

Making Community Networks Economically Sustainable: The Guifi.net Experience

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ABSTRACT

Community networks have flourished around the world as complementary models for enabling access to the Internet and its services. Nevertheless, there is still an on-going debate on how to make them sustainable and scalable beyond voluntary efforts and non-refundable contributions. The approach taken by Guifi.net has been to enable professional activity and to develop a set of tools to ensure the reinvestment of a fraction of the benefits of this professional activity. This has contributed to building the largest community network, with an annual turnover of millions of euros and the creation of dozens of direct jobs. The implementation of these tools is producing extensive data sets that allow characterisation of key parameters in the deployment and operation of these infrastructures to examine behaviours and trends and to identify good and bad practices, fraud, etc. A more detailed knowledge of the economic aspects has a positive effect on reducing the uncertainty of investments, expansion plans, and operations.

Keywords

Community networks, economic sustainability, capital expenditure, operational expenditure, cost-sharing

1. INTRODUCTION

Community networks are networks built by citizens and organisations who pool their resources, often classified as common pool resources (CPR), and coordinate their efforts to build network infrastructures. They are characterised as being open (everyone has the right to know how they are built), free (access to them is driven by the non-discriminatory principle), and neutral (any technical solution available may be used to extend the network, and the network can be used to transmit data of any kind by any

participant, including for commercial purposes). The coverage of underserved areas and the fight against the digital divide are the most frequent driving factors behind the rise of community networks, but motivations such as contributing to the development of a new telecommunications model or just for pleasure are also often cited as reasons by their contributors. Employed technologies vary significantly, ranging from very low-cost, off-the-shelf wireless (WiFi) routers to expensive optical fibre equipment [1].

The Guifi.net is known to be the largest community network in the world. Some measurable indicators are the number of nodes (>30,000), the geographic scope (>50,000km of links), the Internet traffic (4Gbps peak), etc. This is the result of a collaboration that started in 2004 among four groups of participants: i) volunteers interested in aspects such as neutrality, independence, creativity, innovation, ‘do it yourself’ (DIY) projects, and protection of consumers’ rights; ii) professionals interested in aspects such as demand, service supply, and stability of operation; iii) customers interested in network access and service consumption; and iv) public administrations interested in managing specific attributions and obligations to regulate the participation of society and the usage of public space and even in satisfying their own telecommunication needs. These remarkable tangible results are attributed to subtler contributions [2] like the network’s comprehensive governance tools, the economic activity this toolset has enabled, and the cost-sharing and reinvestment mechanisms that have been developed.

Guifi.net is developing a comprehensive ecosystem based on the following driving principles:

- Sharing network infrastructure increases the efficiency (i.e., better performance or wider coverage for the same investment) of the network infrastructure because it stimulates cooperation, preventing duplication of efforts and facilitating economies of scale; this is particularly true in the case of optical fibre because, once in place and operated, it becomes a non-rivalrous asset (zero marginal production costs) due to its virtually unlimited bandwidth.
- The presence of economic activity is essential for the project’s sustainability because it creates a dependency; thus, it generates the required resources to maintain and expand it.

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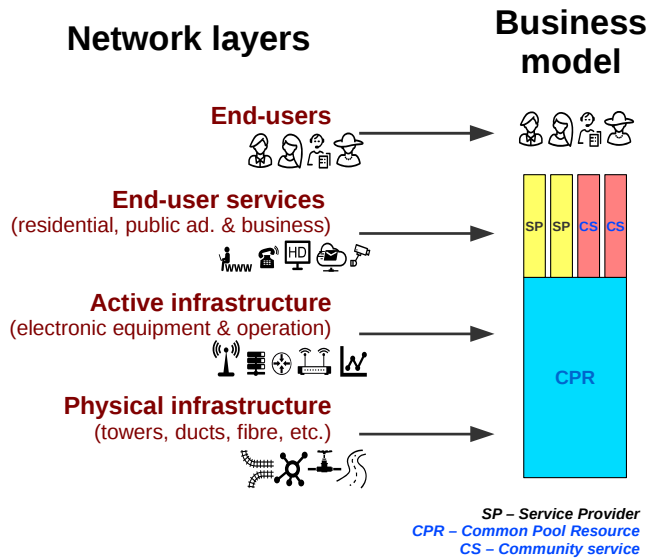


Figure 1: Access network layers vs Guifi.net business model (using Forzati’s [4] representation).

- The professionals (i.e., individuals or enterprises that deliver services in return for an economic remuneration) deserve a fair reward for their work, but speculation on the network infrastructure is not allowed.
- Network participants have the right to satisfy their connectivity needs through their own as well as through the procurement of professional services in a fair competition market.
- The network must remain open, free, and neutral.

As shown in Figure 1, the network infrastructure is considered a CPR; thus, the physical assets are shared and collectively managed according to a collectively built governance system. In this model, ISPs compete to provide services to their customers but cooperate to deploy and operate the network.

The commons model optimises the intended effects on promoting the highest degree of competition in order to maximise the freedom of choice for the end users and to avoid monopoly of the open access model [3] because it increases competition by i) equalising business opportunities¹ ii) lowering the entry barriers due to cost-sharing and pooling resources/services, iii) disintermediation², vi) enabling service delivery to the whole network, and iv) reducing the tasks of the change of supplier to a simple equipment reconfiguration.

This paper aims to provide specific insight into the economic aspects of Guifi.net that are essential to its sustainability³. In this paper, we address the following topics:

- The cost-sharing mechanism, including cost calculations and sharing criteria,

¹The redistribution of opportunities is achieved by enforcing the ISPs to pool their network assets or by issuing a cash penalty.

²The physical layer and the network operator agents disappear.

³See [2] for further introduction to Guifi.net.

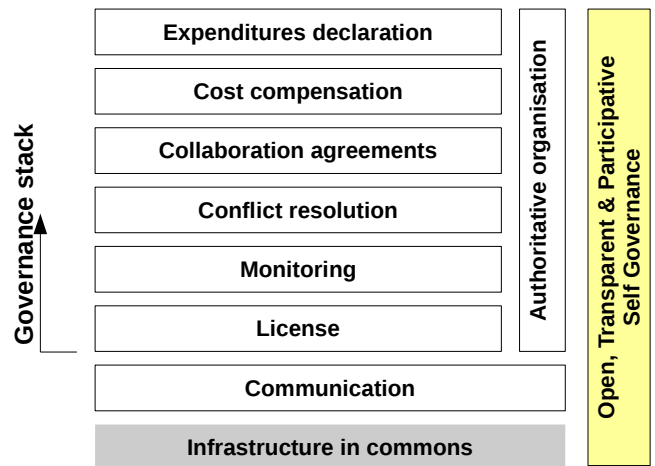


Figure 2: Governance tools (based on [2]).

- The reinvestment flows,
- The analysis of the gathered data and lessons learned, and
- The planned improvements.

The rest of the paper is structured as follows. Section 2 reviews the most significant milestones since Guifi.net started, including the critical challenges faced, and describes the status of the economic compensation framework. Results are presented in Section 3 and the lessons learned in Section 4. The conclusions are presented together with the future work in Section 5.

2. DEVELOPMENT AND IMPLEMENTATION

The CPRs must be properly managed to avoid depletion [9]. The governance tools presented in Figure 2, which is a refinement of the one presented in [2], are the result of more than a decade of theoretical and practical work. Generally, the improvements in the governance system have been introduced in response to specific challenges as they appeared. Figure 3 presents the most relevant threats and needs faced over time, their context, and the governance tools developed in response to them. Tools and methodologies are under constant revision in an open and participative process chaired by the Guifi.net Foundation.

The *Licence* [5] (forming the lower layer of the governance tools (Figure 2)) is mandatory for participation and also sets the legal foundation for the development of the rest of the governance tools. The participants who use a significant amount of resources from the CPR are obliged to sign an *agreement for economic activities and for the participation in the compensation system* [6] with the Foundation⁴. This agreement obligates the participants to take part in the *compensation table* of the scope in which they operate. The compensation tables are regular meetings aimed at establishing the criteria for periodic *compensation settlements*.

⁴In any governance system that is intended to be fair, the governance mechanisms must be driven by organisations without any conflict of interest, and mechanisms for the participation of individuals must be put in place.

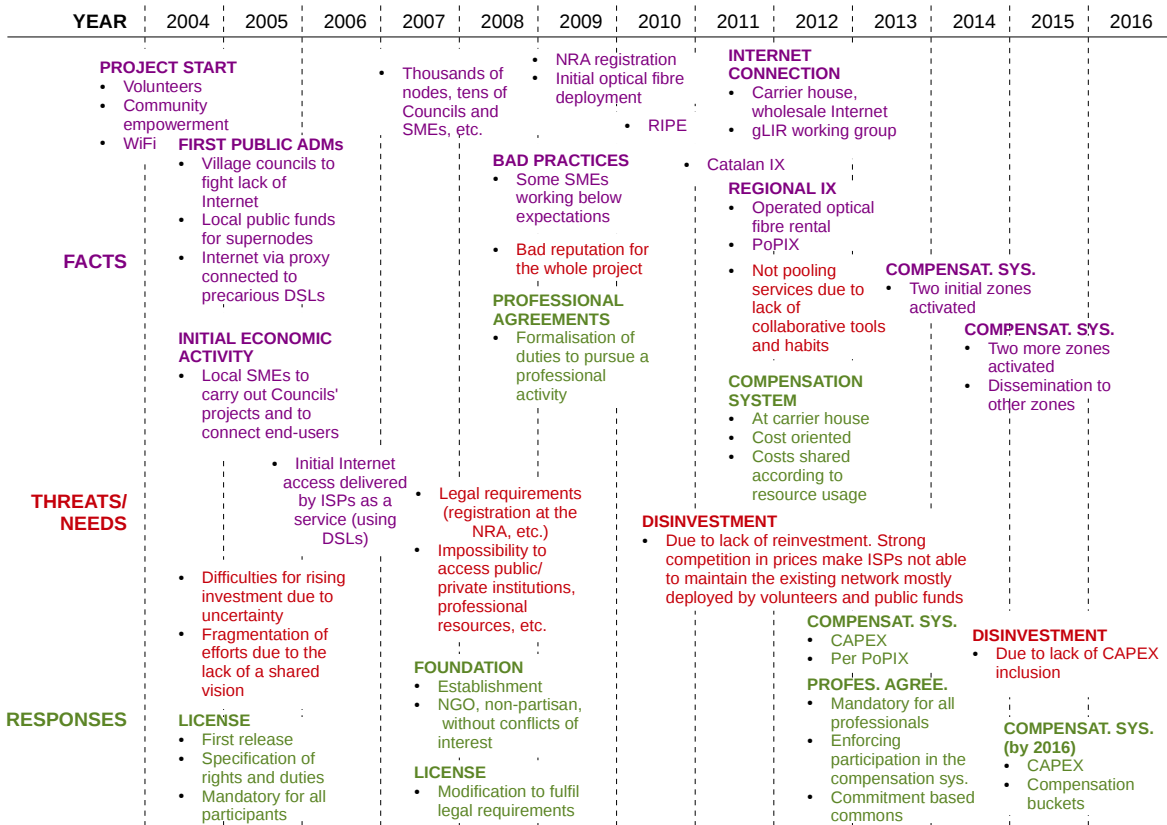


Figure 3: Facts, threats, and responses over time.

2.1 Agreement for economic activities and the participation in the compensation system

The agreement for economic activities and the participation in the compensation system agreement is a legally enforceable contract that establishes the rules for participation of those cases that require regulation beyond licence such as installers, operators, investors, public administrations, etc. It formally defines the foreseen roles, the activities that entail the obligation to sign a compensation agreement, the scope, and the participation guidelines. The essential excerpts of the document are quoted at A.

2.2 Compensation settlements

The compensation settlements are aimed at ensuring i) a fair distribution of the network operation costs based on use of the resources and ii) the generation of the required resources to recover the investments made or to enable future ones. The compensations are implemented by balancing between the contributions or the expenses of each participant and its use of the CPR. The balances are calculated by periodically applying the current compensation criteria. The resulting amounts are settled between the Foundation and each participant either in cash in the case of the installers or by placing them as an accounting entry to a bank account held by the Foundation (the so called compensation buckets) in the case of the operators (i.e., those who have recurring income). In the latter case, if the resulting amount is negative, the participants must make a deposit to settle it; if it is positive, they can use the funds to reinvest according to

their needs or interests.

Table 1 presents a simplified compensation settlement with five participants and the Foundation, which is always present because it plays the management role. The columns present each participant's contribution, its consumption, and its balance, in absolute terms and in percentage. The contributions and the balances are in terms of money. The consumptions are measured according to the criteria established in the corresponding compensation table, in terabytes of a given port of a specific router in this example case. The balance percentage is reached by subtracting the consumption from the contribution and the absolute term is arrived by multiplying the balance percentage by the total contribution. Participants 1, 2, and 3 have both contributions and consumptions, which is the typical case for operators that extend or maintain the network and simultaneously use it to deliver their services. Participant 4 only declares contributions but not consumptions and therefore is either a pure maintainer or an investor. In contrast, Participant 5 just has consumptions, which indicates that, in this compensation table, Participant 5 is the only one using the existing network as a means of transport of its services, thus, it is acting as a pure operator. The contributions declared by the Foundation at least include the management costs of this compensation table.

2.3 Revenue split and accounting

In order to ensure that the operators charge the reinvestment quantities agreed in the corresponding compensation tables to their customers and to increase the overall trans-

	Contribution		Consumption		Balance	
	EUR	%	TB	%	%	EUR
Participant 1	300	30	4.5	45	-15	-150
Participant 2	250	25	1	10	15	150
Participant 3	150	15	1.5	15	0	0
Participant 4	250	25	0	0	25	250
Participant 5	0	0	3	30	-30	-300
Foundation	50	5	0	0	5	50
TOTAL	1000	100	10	100	0	0

Table 1: Demonstrative compensation settlement.

parency, all the operators must issue their bills using a standardised model in which the contributions to the CPR are explicitly stated as i) contribution to the deployment of infrastructure or ii) contribution to its maintenance (currently 17€ and 6€ for optical fibre customers and 4€ and 4€ for WiFi customers, respectively).

In each billing cycle (monthly), the operators must provide the list of the amounts per customer they have collected to the Foundation. The Foundation uses this data to i) calculate the compensation settlements of the next compensation cycle, ii) ensure that the operators are properly reinvesting these funds by cross-comparing these lists with the expenses they have declared through the expenditures declaration system and other sources of information, and iii) issue the donation certificates to the end users, where appropriate (according to Spanish regulation, a contribution to the commons infrastructure is a donation; thus, the donors (i.e. the customers of the operators) may benefit from a tax deduction).

3. RESULTS

In this section, we will present some of the results from the implementation of the compensation tables in four regions: two started in 2014, Osona and Lluçanès, and two in 2015, Bages and Vallès Oriental.

3.1 Quantitative

The accuracy of the monitoring and reporting systems necessary to operate the compensation tables entails vast amounts of data, which, in turn, produce some interesting results. The results presented here are aimed at showing the level of detail that can be obtained. Nevertheless, these results are valuable by themselves because they quantify some parameters essential for the network operation that, thus far, were estimated with very limited data sets at best. All the data are publicly available on the Guifi.net website⁵.

Table 2 links the accumulated number of nodes and the expenditures declared in 2014 and 2015 of the wireless network. Taking into account the small variation between the number of nodes, which means that the capital expenditures (CAPEX) can be neglected, we may conclude that the EUR/node/month rate shown corresponds to the operational costs (OPEX). This analysis shows that, roughly, the OPEX of a rural zone, Lluçanès, is double that of a semi-rural area, Osona.

3.2 Qualitative results

⁵<https://guifi.net/>

Table	Year	Nodes acc.	Expen. EUR	Expen./ /node/ /month
Osona (from 01/14)	2014	8,356	51,569	0.51
	2015	8,978	49,779	0.46
Lluçanès (from 03/14)	2014	1,069	9,079	0.85
	2015	1,111	11,135	0.83
Bages Or. (from 6/14)	2014	423	17,179	5.80
	2015	536	8,849	1.37
Vallès Oriental (from 7/15)	2014	-	-	-
	2015	1,507	8,849	0.97

Table 2: Yearly expenditure per compensation table.

The analysis of the data also produces qualitative results like the effectiveness assessment of a given measure, the identification of bad and good practices, the detection of errors and frauds, etc. For instance, we observe that, in all compensation tables, the first year accounts declared higher expenditures, while they have fewer nodes. This fact is partially attributable to the irrational perception that declaring more expenditures is beneficial for the person. This behaviour has the positive consequence of helping ‘normalisation’ (declaration of secret nodes, update of hardware description, etc.), but when taken to the extreme like in the Bages dispute case in 2014, it may put the ecosystem at risk. Such situations can only be rectified through a combination of education, social skills, and technical expertise to accommodate the compensation system to the local circumstances.

The overall experience of applying the compensation system is entirely satisfactory since it has been key to settling entrenched disputes, reactivating investments, strengthening collaborations, unveiling and eradicating bad practices, etc. Concrete examples include the merger of two companies that were fighting each other to the point of putting the whole project at risk due to the amount of customers they had and the number of preparatory meetings to activate new compensation tables arranged in the last few months. The feedback received has been used to improve and fine-tune the system and is the basis for future work.

4. LESSONS LEARNED

This section discusses what, in our understanding, are the main lessons learned:

Scientific approach Solutions must be designed for a worst-case scenario, not based on expected collaborative attitudes. The Guifi case shows that ISPs tend to confuse accounting and cash flow concepts, such as those generated by the services they provide and those generated by the exploitation of the CPR that have reverted to them. Hence, a strict monitoring and continuous learning environment is required to ensure best practices and to avoid the risk of fraud-like deviation of the cash flow to private profits.

Formality During the early stages of the CPR bootstrapping process, where there is a reduced circle of confidence, trustworthiness and verbal agreements between partners may be sufficient. However, as the network grows larger and when multiple stakeholders with varied interests begin to participate, governance is a must

to keep the networks truly open to all. It is mandatory to implement formal mechanisms that prevent exploitation of the CPR and its essential values. For example, preventing incumbents from being tempted to forget the principles that allowed them to grow in prosperity due to the collaborative environment since some beneficiaries of the network may start using the CPR for their own economic benefit.

Volunteers The compensation mechanisms do provide an effective way to put a value on their contributions; however, volunteers typically feel less legally bound to the project and may disregard or dislike accounting, paperwork, or procedures. Thus, the group must understand that a methodology and some metrics are needed for recognising results and reputation and that there is no way to claim contributions made without accounting for them first.

Minimum prices Customer fees must guarantee not only the reinvestment of cash flow but also the survival of the ISP itself. Hence, they cannot go below a certain threshold that may put the sustainability of any of the two at risk. The agreements on minimum prices made in the compensation tables must not be seen as a violation of the free market rules but as a strategy to ensure the sustainability of the ecosystem, as they help prevent bad practices, such as disinvestment and dumping.

Early adoption of the governance tools The governance tools were already mature enough to be adopted since the very beginning by new bootstrapping communities. The experience shows that late adoption is challenging and time-consuming, as it usually breaks implicit assumptions.

5. CONCLUSIONS

Guifi.net is a good case of an infrastructure commons in the telecoms field that has successfully grown and is still growing while successfully evading the collapse of the tragedy of the commons [8]. Undoubtedly, this is due to the governance model that the foundation has developed to ensure its prosperity and sustainability. The compensation system we presented in this paper has been a key factor to enable and boost the sufficient economic activity in order to assure the required resources to maintain and extend the network. The data sets and the implementation of the compensation system allows systematic computation of crucial parameters that so far have been estimated just based on short data samples in the best cases.

There is still further work to do. The governance and methodologies described in this paper have not yet effectively been applied to all existing zones. Guifi.net started in 2004, and the governance model was gradually developed during the last 5 years and only implemented in the most active and dense areas, where the symptoms of the risk of collapse appeared or conflicts between parties were identified. There are also many other areas in the early stages where governance is yet to be implemented. Ensuring the governance is implemented early on can avoid future tensions and conflicts and boost prosperity and sustainable expansion. In addition, optical fibre installations represent a significant shift from OPEX to investments on CAPEX.

This makes the compensation mechanisms more complex; thus, this requires a continuous revision of criteria, simplification, better definition of targets, and refinement of the strategies to achieve them.

6. ACKNOWLEDGEMENTS

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APPENDIX

A. AGREEMENT FOR ECONOMIC ACTIVITIES AND THE PARTICIPATION IN THE COMPENSATION SYSTEM

The participants can select one, and only one that applies, among the following roles:

Volunteers Individuals or legal entities that participate in the CPR or that deliver services without any service level agreement (best-effort).

Non-profit organisation or collective When, in contrast to the volunteers and despite being non-profit, they offer services in exchange for economic compensation, if legally empowered to perform these services.

Professionals or enterprises For those who are legally qualified to offer services in exchange for economic compensation and who do so.

Investors, contributors, or public administrations

They are contributing to the CPR and are interested in participating or in tracking the compensations, specifically, in deciding how to manage their contributions within the compensation system.

This agreement must be signed by all those participants who wish to:

1. Ensure that the contributions made are taken into account,
2. Track and determine the allocation of investments or contributions made,
3. Advertise and provide services to third parties,
4. Offer services in exchange for economic compensation,
5. Transfer tax benefits that are valid and applicable to those entitled where possible, and
6. Make significant use of the network, such as to be convenient to compensate or to ensure the proper operation of the network or its sustainability.

Participants may partake in the following provisions (scope):

1. Interconnection with other networks and Internet transit, also called wholesale traffic or carriers.
2. Regional transport networks and points of presence and concentration and distribution of regional connectivity, also called 'regional PoPs' [7].
3. Access network for end users, also called the 'last mile'.
 - (a) In wireless networks, including the supernode backbone [7] that provides connectivity, excluding the equipment that is only connected in the 'client' mode or end user that does not provide coverage to other users.
 - (b) In optical fibre, including the multiplexed passive network (xPON) and the end user components (optical line terminal (OLT) and optical network units (ONUs)) and the so-called 'drops' (the terminal connection between the end user and the closest horizontal deployment).

Participation guidelines:

1. It enables the coexistence of non-profit and for-profit, exploiting a CPR cooperatively, so that everyone wins.
2. It provides the public administrations the necessary guarantees to ensure that, when making agreements with the Foundation, any operator can access the infrastructure without discrimination and in free competition in accordance with the current legislation.
3. The compensation table balances among the contributions, on one hand, and the use of the shared resources and the volume of activity of each participant, on the other hand, are according to orderly, fair, transparent, non-discriminatory and proportional criteria. The objective is to periodically settle the result of this balance (with flow in either direction) to achieve the economic sustainability of the network infrastructure.

4. The compensation criteria are established in a collaborative manner by the stakeholders according to the same general principles, so that the criteria:

- (a) Can be revised in each compensation periodically or through the meetings on compensation tables,
- (b) Are tailored to the circumstances at the specific time,
- (c) Are tailored to the local circumstances,
- (d) Harmonise the contribution efforts in proportion to the volume of activity and the consumption of resources.
- (e) Recognise the contributions and investments, being subject to the compensation to be determined,
- (f) Facilitate a collaborative economy ecosystem in the sphere of the commons, in terms of equality and avoiding speculation about the infrastructure commons, defending it against those who may illegally and maliciously intend to harm the commons by abusing a dominant position or by any other illegal or anti-competitive practice,
- (g) Provide an economy of scale among all participants due the effect of cost aggregation generated by the sharing of common resources, which when applied consistently in each compensation, results in the most immediate effect in cost reduction, and
- (h) Facilitate the incorporation of new entrants, reducing entry barriers.

5. The costs to be compensated must be declared in advance to let participants anticipate the applicable contributions. When, instead of a cost reduction, there is an increase, they seek to soften it as much as possible.
6. It provides truthful and updated information on the network, how it is managed, the contact points in case of incidents, and if defined, the committed quality of services resulting from professional activity.
7. It guarantees the users, the participants, the investors, and the volunteers that their contributions and sponsorships are only used for the network infrastructure in commons and that they will never be privatised by an operator.

The compensation tables are scope-based regular (monthly) meetings. They are restricted to those who have signed the specific agreements in order to ensure the confidentiality of the information handled. The main rules for participation are:

1. All the participants can make proposals.
2. In any case, the Foundation must always contribute a proposal for the calculation of the next compensation cycle.
3. The proposals must be discussed and, occasionally, approved by consensus. If the consensus is not possible, they may be submitted to a vote.
4. The Foundation has the veto right in the case of decisions contrary to the FONN Compact or to the objectives of this agreement. In this case, the Foundation must always justify its actions.
5. The investors or the public administrations, in addition to the rights of say and vote rights, can decide on the destination of their contributions and the income that these contributions generate.