energy prices (i.e., regarded from each member's perspective). Note that the

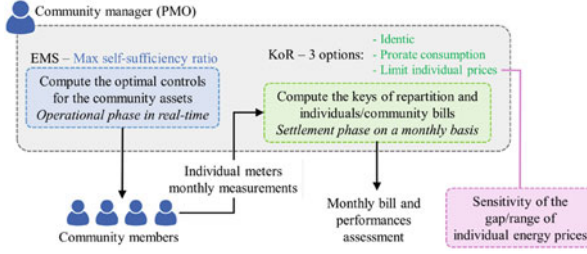


Fig. 2 Proposed methodology for the management in an energy community

management lies in the active power flow only while the low voltage grid is not modeled and outside the scope of this paper.

3.1 Energy Management Strategy

The EMS is modeled in the form of an optimization problem adopted from our previous work [10] with an objective to maximize the SSR, the ratio of the consumption ($P_{n,t}^{load}$) that can be supplied by the local production [9]. Based on the expression of the SSR (14), maximizing this metric implies to minimize the energy import from the grid ($P_{n,t}^{gd+}$).

Therefore, the objective formulation is shown in (15). This optimization-based EMS is performed for a whole simulation horizon (i.e., 1 month in this case). All the powers are in kW and defined over the monthly horizon at a half hourly resolution.

$$SSR = 1 - \frac{\sum_{n \in \mathcal{N}} \sum_{t \in \mathcal{T}} P_{n,t}^{gd+}}{\sum_{n \in \mathcal{N}} \sum_{t \in \mathcal{T}} P_{n,t}^{load}} \quad (14)$$

$$f = \min \sum_{n \in \mathcal{N}} \sum_{t \in \mathcal{T}} P_{n,t}^{gd+} \quad (15)$$

The decision variables in this optimization are the energy flows of individual assets. These variables are modeled as positive semi-definite.

- The storage charge $P_{n,t}^{st+}$ and discharge $P_{n,t}^{st-}$:
 - Battery $P_{n,t}^{bat+}$, $P_{n,t}^{bat-}$,
 - EV $P_{n,t}^{EV+}$, $P_{n,t}^{EV-}$.
- The state of charge of storage $SOC_{n,t}^{st}$ which refers to both battery and EV;
- The individual self-consumed power $P_{n,t}^{indsc}$ and exchanges at the individual level:

- The grid import $P_{n,t}^{gd^+}$ and export $P_{n,t}^{gd^-}$;
- The community import $P_{n,t}^{com^+}$ and export $P_{n,t}^{com^-}$.

Additional constraints are introduced in order to represent the operation of the EC. A first set of equations regarding the limitation of energy exchange by the household subscription power is defined by (16) and (17). Also, (18) defines that the peak power from the grid after joining the community cannot be higher than when acting individually.

$$P_{n,t}^{gd^+} + P_{n,t}^{com^+} \leq P_n^{subs} \quad \forall n \in \mathcal{N}, \forall t \in \mathcal{T} \quad (16)$$

$$P_{n,t}^{gd^-} + P_{n,t}^{com^-} \leq P_n^{subs} \quad \forall n \in \mathcal{N}, \forall t \in \mathcal{T} \quad (17)$$

$$\max \left(P_{n,t}^{gd^+} \right) \leq \max \left(P_{n,t}^{load} \right) \quad \forall n \in \mathcal{N} \quad (18)$$

The next set of constraints covers storage systems boundaries from the power and energy point of view (19), (20), the assumption of the SOC level at the beginning and end of the simulation time horizon to fulfill the principle of energy conservation (i.e., cyclic constraint) (21), (22), and the computation of state of charge (SOC) (23).

$$0 \leq P_{n,t}^{st^+}, P_{n,t}^{st^-} \leq P_{max,n}^{st} \quad \forall n \in \mathcal{N}, \forall t \in \mathcal{T} \quad (19)$$

$$SOC_{min,n}^{st} \leq SOC_{n,t}^{st} \leq SOC_{max,n}^{st} \quad \forall n \in \mathcal{N}, \forall t \in \mathcal{T} \quad (20)$$

$$SOC_{n,1}^{st} = SOC_n^{init} \quad \forall n \in \mathcal{N} \quad (21)$$

$$SOC_{n,end}^{st} \geq SOC_n^{init} \quad \forall n \in \mathcal{N} \quad (22)$$

$$SOC_{n,t+1}^{st} = SOC_{n,t}^{st} + \left[P_{n,t}^{st^+} \times \mu_n^{st} - \frac{P_{n,t}^{st^-}}{\mu_n^{st}} \right] \times \Delta t \times \frac{100}{E_{max,n}^{st}} \quad \forall n \in \mathcal{N}, \forall t \in \mathcal{T} \quad (23)$$

At the individual level, the local generation can come from the PV production ($P_{n,t}^{PV}$) and/or the storage discharge, which then can supply its own self-consumption ($P_{n,t}^{indsc}$) and/or export to the grid/community, (24). Likewise, the total individual consumption consists of the load ($P_{n,t}^{load}$) and/or storage charge, which can be supplied from its own self-consumed energy and/or the imported energy from the grid and/or the community. These result in the individual power balance (25). Finally, a power balance equation at the community level is described in (26).

$$P_{n,t}^{PV} + P_{n,t}^{bat^-} + P_{n,t}^{EV^-} = P_{n,t}^{indsc} + P_{n,t}^{gd^-} + P_{n,t}^{com^-} \quad \forall n \in \mathcal{N}, \forall t \in \mathcal{T} \quad (24)$$

$$P_{n,t}^{load} + P_{n,t}^{bat^+} + P_{n,t}^{EV^+} = P_{n,t}^{indsc} + P_{n,t}^{gd^+} + P_{n,t}^{com^+} \quad \forall n \in \mathcal{N}, \forall t \in \mathcal{T} \quad (25)$$

$$\sum_{n \in \mathcal{N}} P_{n,t}^{com+} = \sum_{n \in \mathcal{N}} P_{n,t}^{com-} \quad \forall t \in \mathcal{T} \quad (26)$$

After performing this optimization, the physical power measured at the house meter is available and defined by (27) to be used later for the energy allocation computation.

$$P_{n,t}^{meter+} - P_{n,t}^{meter-} = P_{n,t}^{gd+} - P_{n,t}^{gd-} + P_{n,t}^{com+} - P_{n,t}^{com-} \quad (27)$$

3.2 Energy Allocation Through Keys of Repartition

Once the EMS results are available, the next step consists in the allocation of the community energy between the different members with the computation of the KoR. We propose three strategies that distribute the energy differently.

3.2.1 KoR₁: Identical Repartition

The first KoR allocates the community energy equally for each member of the community (i.e., everyone receives an exact same portion) as in (28). The notation $|\cdot|$ represents the cardinal function (i.e., $|\mathcal{N}|$ means the number of members in the community). Ultimately, at every time step, the same ratio of community energy is allocated to each participant.

$$\lambda_{n,t} = \frac{1}{|\mathcal{N}|} \quad (28)$$

3.2.2 KoR₂: Prorate Consumption

The next keys is the default KoR proposed by the main French DSO, Enedis. It relies on the amount of consumption measured at the level of individual meters (29). Hence, the more a member consumes energy at a given time step, the more energy from the community is allocated to him.

$$\lambda_{n,t} = \frac{P_{n,t}^{meter+}}{\sum_{n \in \mathcal{N}} P_{n,t}^{meter+}} \quad (29)$$

3.2.3 KoR₃: Limit Individual Energy Prices

The last KoR is different from the previous ones by not relying on a simple equation to share the community energy between members. The third KoR strategy relies on

an optimization that limits the range of individual energy prices from the perspective of each member. The energy prices here are defined as the cost of energy (in $c\text{€}/\text{kWh}$) on a monthly basis, once the billing is computed. In particular, the keys $\lambda_{n,t}$ here are decision variables to be optimized while the power measurements at the meter $P_{n,t}^{meter+}$, $P_{n,t}^{meter-}$ are the input parameters. The objective of this optimization is to minimize the total community bill (30).

$$f = \min B_{coll} \quad (30)$$

Additional decision variables are the partition of meter flows (i.e., from/to the grid and the community) $P_{n,t}^{gd+}$, $P_{n,t}^{gd-}$, $P_{n,t}^{com+}$, $P_{n,t}^{com-}$ and the allocation energy $P_{n,t}^{alloc}$ with positive semi-definite variables properties for all. A set of constraints related to the KoR is taken from Sect. 2.1, (1)–(9).

We define the individual net energy price as the bill over the total consumption measured at the meter as in (31). It reflects the net price perceived by each member, which is different from one another. The objective of the approach proposed here is to increase the fairness in the energy allocation between the different members. The net energy price is then considered as a metric and the optimization aims at minimizing the gap between these individual prices. Thus, one constraint is added based on the difference between the maximum and minimum individual energy price following (32). This additional constraint may endanger problem feasibility because it reduces the compatible solution area.

$$\pi_n^{net} = \frac{B_n}{\sum_{t \in T} P_{n,t}^{meter+}} \quad (31)$$

$$\Delta\pi_n^{net} = \max(\pi_n^{net}) - \min(\pi_n^{net}) \quad (32)$$

4 Result Analysis

4.1 Case Study

In this section, we apply the proposed framework to a real demonstrator of an EC that comprises of seven households located in Le Cailar, south of France. Each household is equipped with different types of assets whose rated capacities are shown in Table 1 and subscribed to different power ratings which lead to different tariffs. The data includes consumption and PV production profiles for a month of March 2021 at a 30 min time step. We define a baseline case where there is no community such that all the power flows through the meter is transacted with the main grid (i.e., excluding the purchase/sale in the community).

Table 1 Household parameters of the study case

House	PV (kW)	Bat. (kW/kWh)	EV (kW/kWh)	Subs. (kVA)	$\Pi_n^{subs,gd}$ (€/mo)	$\pi_n^{buy,gd}$ (c€/kWh)
1	3.2	5/9.8	11/40	6	8.4	12.97
2	6.12	5/9.8	–	36	24.96	13.31
3	–	5/9.8	–	6	8.4	12.97
4	3.2	–	–	9	10.05	13.31
5	3.2	–	–	9	10.05	13.31
6	3.2	–	–	6	8.4	12.97
7	–	–	–	9	10.05	13.31

4.2 Managing the Energy Community

4.2.1 Energy Management Strategy

The first step of the proposed management of an EC consists in the operational phase through an EMS that maximizes the SSR for the whole community. In terms of energy, for a total collective monthly consumption of 8.7 MWh and PV production of 3.7 MWh, the collective grid energy import and export are 5 MWh and 0.05 MWh respectively once the EMS is run. The significant energy import is caused by the mismatch time between the local production and consumption. The considered EMS returns 42% SSR, with almost full self-consumption (i.e., all the community production is consumed locally, 98.6% SCR). This is considered a significant improvement compared to a case where the EMS is performed individually (i.e., 27% SSR and 64% SCR). The results on the profiles of household meters and the storage's SOC are shown in Fig. 3.

Figure 3a corresponds to the power meter and SOC profile of house 1 without any control and Fig. 3b with the proposed EMS to control the storage. It can be seen that the peak load observed at the meter is reduced thanks to the EMS that operates the storage to achieve the objective (i.e., maximize SSR). The evolution of the SOC indicates that the battery is discharged gradually particularly during the time of low local PV production and high consumption (i.e., in order to lower the individual import from the grid). In the presented sample day, EV charge occurs at the time of high PV power generation and the discharge at night.

In the perspective of the overall community, Fig. 3c displays the summation of power meter of all houses that reflects the total import and export energy from/to the main grid. There is no export energy observed at the community level for the sample day as all local production is utilized within the community.

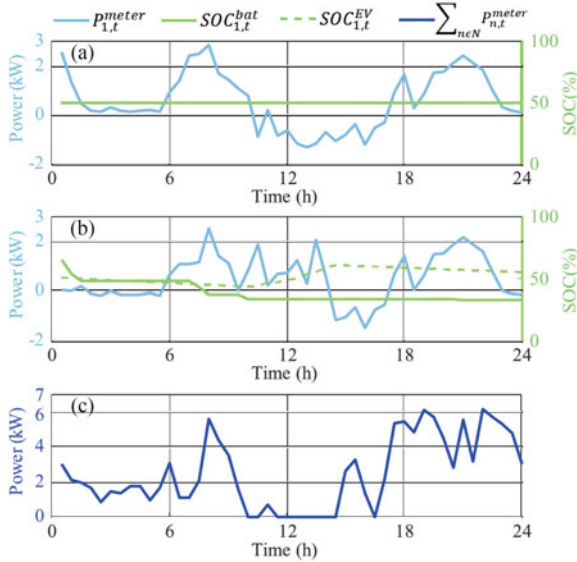


Fig. 3 Profiles measured at a sample day of (a) the power at the meter and storage’s SOC of house 1 without EMS, (b) with EMS, and (c) for all houses at the community level

4.2.2 Keys of Repartition

The physical flow at the individual meters are then returned by the EMS and available at the end of the month before running the billing process through the computation of KoR. Before comparing several strategies of KoR, the new proposed metric used in KoR_3 is investigated first in terms of the gap value of the individual energy prices as the computation of KoR_3 depends on it. Remind that the optimization problem to compute the keys following KoR_3 requires to input the maximum allowable net energy price range between the participants. The impact on the collective bill for different ranges of individual prices in KoR_3 is illustrated in Fig. 4a. If the additional constraint ($\Delta\pi_n^{net}$) is disable, the gap between individual prices is equal to 5.62 c€/kWh with a minimum overall bill (497 €). The KoR_3 billing strategy is then run while decreasing the maximum allowable price range (per steps of 0.2 c€/kWh) until the calculation is not feasible anymore. The infeasible limit of $\Delta\pi_n^{net}$ is denoted by the gray area, which lays below 4.5 c€/kWh. Close to this area, the collective cost increases significantly and it is not possible to further decrease the error difference in terms of individual prices for a fairer community.

The impact of the range of individual prices to the bill savings (i.e., compared to the baseline case) and the detail prices are presented in Fig. 4b and c respectively. The higher the individual energy price, the lower its associated saving. While the saving of house 4 decreases significantly when the gap between individual prices reduces, the saving trend for other houses is rather constant in the median area of the

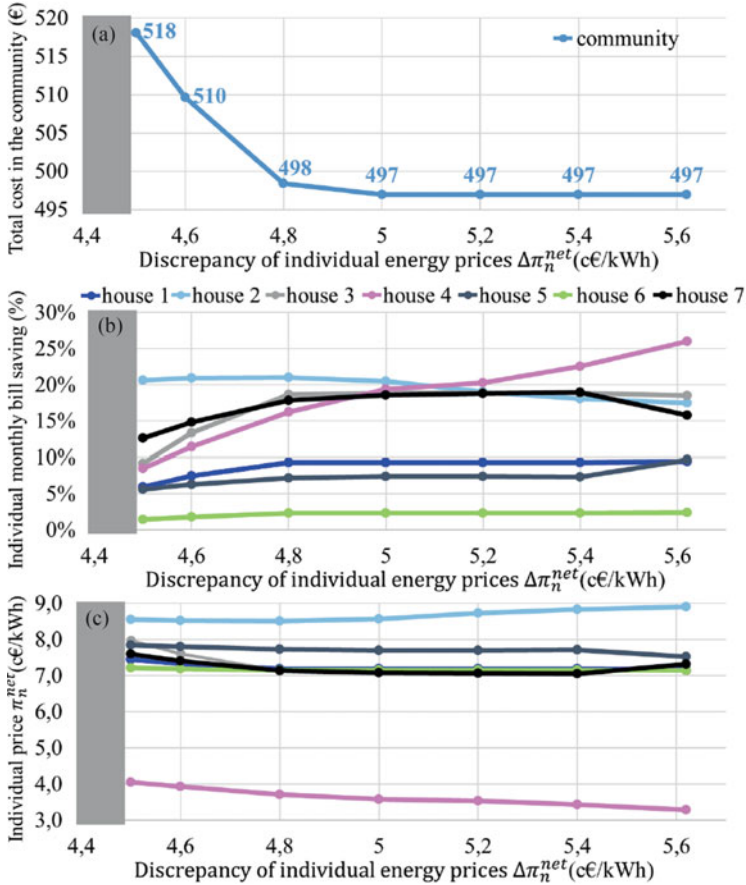


Fig. 4 Behavior of (a) collective cost, (b) individual saving ratios, and (c) individual prices for different range of individual prices in KoR_3

gap values tested. Figure 4c indicates that the gap of individual prices is linked to the discrepancies between house 2 (i.e., the highest price 8.5–8.9 c€/kWh) and house 4 (i.e., the lowest price 3.3–4.1 c€/kWh). The rest of the houses in the community always have their price in between 7 and 8 c€/kWh. The big gap between house 4's price and the rest of the members is caused by its lowest consumption with the same PV capacity as most of the members, hence it leads to the lowest bill of house 4.

From the three graphics provided in Fig. 4, the lowest gap of the individual energy prices chosen for the next analysis is 4.8 c€/kWh because of the tiny increment of collective bill compared to its best minimum value. At that gap, the variations between individuals' saving are still acceptable (i.e., before the aggressive increment of house 4's saving).

After finding the best gap for KoR_3 , we compare it with the baseline and other computations of KoR. Table 2 demonstrates the effect of the different KoRs to

Table 2 Collective bill for different computations of KoR

Baseline	KoR_1	KoR_2	KoR_3
563 €	530 €	497 €	498 €

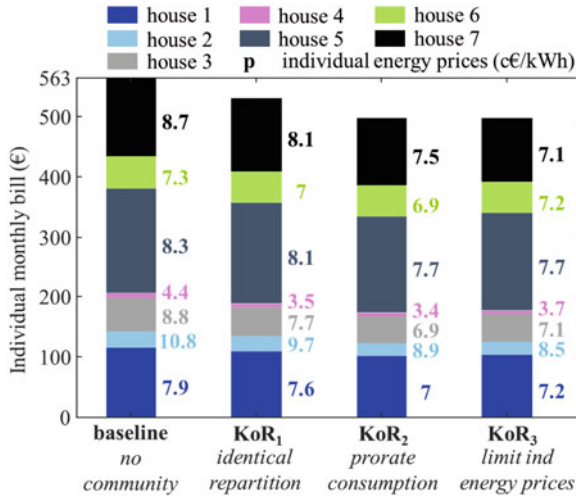


Fig. 5 Individual comparison of the baseline and three different computations of KoR

the overall bill at the community level. The lowest collective cost is reached by the second KoR that distributes the community energy based on the ratio of each member’s consumption (i.e., corresponding to the maximum load covered by the community generation). The last KoR returns 11.5% collective bill saving (i.e., compared to the baseline) with a smaller gap of individual energy prices.

The individual bills and monthly net energy prices regarded from each member’s perspective for the three computation strategies of KoR is shown in Fig. 5. The collective bill in Table 2 is composed of individual bills as presented in the bar graph of Fig. 5. The static keys (KoR_1) lead to a very wide percentage of individual prices, from 3.5 to 9.7 c€/kWh. With KoR_2 where the community generation is shared among the participant based on the individual consumption level at each time step, the range of net prices is still significantly far from each other, from 3.4 to 8.9 c€/kWh (i.e., the gap between maximum and minimum values is 5.5 c€/kWh). The last proposed keys (KoR_3) returns the best results with the narrowest range of individual prices (from 3.7 to 8.5 c€/kWh). The lowest individual price is always observed in house 4 because its bill is significantly lower than the other houses (i.e., less consumption).

5 Conclusions

In this paper, we introduce a new metric of individual net energy price in order to allocate collective energy for each member in an EC. The proposed keys of repartition (KoR) is based on an optimization model that utilizes the metric as an additional constraint from each member's perspective. The benefit of this strategy is that we can set a gap limitation to the range of individual energy prices such that it lowers the disparity between community members. This KoR provides an overall bill reduction of 11.5% compared to the baseline case where there is no energy community. This paper provides then an alternative of KoR to energy community stakeholders for a better share of the collective energy by considering price from every member's viewpoint. Future work would include long-term planning of the community assets and ancillary services at the community level.

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