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METHODOLOGY FOR DESIGNING AN ENERGY COMMUNITY AND ITS APPLICATION TO THE MUNICIPALITY OF VINALESA.

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INTRODUCTION

- Energy communities are a new model of energy management that aims to take advantage of local energy resources and involve the different social agents of the environment in order to obtain energy, environmental, social and economic benefits.
- Information provided by the directives or available literature about energy communities is limited to the concept and its properties or shows some cases of similar configurations such as energy cooperatives but does not go into detail on the more technical necessary aspects to set up an energy community.

► OBJECTIVE

To shed some light on the more technical aspects related to the design of energy communities, through the development of a methodology and its application to a practical case in the municipality of Vinalesa (Valencia, Spain) in order to support the sizing of the community's generation assets and the design of the electricity tariff according to the conditions of the environment, as well as to study its technical and economic viability.

METHODOLOGY

The methodology developed is a roadmap that considers the most important technical and economic parameters when designing an energy community which is connected to the grid, has renewable energy generation assets and makes an equitable distribution of the benefits obtained.

It consists of 3 different phases depending on the decision to make. At each step you will get key information that will guide you to fine-tune the starting conditions until you achieve an Energy Community design that fits your needs.

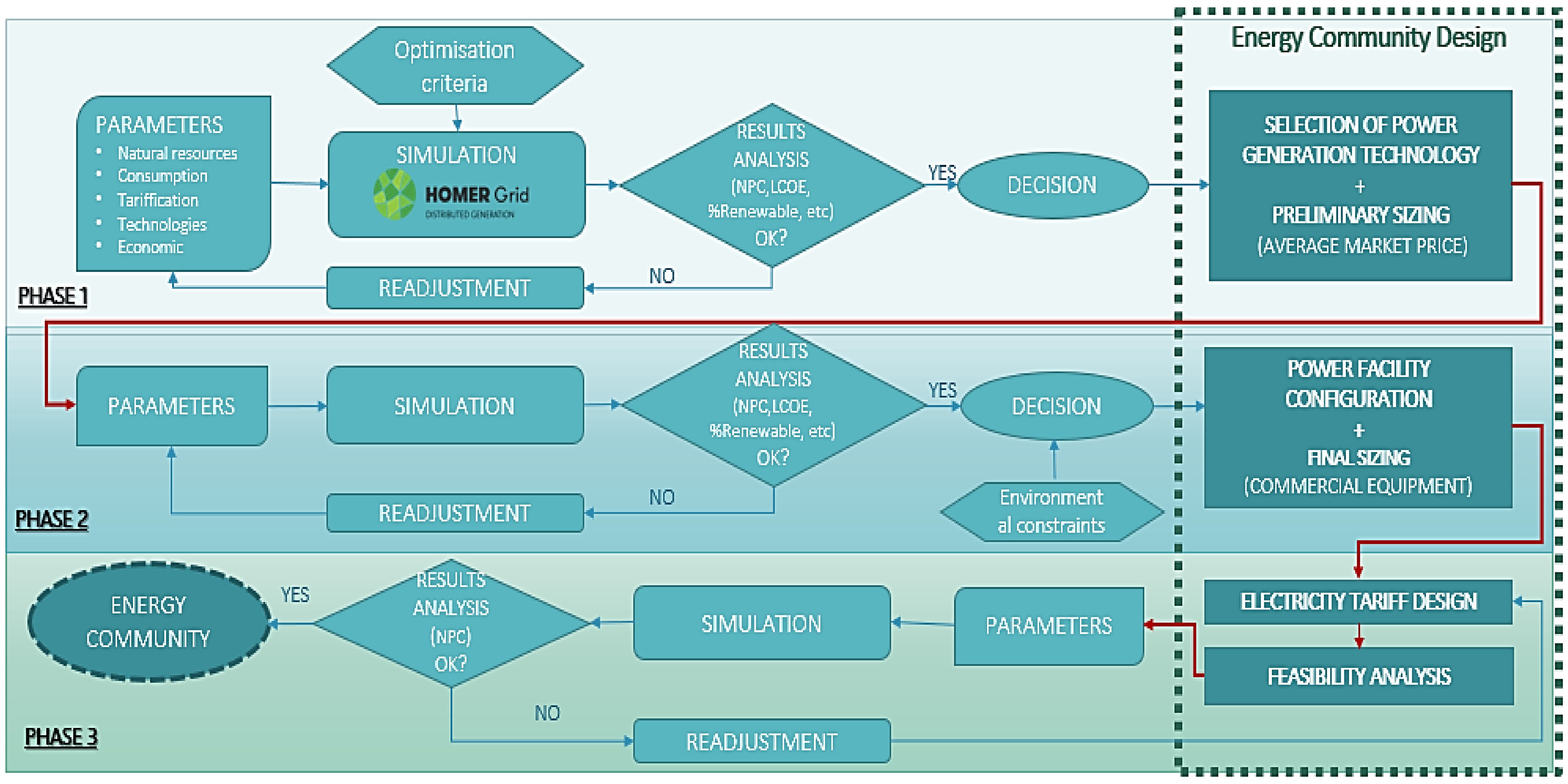


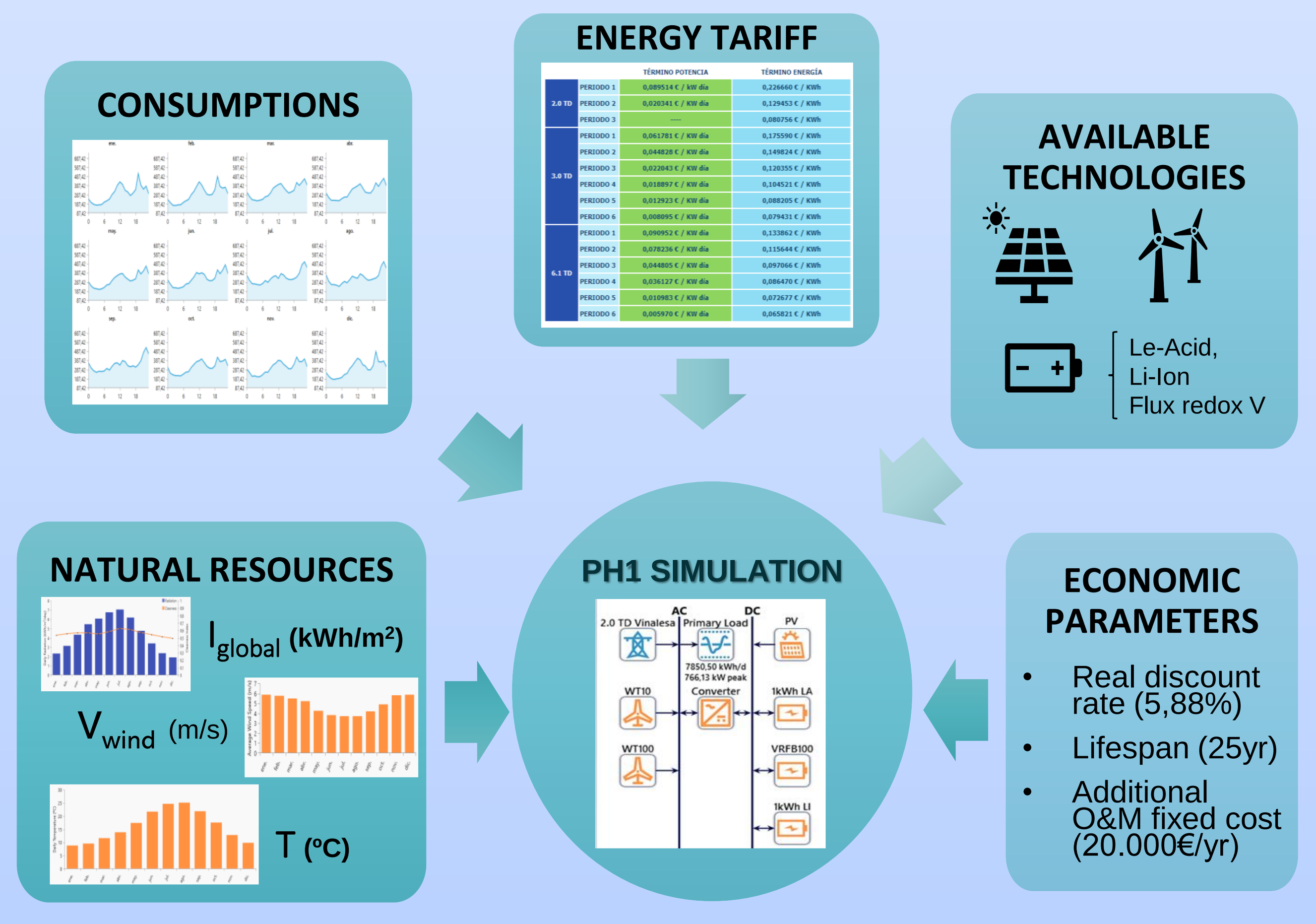
Fig. 1: Methodology for the design of the Energy Community

Phase 1: Selection of generation technology and preliminary sizing.

METHODOLOGY

- **Input parameters →** natural resources, consumption, electricity tariff, energy technologies and economic parameters. Design criteria.
- **Calculation tool→** Homer Grid
- **Analysis of results→** Net Present Cost, NPC (€) and Levelized Cost of Energy, LCOE (€/kWh), fraction of renewables, excess energy, payback period.

CASE STUDY



RESULTS

Table 1 Results of the optimal scenarios of simulation 1 in Phase I

Winner system	Architecture							Cost				System
PV (kW)	WT10	WT100	1kWh LA	VRFB100	1kWh LI	2.0 TD	Converter (kW)	NPC (€)	COE (€)	Operating cost (€/yr)	Initial capital (€)	Ren Frac (%)
977					633	1	486	5,51 €M	0,149 €	323.579 €	1,32 €M	39,1
989	1				674	1	510	5,55 €M	0,150 €	320.850 €	1,40 €M	39,8
914						1	492	5,60 €M	0,151 €	356.453 €	991.214 €	34,3
943				1		1	483	5,61 €M	0,151 €	348.783 €	1,10 €M	35,3
877			15			1	487	5,61 €M	0,152 €	359.660 €	963.086 €	33,8
818	2	1	63			1	515	5,96 €M	0,161 €	358.828 €	1,33 €M	35,5
Base Case						1		6,99 €M	0,189 €	540.896 €	0,00 €	0

- **Decision→** PV panels + lithium batteries + Grid
- LCOE= 0.149€/kWh + % Ren=39,1%

Phase 2: Final configuration and sizing of the power plant with commercial components.

- From phase I, we obtain the most suitable generation technologies available and the order of magnitude of the power needed in order to search for **commercial equipment** and compare them by simulating again with Homer to choose the ones that best fit our needs.

- Different models were compared and iterated until good enough results were obtained. Some of the commercial equipment used for the second simulation is shown in Table 2.

Table 2 Commercial technologies considered for the energy community

TECHNOLOGY	Model	Main features	Investment cost	Life span
Photovoltaic	FV Model A-330p Ultra	330 W	500€/module	25 years
Battery modules	LGChem M48126P3B (2P	126 Ah / 6,44kWh	5000 €	10 years
	EnerDel Secure plus	168 Ah / 101 kWh	45.000 €	10 years
	Tesla PowerPack 2	553 Ah / 210 kWh	150.000 €	10 years
Conversion system	Centralised Inverter Sinexcel 500 Kw	500 kW	76.500€	10 years

Table 3 Optimal scenarios results in Phase 2 simulation

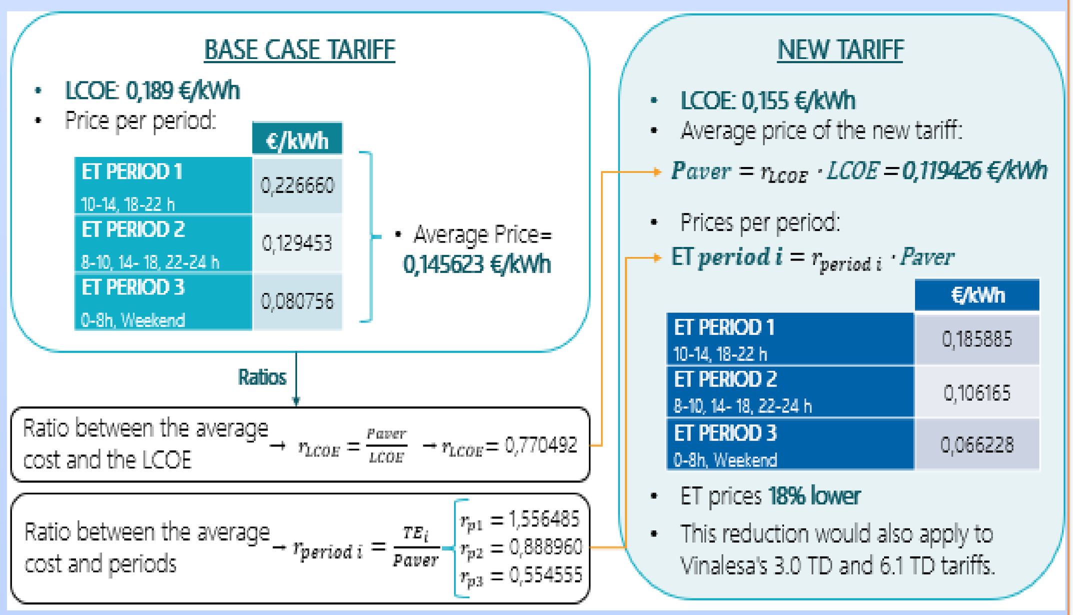
Winner system	Architecture					Cost				System
330P Atersa	LGChem6.4	EDel151	TeslaPP2	2.0 TD Vinalesa	Sinexcel 500 (kW)	NPC (€)	COE (€)	Operating cost (€/yr)	Initial capital (€)	Ren Frac (%)
870	168			1	472	5,74 €M	0,155 €	301.973 €	1,83 €M	42,2
735				1	466	5,94 €M	0,160 €	368.325 €	1,18 €M	32,9
742		1		1	464	5,95 €M	0,161 €	364.699 €	1,23 €M	33,8
751			1	1	468	5,97 €M	0,161 €	357.456 €	1,35 €M	34,6
Base Case				1		6,99 €M	0,189 €	540.896 €	0,00 €	0

- **Decision→** hybrid system: 870 kW PV + 1,08 MWh storage.
- LCOE= 0.155€/kWh + % Ren=42,2%

Phase 3: Design of the new electricity tariff and economic feasibility analysis.

- The new community energy tariff will reflect the savings due to shared self-consumption.
- The power term and the tariff periods of the current tariff will be maintained, and the energy term will be calculated based on the levelised cost of energy (LCOE) obtained in phase 2.

Fig. 2 Methodology for the calculation of the new electricity tariff for the energy community



- The new tariffs would bring members a saving of 16.4% on their electricity tariff.

- Last simulation in Homer to see if it is feasible (covers all depreciation and operating costs of the hybrid renewable system plus grid purchases).

Fig. 3 New electricity tariff of the Energy Community

New EC Electricity tariff		Power Term (€/kW day)	Energy Term (€/kWh)
2.0 TD	P1	0,0895	0,1859
	P2	0,0203	0,1062
	P3	---	0,0662
3.0 TD	P1	0,0618	0,1440
	P2	0,0448	0,1229
	P3	0,0220	0,0987
	P4	0,0189	0,0857
	P5	0,0129	0,0723
	P6	0,0081	0,0651
6.1 TD	P1	0,0910	0,1098
	P2	0,0782	0,0948
	P3	0,0448	0,0796
	P4	0,0361	0,0709
	P5	0,0110	0,0596
	P6	0,0060	0,0540

CONCLUSIONS

- The proposed methodology is a useful tool for designing energy communities as it allows choosing and sizing renewable generation assets in a precise way as well as knowing its economic and technological feasibility. It also offers a simple calculation method to design new electricity tariffs for the members of the community based on the Levelised Cost of Energy obtained with the hybrid system.
- Thanks to this methodology, it has been possible to verify that with the installation of 870 kW of photovoltaic power and a storage capacity of 1.08 MWh in lithium-ion batteries, the residents of the municipality of Vinalesa could have **additional savings of around 16.4% on their electricity bill**, considering a payback period of 8.83 years for the power plant.