Renewable and Sustainable Energy Reviews 45 (2015) 278–289

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Shaping changes through participatory processes: Local development and renewable energy in rural habitats

Silvina Belmonte [a,*], Karina Natalia Escalante [a,b], Judith Franco [a,c]

[a] Instituto de Investigaciones en Energías No Convencionales (INENCO), Consejo de Investigaciones Científicas y Técnicas (CONICET), Universidad Nacional de Salta, Avda, Bolivia 5150, Salta CP 4400, Argentina
[b] Instituto Nacional de Tecnología Industrial (INTI), Centro Salta, Avda, Durañona 822, Salta CP 4400, Argentina
[c] Facultad de Ciencias Exactas, Universidad Nacional de Salta, Avda, Bolivia 5150, Salta CP 4400, Argentina

ARTICLE INFO

Article history:
Received 5 March 2014
Received in revised form
10 December 2014
Accepted 6 January 2015

Keywords:
Technology transfer
Renewable energy
Participation
Stakeholders
Knowledge building

ABSTRACT

The socio-technical adequacy processes of technologies, in general, and particularly, renewable energy, require paradigm changes in the way of thinking and acting in the territory. These processes are key, on post, to achieve greater equality, democratic management, quality of life and environmental sustainability, particularly in the rural areas of Northwest Argentina. The article is based on the premise that these changes are socially constructed.

A set of workshops were conducted on purpose to discuss and reach a consensus on conceptual, methodological and practical aspects, associated with the processes of 'technology transfer' and rural development. Participation in the workshops focused on technical stakeholders (researchers, technicians and extension workers), identified as links between new technology and the users thereof. From these shared spaces, the conceptual model of socio-technical adequacy was validated and multiple determinants for the processes were identified and prioritized. Finally, consensual action oriented proposals in the following levels: personal-institutional, inter-institutional and public policy.

This article concludes that the areas of interaction and collective construction are necessary and feasible for implementation. These areas represent real opportunities to increase equity and improve interventions in rural habitats.

Contents

* Corresponding author. Tel.: +54 387 154445690, +54 387 4255424.
E-mail addresses: silvina_belmonte@yahoo.com.ar (S. Belmonte), escalantekarina@gmail.com (K.N. Escalante), francojudita@yahoo.com.ar (J. Franco).

http://dx.doi.org/10.1016/j.rser.2015.01.038
1364-0321/

1. Introduction

The search for comprehensive solutions to social and environmental problems requires a shift in the way of thinking, and focusing on the interventions on different groups of stakeholders involved in local development processes. The management in the territory change [1,2] requires the development of interest, the strengthening of strategic alliances, the formation of local capacities, the legitimization of the decisions made, the flexibility and the continuity of the processes [3,4]. In this way, the construction of new models for a territorial approach demands specific times and space for reflection, discussion and consensus building [5,6].

The socio-technical adequacy processes of technologies in general, and renewable energy, in particular [7–9], do not escape from this need. This results key if the evaluation of the projects and actions are part of systemic judgment criteria, such as relevance, efficiency, effectiveness, appropriation, sustainability and long-term impact [10,11]. Lineal and scientific focus (in the traditional and 'behavioral' sense of the word [12] can result insufficient to address the complexity of the sceneries and processes that characterize the socio-technical interactions. The acceptance of the term 'socio-technical adequacy' in detriment to the traditional concept of 'technology transfer', implies the inclusion of different stakeholders and perspectives (users, technicians, investigators, government officials, non-government organizations, etc.) in the processes of production and social construction of the utility and performance of the technologies [8].

Particularly, in the rural areas of Northeast Argentina, these processes are critical in post of *'achieving a more integrated, balanced, better equipped and sustainable territory…'* where each inhabitant and their community has achieved: a territorial and cultural identity, economic progress, environmental sustainability, democratic management and quality of life [13,14].

In these processes of change, renewable energies are identified to have a high potential for the improvement of living conditions, environmental quality and the socio-productive developments in the rural areas [15,4]. Through the use of renewable energies resources it is possible to encourage the emergence of local innovation dynamics, generate new local development opportunities, promote new productive activities and articulate new forms organization of production [16]. As well as this, renewable energy is identified as an opportunity to generate environmental benefits [17,18], to solve economic inequalities faced by rural areas [19–21] and a key component in energy planning processes at different scales [22,23].

However, technological interventions are not always 'successful' and comply with the scope and expected results [7,9]. Various limitations and technological, technological, economical, financial, institutional, social, cultural, and political barriers hinder the effective dissemination and implementation of renewable energy [24–29].

Improving the renewable energy socio-technical adequacy constitutes a significant challenge to create change at local and regional levels, transferable (in an experience and learning sense) to other technologies of interest, for social inclusion and improvement of rural habitats. On the other hand, renewable energy socio-technical adequacy processes are not isolated from the context and require to be analyzed in a systemic manner in order to overcome representations and point solutions in the territory [30–32].

In this line of systemic thinking, Ostrom [33] claims that the political environment and the management of natural resources – including the renewable energies – are crucially conditioned by the perspective of the stakeholders linked to the system, in terms of problems identification and decision-making.

Among the key stakeholders inherent to these processes at the local level, two groups can be highlighted: a) the so-called 'beneficiaries or recipients' of technologies, and b) professionals and technicians that, from various academic-scientific institutions, development agencies, government agencies and non-government organizations, act as intermediaries or connectors between possible technological solutions and their end users. However, the system is much more complex. Other stakeholders and multiple relationships are established among the artifacts, processes and organizations that define each technology [8]. However, the possibility of direct interaction with groups of researchers and extension agents who work in the development and application of technologies in the territory is taken as a starting point for this research. In this line, the article is oriented primarily to present the advances in the construction of knowledge and actions performed from dialogue processes with the second group of actors.

Also, the article is based on the premise that change is constructed. And, it is socially constructed [34]. In this sense, reflections and agreements generated from a set of social interaction places, which addressed both conceptual issues and practices to improve the social-technical adequacy of renewable energies and social technologies, in general, are presented.

Methodologically, the article fits into the so-called qualitative and socio-critical approaches, in which the understanding and deepening of relations and significant situations are prioritized, before the prediction and generalization of concepts [35–37]. The socio-critical paradigm also implies a constant interaction between research and action [38]. This suggests that research is built on participatory action, but at the same time, that research action generates a change [12], it modifies the initial reality. Therefore, the act of researching is not neutral. Changes are not considered externally from research, but on the contrary expected results, are intentional. This is based on the belief that participation, in itself, reflection processes, criticism, self-criticism, agreements, proposals and commitments cause a real change in people and, through these, in the institutions, the actions carried out and the environments where they occur. However, these changes are more linked to internal processes than certainties, observable conditions or directly measurable and short term. Hence, the connotation of continuity and permanence on the word 'shaping' in the article's title, on relation to something that is happening but, it has not still finished nor closed.

2. Research framework

2.1. The need to redefine the 'technology transfer' concept

'All technologies play a central role in the processes of social change. They limit positions and behaviors of the stakeholders; condition social distribution structures, production costs, access to goods and services; generate social and environmental problems; facilitate or hinder its resolution. Technologies are not merely

instruments… They exercise power in social, economic and political networks' [39].

Assuming these postulates necessarily implies rethinking the processes in which technologies are produced and spread in which they provide solutions in the social fabric. Traditional concepts linked to the so-called 'technology transfer' [40,7] are associated with linear and unidirectional processes, which do not allow comprehension of the complexity of interactions and results, that underlie the building of knowledge and technological capabilities. The very concept of 'technology' extends its impact beyond the vision of 'objects to satisfy human needs' and incorporates, in its definition, the techniques, knowledge and social processes that caused them [41].

The new meanings of science and technology surpass the deterministic vision of yesteryear when technologies only answered to demands, or demands were generated by the existence of new technological offers. Reality takes to accept that technologies are socially constructed by dynamic and complex processes. Technologies are social constructs. And, at the same time – reciprocal, systematically – societies are technologically built. Only a socio-technical analysis reveals effective explanatory competence to understand this complexity [39].

In this line of thinking, processes of technological adequacy are based on joint, stable socio-technical partnerships, which result from the integrations of heterogeneous elements such as artifacts, ideologies, regulations, knowledge, institutions, stakeholders, financial resources, environmental and material conditions [9,16,39]. New trends require, therefore, overcoming the limitations of scientific-technological linearity to advance on the perception of integration dynamics in social technological systems and re-signification processes and technologies transduction [8,39].

2.2. Social technological systems and renewable energy in rural habitats

Rural habitats in Northwest Argentina are sensitive and vulnerable from both socio-cultural and environmental perspectives. In particular, mountainous sectors are characterized by unsatisfied basic needs, an economic system of survival, isolation (by access difficulties but also by ideological barriers) and recurring problems of land tenancy [42]. From the environmental perspective, the intense production activities of powerful groups (equivalent to the historical 'estates'), in addition to increase marginalization of small producers and ancestral inhabitants, generate negative impacts on the natural resources that are exploited without sustainability and equity criteria. These conditions deepen the strong territorial inequality and a growing tendency for the rural population to migrate to urban marginal settlements, with consequent cultural rootlessness and loss of identity, among other problems [5]. This vulnerable situation is similar to other rural areas in various countries of the world [43,19,20]. In this context, diffusion and use of renewable energy represents a strategic opportunity in relation to rural needs: infrastructure and services, productive development, local organization and conservation of the natural-cultural heritage.

An approach to these questions in socio-technical and territorial terms raises the need to generate resolution abilities for systemic problems, rather than solve the specific deficit [39,44]. From this perspective, social technologies (products, techniques and/or methodologies), represent effective solutions for social transformation [45,12]. The approach of social technological system requires consequently, focusing on the dynamics of social and economic inclusion, democratization and sustainable development [8,39]. This change of strategic vision (from specific to systemic) involves creating new ways to regard relations problems/solutions and designing significant socio-technical dynamics.

Particularly, in relation to the use of renewable energy, the complexity of technological systems requires analysis from a holistic perspective [30–32,43]. Renewable energy is inserted into different socio-economic systems other than conventional systems, not only in terms of energy source characteristics and their technical aspects, but also in regard to its spatial density, structural and organizational elements, regulatory practices and management [46,7].

Some management tools were identified as priorities on the local level, aimed to promote rural land planning (with the perspective of equity and inclusion), the development of more systematic technology solutions and the linking of the renewable energy to the territory [5,6,4,7]:

- *Institutional strengthening:* concerning the coordination and linkage between institutions and sectors for concertation of goals and interests, the development of actions and the evaluation of processes and results.
- *Participative processes:* to enable greater interaction in the construction processes of change, the generation of partnerships and the social legitimization in decision-making, always within the framework of comprehensive and inclusive policies.
- *Initiative and local development*: in relation to the momentum of local organizations and the creation of networks for socio-environmental conflict resolution, diversification and productive innovation and the promotion of equity conditions in access to and use of natural resources.
- *Integral socio-technical dynamics:* This implies on-going and systemic mechanisms for information organization, participatory planning, socio-technical adequacy of technology, and the promotion of new spaces and strategies for action.

Understanding the socio-technical dynamics finally implies, delving into the set of interaction, institutions, policies, rationales and ideological formation of stakeholders [39]. Interests, negotiations, controversies, the strategies associated with human elements, as well as the aspects relating to non-human elements and their corresponding resistance and relative strength, would be the starting point to understand the dynamics of a society in which the sociological and technical considerations are inextricably linked [47].

2.3. Social capital and the management of change

The points raised above require what several authors agree on recognizing as the 'viability construction' [3,48,49,50,51]. This concept refers to the possibility the social capital needed for the design and implementation of new policies and action, is locally generated. Social capital can be defined as the set of values, attitudes and institutions that generate social cohesion, solidarity and cooperation between people, through actions and collective resources [49], including relations based on trust and credibility [3], reciprocity and the sense of belonging [52,49,5].

For the rural territorial development, Schetjman and Ramirez [3] proposed a model of 'institutional architecture' that incorporates legitimate, power and cooperation relations, for a participatory management. The governance concept complements this position, and suggests that *'the process of change (of values, paradigms and ways of doing) needs to be governed from a high capacity for learning and adequacy to the changing environment, in contact with reality and strategic vision'* [49]. The notion of governance refers to the strategic coordination between political and social stakeholders overcoming the hierarchical model of decision making [53].This set of *'collective action capabilities'*, is visualized as the basis for proposal of territorial management tools more flexible, efficient, sustainable and innovative [54,49,6]. These new models accentuate the interdependence

between socio and ecological systems and emphasize the importance of social capital for the governance on multiple levels [55–57].

The belief that 'viability construction' – and therefore change – is not only necessary but also feasible, leads us to 're-think' institutional models and management [5,6,4,3]. But how do we promote and support this change?

Two aspects are important for the construction of change in direct relation to this article:

First of all, a change is needed in the way of thinking and acting to improve interventions in the rural habitats, i.e., a radical openness to new concepts and methodologies. Top-down, linear, sectored, and scarcely participative structures, may not welcome changes and will be inevitably destined to disappear in the short term [5]. This situation (the need for a paradigm shift) is key, both for the implementation of energy planning and territorial ordering processes [6,4,23], as well as the development of socio-technical dynamics in various fields and scales [39,9,16].

This change in the way of thinking and acting will require, in turn, a trigger motor for the process and a local level. Schetjam and Ramirez [3] maintain that the initiative to trigger a development process in a given area may have different origins, and that there is not only one way by which the process of advancement and consolidation passes. These authors mention as a starting point and process determinants: individual leadership, innovative entrepreneurs, cooperatives, local governments, mobilizations and collective actions. The local reality counts on: institutional changes, group leadership, external incentives, scientific-technical transfers, among others [6]. However the diversity of elements that can become movers of change, this article takes as its own responsibility the creation of social interaction spaces to progress in the reflection and construction of viability. This is based on the premise that the same local stakeholders (in this case, researchers, technicians and extension workers), with the practice of their territorial interventions, can build new paradigms and promote change. What mobilizes one is the desire to improve living conditions in rural habitats; but, in this case, HOW is this geared to promote changes in ways of seeing and doing things. To link the formal and not-formal, academic and local knowledge, research and practice, new and pre-existing technologies, individual, institutional and collective work, is always rooted in a real and concrete context.

Second, the effort focuses on the construction of the social capital needed to multiply and consolidate the actions of change. This suggests generation of communication capabilities, trust, reciprocity, feeling, belonging, complementarity, collective and cooperative sense, leadership and coordination, ability to act, continuity and sustainability through time.

The proposed theme of consultation for social interaction was, in this case, the 'technology transfer', and within this large theme, applications of renewable energy. This decision explains the need to narrow the analytic world for the participative construction of new concepts and methods. The formation of organizations, and reflective and creative spaces with common goals [12], could significantly boost local capacities. On the other hand, the implementation of a participatory management model necessarily suggests the creation of transition scenarios, where the new forms of acting would be practiced. However, as any activity founded in human relations, this could represent an arduous and complex effort combining visions, interests and characters [6].

Both points suggest an active participation in the construction of agreements that transcend personal and/or institutional interests, and which would create shared power areas. This would help to take more fully the complexity and mainstreaming of environmental and social issues that go beyond the issue of renewable energy, positively influencing existing territorial scenarios.

In addition, systemic analysis and the creation of networks (research and practice) are displayed as an opportunity to address new social challenges. We need more and better data in many disciplines. It is not enough to look at the patterns, we need to study how they relate, evolve and change. The magnitude of challenges that face us shows how much still needs to learn. *'We are caught in an inescapable network of mutuality…. Whatever affects one directly, affects all indirectly' (Martin Luther King)* [58].

3. Tools and methodology strategies

3.1. Methodological support: participatory action-research

The epistemological and methodological focus on action-research proposes to first analyze and later reverse the dehumanization process of science. From this perspective, its object is man in society, understood as an historical agent of reflection, assessment and action [12]. Action-research proposes two challenges in actual practice: firstly, the incorporation of social subjects studied in the process of dynamic knowledge generation and, secondly, 'understanding' of agreements, meanings and the social rules of direct action-oriented transformation [59,38,12,37].

This approach cannot be understood as opposed to the rational, less even as irrational or intuitive. Action-research does not reject empirical research or data collection techniques [12]. However, its focus is on trying to get unique facts, experiences and situations from a critical approach to reality [38]. Also, it favors the construction of social situations successfully attempting to collect information, trying to make communication and dialogue processes more flexible. Overcoming the traditional experimental model requires the search for new modes of interaction, the development of less rigid methodological tools, such as game and role-playing [12], among other potential participatory popular education techniques [59,51], and qualitative tools applied in social analysis systems [53]. The use of these and other participatory strategies requires creative processes for its selection and adaptation and necessarily includes feedback processes to analyze not only the structure or reality in its status quo, but also the contradictory aspects and, therefore, its dynamic. This new model suggests: penetrate reality through a dialectical process of action and reflection, mutual acceptance and extending this understanding to a common process of cooperation, solidarity and transformation of living conditions through their own actions [12]. Finally, the research-action process involves double learning. On one hand, for the participants (subjects/stakeholders) to the extent that it represents an awareness through action and, on the other hand, for the researchers, whose function appears as the initiator of a process which guides and learns [12].

The implementation of this conceptual model is based on the generation of participative spaces and original and efficient methodologies, for co-construction of new knowledge and transformation of the local scope [5,6]. The challenge of collective thinking and creating involves the development of a systematic and integrated set of tools, techniques and dynamics that favor the following conditions: communication, understanding, critical and prospective thinking, collective development of innovations and building consensus on the cross-sectorial management processes.

Participatory processes allow obtaining relevant and suitable information (to be analyzed for decision making) at the same time generating individual and group capacities for territorial, articulated and democratic work. Thus, opportunities for analysis, reflection and proposals are generated, not as exceptional but as a systematic way of doing [51].

Finally, the participatory tools are recognized themselves as 'innovation technologies' [51], that lead to scenarios and opportunities for dialogue on rural territorial development [57,53,13,5], habitat construction [51], planning and strategic management

[23,59], and the socio-technical adequacy of social technologies [12,39], in particular, renewable energy [7,9,16]. Specifically, participatory focus is strategically valued at an international level in various papers on renewable energy [26,32,21,4,19,22,46,43,25] that incorporate, or propose to incorporate, the perspectives of stakeholders in the processes of planning, management and/or system evaluation. On the other hand, various strategic planning processes, at a national level (Argentina) [60], and provincial (Salta) [61] are promoting the exercise of participation involving, particularly, the scientific-technical and government sectors, as 'representatives' of the set of stakeholders. This represents a status conducive to the participatory process for this research [62], in relation to the good 'availability' of the stakeholders and the generation of a 'social capital' in terms of diagnostics and priorities agreed upon in the field of energy, environmental and sustainable development of habitats.

3.2. The logic behind the participative process

The presented article is part of a university research Project (2010–2013) *'Tools for the improvement of technological appropriated processes. Interaction or transfer?'* [62]. The research is centered on the need to analyze and reflect on the 'processes' of technologies adequacy, in general, and particularly on renewable energy, its aim being to deepen the understanding of them and provide specific criteria to improve them, in practice. The project is in its final phase of execution and includes various activities during its development, including:

- *Study and definition of the conceptual framework:* From bibliographical contribution, courses and training, and interaction with other groups working on the same issue, we got to position ourselves in the conceptual approach of socio-technical adequacy of technologies as opposed to other more traditional concepts such as technology transfer, technology adoption, or appropriation of technology.
- *Analysis of 'transfer' processes in real situations:* A survey of ten cases related to technology 'transfer' processes were studied, mainly on renewable energy (solar water heaters, cookers and dryers), and also on organizational processes, of GESTION, of information, tourism, water resources and agricultural technology. A background check, mapping of stakeholders and visits to the field was conducted for each surveyed experience. Direct observation methods and open and semi-structured interviews to stakeholders and key referents were applied in each survey.
- *Links with other research groups in the country:* Contact was made with other research institutes which are working both in the conceptual development and survey of case studies of technology transfer. These include: RED-TISA (Network of technologies for Social Inclusion of Argentina); Research Institute on Science, Technology and Society (University of Quilmes); Institute for Research and Policy of Built Environment (La Plata National University); Human Environment and Housing Lab (National Council on Scientific and Technical Research – Mendoza).
- *Advancement of participatory areas for reflection and discussion on the process of technology transfer:* Several participatory workshops were conducted by technicians and professionals involved in research, development and / or extension technologies in rural habitats.

In the search for 'constructive' spaces for learning and action, was selected the methodological tool of face-to-face workshops, which represents real and dynamic areas for exchange [63,5]. Discussion and debate of ideas, criteria and points of view is enriched by the interaction of a group of heterogeneous individuals who perceive the problems differently [64]. *'The workshop is a participatory methodology which facilitates the ability to questions and wonder, to open channels of internal and external dialogue, and of reciprocity subjects…In its dynamic are manifest beliefs, knowledge, values and attained skills that, in reciprocal exchange of subjectivities, can reach a collective re-significance'* [34].

The participatory process was implemented in a flexible and dynamic way through, what is often called, an emergent design. The logic of an emergent design suggests its continuous restructuring from the successive findings, carried out during the course of research [37]. The planning of the workshops was based on the identification of sets of strategic stakeholders linked to the technology transfer in Northwest Argentina, and with renewable energy throughout the country. Flexibility in the process design was principally identified with the selection and adequacy of content, instructions and proposals for the development of participatory instances. This selection was done on the basis of spatial-temporal conditions, groups of participants, results of previous workshops, and goals identified as priorities in the research process.

Two groups stood out in relation to the selected areas of reflection and action:

- Internal areas: within the institutions themselves.
- Inter-institutional areas: thematic (renewable energy) and general (linked to technology transfer).

The logic for the participatory process is iterative and interactive. It is a multi-sector and multidisciplinary integration of technical actors operating in rural areas. The other activities were carried out during the overall research project [62] provided input for the development of the workshops.

3.3. Workshops carried out with researches, technicians and extension workers

Six participatory workshops were held, three for each one of the previously mentioned areas, institutional and inter-institutional. Table 1 shows one detail of the presented participatory applications. The institutional workshops were held in the local-provincial area (Salta), one in the National University of Salta-in an institute that specifically works on renewable energy (INENCO), the National Institute of Industrial Technology (INTI) and the Undersecretary for Family Agriculture (SSAF). In the case of renewable energy at a national level, annual meetings were held, where scientific and technological advances on this topic were presented and specifically discussed (Argentina Association for Renewable Energy and the Environment – ASADES 2012 and 2013). The NOA workshop was inter-institutional and sought integration, at a local level, of public agencies working in the transfer of technology in rural habitats of Northwest Argentina.

The focus of the participants was based on researchers, teachers, technicians and extension workers who work linked to the development and transfer of technologies. Within a general mapping of stakeholders, this focal group is identified as one of the links between new technologies and its users. Their role is essential for local development processes, in particular in rural habitats, sensitive to technological changes. Several partnerships are established between individuals and institutional stakeholders in the processes of socio-technical adequacy. The Fig. 1 shows a generalized scheme of these interactions, and intended to highlight the role of this group of intermediaries' actors. However, these there are different scales and levels of intervention and each technological process is unique.

In total, 121 people participated in the workshops. The quantity of participants per workshop is detailed in Table 1. The participants' profile is summarized in Fig. 2. There was a wide diversity in

Table 1
Executed participatory workshops.

Participatory proceedings	Workshops	Areas of discussion	Participating group (number of participants)	Date
Institutional meetings (local-provincial scale)	*"Technology transfer – experiences and learning"*	Non-conventional energy Research Institute (**INENCO**) Salta National University - CONICET	Researchers, teachers, scholarship holders (17)	10/12/12
		National Institute of Industrial Technology Center **INTI** Salta	Professional technicians and extension workers (7)	05/31/13
		Undersecretary for Family Agriculture **SSAF** - Salta Headquarters	Professional technicians and extension workers (8)	08/20/13
Inter-institutional meetings (regional and national levels)	*"From the technology transfer to a socio-technical adequacy of renewable energy"*	ASADES 2012, Rosario - Santa Fe	Professionals and students from different areas working in renewable energy (20)	10/24-25/12
	"From specific interventions to public policies for renewable energy"	ASADES 2013, San Miguel de Tucumán	Professionals and students from different areas working in renewable energy (26)	10/23-24/13
	"Technology transfer: stakeholders, questions and proposals"	Institutions linked to technology development and transfer (Salta and NOA)	Representatives from different academic, technical, governmental, and not governmental institutions (43)	08/29/13

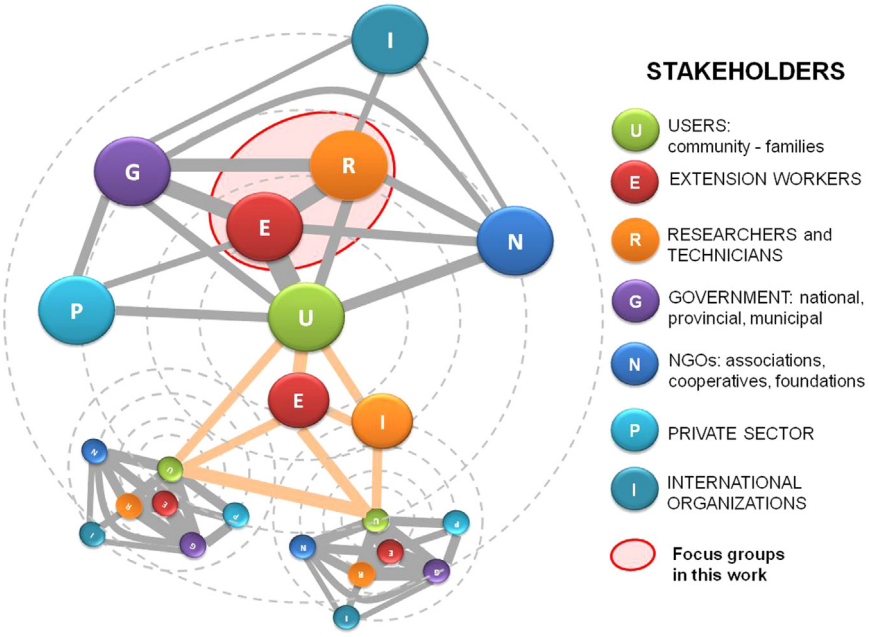

Fig. 1. Diagram of relations between stakeholders in a process of socio-technical adequacy.

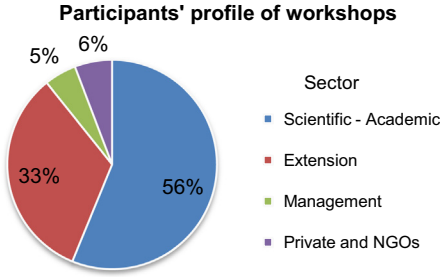

Fig. 2. Sectors represented by the workshop participants.

terms of scientific disciplines, including: exact, natural and social sciences.

According to the workshops' method, various participatory dynamics were applies to the group and collective work. The content and main used techniques are in Table 2. The use of posters, postcards and other solid methods was of great use to encourage group work, implementation and interaction, in general, between the participants.

3.4. Linkage with renewable energy projects

One of the starting points for discussion and reflection in the workshops was the experience of participating in processes of socio-technical adequacy of technologies in general and renewable energy in particular.

In this regard, renewable energy projects that underlay the workshops had the following characteristics:

- The projects are executed from various governmental and non-governmental organizations (not private sector), related to scientific and technological development, extension work and / or technology transfer.

Table 2
Participatory techniques applied in the workshops.

Participatory process	Content, applied techniques and dynamics		
	Conceptual framework	**Critical factors**	**Proposals for action**
Institutional workshops (INENCO-INTI-SSAF)	Motivation from anecdote Round of presentations	List of factors that favor and limit the technology transfer processes	Proposition of recommendation to improve the process. Preparation of diagrams and graphics
Workshop ASADES 1	Path: from 'transfer' to 'socio-technical adequacy' of renewable energy. Case studies. Features that differentiate the processes		Group and collective definition and prioritization of actions and strategies
Workshop ASADES 2	Map of interventions in renewable energy (Argentina). From the exact to the integral Analysis FODA (strengths, opportunities, weaknesses and threats)		Full discussion and listing of proposals
Inter-institutional workshop NOA	Key stakeholders. Dynamic of roles Scene analysis	Collective analysis and review of determinants in the processes of socio-technical adequacy. Individual voting in plenary	'Motor' of change Debate and agreements in plenary

- The majority are small-scale projects: defined local geographical extent, limited number of recipients, focalized scope and impact.
- The technologies related to these projects are considered 'social inclusion', as they are intended to improve the living conditions of local communities. In particular, two objectives are associated: 1-access to basic services for isolated or vulnerable populations, 2 - development local productive of families, small farmers and cooperatives. The use of renewable energies in these projects is itself framed by a focus on environmental sustainability.
- In general, the funding sources of these projects are external (national and international) but with a component of self-management and strong local counterpart.

The projects under review included a wide range of renewable energy technologies. Given the climatic conditions of the Argentine Northwest, the largest number of applications were for solar energy, but also had experiences on biomass, wind and micro-hydro. With regard to solar energy technologies, projects for water heaters, stoves and ovens, water distillers, photovoltaic panels, bioclimatic buildings, greenhouses and drying production were highlighted.

4. Knowledge building in participative and creative spaces

4.1. Building conceptual agreements

Spaces were opened in the different workshops, some were expected and other spontaneous, to discuss the concepts related to the 'transfer' processes. A common concern was the need to find new words to refer to what here is called, precisely, 'technology transfer', indicating the narrow outlook this terminology can have in everyday practice.

The importance of a 'name', what things are called and how they are defined, was repeatedly brought out in the workshops. This obviously relates to the need to promote and incorporate new conceptual-methodological approaches. The need for a paradigm shift was stressed. Strongly rooted terms impact still on our actions: 'transfer', 'transmitter-receivers', 'beneficiaries', 'acceptance', 'real scientific knowledge', 'technology = object', among others, for which we need to find new ways to refer to these processes.

In this regard, it was agreed that the concept of 'technology transfer' has involved from extension to transfer, and now, a new term 'socio-technical adequacy of technologies'. There was a strong interest among all the participants to deepen this new conceptual approach. In that respect, documents and specific literature was requested with the idea to disseminate them within the institutions themselves, and a proposal to continue these types of meetings to continue considering the subject was suggested.

In this paradigm shift, linear approaches (appropriation, adoption, innovation, etc.), in this case called 'technology transfer' and the interactive approaches aligned with 'socio-technical adequacy' were characterized and compared. Table 3 summarizes the contributions constructed in the workshop.

In general terms, it is recognized that the standard technology transfer is presented as a linear and unidirectional process in which valid knowledge is 'scientific', generated in the universities or institutions for Science and Technology. Also discussed these processes, beneficiaries participation is very limited, with almost no intervention in design and concept of the technologies to be transferred. Thus, the resolution of technological problems is a task performed exclusively by scientists or technicians.

When thinking of an alternative to the conventional transfer model, participants brought up the need to develop a process based on co-construction between users and technicians, for the problems and possible technological solutions. This alternative proposal is an interactive and multi-actor model, based on the incorporation of various knowledge, practices and customs. In addition, the need for these processes to include instances of feedback arose.

Other conceptual issues related to the new model were also showed consensus in the workshops. Regarding the technological concept, for example, technology *as part of our culture* was denoted as important. The application of the new approach, in all scales, involved *prioritizing the common good above personal interests.*

In this sense, the improvement of quality of life, but always respecting local idiosyncrasy, was seen as an expected impact from the socio-technical adequacy concept. However, a chasm between 'technologies' and the 'goal' of improving living conditions was recognized. This leads participants to reflect on one of the key issues identified in the technological processes: the real satisfaction of a need. For some, the concept of satisfying a demand and its real use is implied, and it is inherent in the term 'technology'; for others, however, the relationship is not so direct, since there are numerous examples of productive and social technologies being abandoned or with little use in various fields, scales and contexts.

Consequently, 'learning from our mistakes' arises evidently. Many technological interventions did not happen, as is shown in the so-called 'archeology of development', where numerous geological layers of abandoned technologies accumulate in rural Northwest Argentina (personal contribution Baudino, 2013).

The difference between 'intervention' and 'interaction' was another question brought up in the workshops. Assuming the

Table 3
Conceptual differences agreed with participant's workshop.

	Technology transfer	Socio-technical adequacy
Intervention approach	Linear, mono-variable	Systemic, allowing addressing of the complexity of problems and solutions
Involved actors	Researchers, technicians, extension workers Beneficiaries	Multiple actors Researchers, technicians, extension workers
Relation among actors	Unidirectional, linear (transmitter-receiver). Hierarchy	Users, among others Horizontal
Method of participation	Beneficiaries-receivers are objects, not participating subjects	Active, criticism leading to adjustments and new proposals
Problem	Supposed in study without consulting the affected actors or with minimal interventions	Comes from the users
Solution	Technical, only, from a universal technology stock	Various, suitable in function of each problem and context Designed and co-built
Knowledge	Asymmetrical The scientist has it Popular prior knowledge is not taken into account	Symmetrical - Interchange Previous and popular knowledge is valued as much as scientific
Stages	Survey of the need, design and execution Follow-up, in general, does not exist	Multiple and self-feedback (diagnosis, solutions, testing, tracking, etc.)
Expected results	Suitable technology accepted and used by the beneficiary	User empowerment. Appropriate technology
Impact	Massive, superficial, immediate short term	Custom or personalized in each case, long-term stay, with multiple effect

second option, of interaction, implies reviewing the socio-cultural patterns that often guide our exchanges and relationships with agents that do not belong in the fields of science, education, academic, bureaucratic, or development, which is – so to speak – the usual areas where these initiatives emerge.

We always tend to think that the social-cultural is a residual aspect located in others, but it is also within us and sometimes has a decisive weight in enabling or hampering our relationships. To assume an interaction implies identifying and recognizing our own social-cultural frameworks, insofar as these have an implicit way of understanding the world (personal contribution Ibarra, 2013).

Finally, a general agreement came to light about the way of thinking about these processes, and that some changes in the forms of intervention-interaction already are being implemented was agreed on, (e.g.: Included is greater local participation in diagnostics and projects). The critical point is still the 'path' to significantly improve the process and results. What we do know: 'what shouldn't be done'. Now: how do we create new practices, proposals and solutions? The highest challenge in the link between theory and practice is 'HOW'.

4.2. Identification of determining factors in social-technical adequacy processes

In the institutional areas of reflection (internal areas) and in the inter-institutional workshops, different dynamics for the identification of factors that condition (favor and limit) the socio-technical adequacy processes were worked on. The participants agreed in their identification of various determining factors. These identified factors are applicable to the case of renewable energy as well as other social technologies for rural habitats.

For presentation in this article, the factors were organized in five themes: 1) Mutual respect and communication, 2) Adequacy process and Technology functioning, 3) Linking stakeholders, 4) Efficiency and sustainability, and 5) Education. These were expressed in a positive way, highlighting their potential effect on the improvement of processes. Table 4 describes the determining factors based on workshop's specific contributions.

4.3. Prioritization of critical factors

These are the elements which emerged from dialogues and consensus within the workshops, correlating with factors previously identified by the research group through the survey of experiences and projects [62,7,65]. Finally, the prioritization of these factors moved forward in the inter-institutional workshop held by NOA, for the purpose of identifying those most critical issues in the socio-technical adequacy processes.

Critical factors were prioritized in the following order at this workshop:

- *Highest priority*: satisfaction of a real need.
- *Very high priority*: participatory diagnostic and planning; cooperation and complementarily among institutions; relationships of power, legitimacy and interests; continuous accompaniment of the processes.
- *High priority*: cultural conditions; good communication; attitude of openness and dialogue; adequate information and training; recognition of local contributions; respect for the dynamics of social processes.

As can be seen, the first critical factor is related to the social function of technology. The project is doomed to failure if the technology does not solve a problem felt by recipients (community, family, producers, etc.). This was the point of greatest consensus.

Second, a set of factors related to the process of socio-technical adequacy in itself, i.e., in the way of 'doing', and the linkage between stakeholders were identified.

The third group is made up of factors related mainly to the interaction, mutual respect and communication.

Identification and prioritization of critical factors allow pose starting points to be considered, to go forward with the definition of proposals and strategies which improve processes of socio-technical adequacy. On the other hand, the principle of complementarily and dependence among the diverse factors is assumed [7,65]. This means recognizing the critical factors as 'bottlenecks'. Therefore, the efforts to overcome them will indirectly impact on the whole process.

4.4. Generation of commitments and proposals for action

After several workshop exercises for generation of proposals and actions, we learned that the construction of change (the HOW) requires focus on, at least, three levels of acting:

Table 4
Synthesis and description of determining factor in social-technical adequacy processes.

Determining factor	It implies…
Mutual respect and communication	
Respect for local knowledge	Existing valuable knowledge prior to intervention, both in recognition of the problem and in the search for solutions. Listen to the technology beneficiaries. Change beliefs that only the technician-researcher has the knowledge
Consideration of cultural aspects	Take into account the worldview, lifestyle and customs of another, and which implies a new technological input. Put ourselves in the others' place. See their reality. Finding points of meeting and cultural proximity
Appropriate language and dialogue	Ensure good, fluid, complete and appropriate communication among the stakeholders. Improve the lines of communication, favor interchange and know how to listen
Adaptation to social processes	Respect the times and processes of each community. The project or technological intervention must take into account the existing activities in order not to interfere with, or be hindered by them
Technology adaptation and functioning	
Previous diagnosis and real need	Technology should meet a genuine and perceived need. Know what people need and want and not creating the projects only from technician preconceptions. Invest time and resources in the formulation of the problem
Integral approach	Projects should have an integral approach to the problems. When addressing specific issues, isolated, the partial solution of the problem could lead to the emergence of other demands and needs
Appropriate and tested technology	Adequate technology and resources at the conditions and infrastructure of the place. The technical quality is proved in the operation of technology, prior knowledge of users and successful use by other groups
Accessible use and maintenance	Technology should be simple about its installation, use and maintenance
Continuous accompaniment	Technical support should be permanent during the project execution and, at the same time, generate skills and autonomy for maintenance once it has ended
Monitoring and evaluation	Ensure follow-up the process and evaluate the results and impacts. Have funding to perform these actions in the territory
Linking stakeholders	
Participation of the users	Include end-users in all steps of the process but, in particular, in the diagnosis and the search for alternatives. A good access to information and promotion of consultation spaces for decision-making should be sought
Institutional networks	Encourage inter-institutional linkage and synergistic working. Coordinate and reconcile actions in the search for technological solutions to avoid task overlap, account the objectives and resources of each of the involved stakeholders
Organization of community	The rooted existence and practice of local organization, as well as identifying key referents, facilitate the interaction
Role definition	Clearly define the roles of each stakeholder and ensure their fulfillment. Consider functions, obligations and responsibilities from project planning
Shared commitment	Everything requiring effort is more valued. This subject is complex and involved a deep philosophical discussion, but, in principle gratuity does not generate commitments
Trust among the parties	Achieve trust and a good relationship between the parties. Personal contact among technicians and users is the basis for a good project
Recognition of existing power relationships	Recognize the political, economic and other interest that could influence the project's development. Power relationships limit degrees of freedom to act
Efficiency and sustainability of process	
Self-management and local empowerment	Overcome the welfarism and paternalism's vision in projects. To be sustained through time without relying on external institutions
Efficient management and resource control	Flexibility, efficacy and efficiency in resources management. The actions and resources assigned should adapt to the changes that arise in the projects' development
Adequacy of time	Reduce the delay in time between the stages of formulation, formal approval and implementation of initiatives. It facilitates the real problems solving and bestows legitimacy to projects
Prior contact and existing relationships	Previous positive experiences of work could facilitate the interaction. A bad prior expertise, poor organization or irresponsibility from who runs a project, could lead to resistance in the use of technology
Consistency and continuity in public policy	All process fits into a specific institutional framework in which political decisions determine the procedures. In some cases this context could promote technology transfers with incentives, laws and specific programs, which are key especially for the promotion of renewable energies. On the other hand, the discontinuity in State policies is a limiting factor in processes
Values and structural changes	Ethical values should be secured on multiple levels to achieve the changes. Corruption, economic lobbies, etc. cause the failure of many interactions
Education	
Awareness and childhood education	Children and teenagers training on environmental and technological issues represents a space of social awareness
Training for technical-professionals	Overcome compartmentalized knowledge vision which is particularly associated at the 'hard sciences'. Connect scientific-technical with the reality, addressing complexity. Field technicians are recognized as 'privileged', in the sense of working in touch with reality and acquiring knowledge of territory
Technological linkers	It is identified as the 'missing link' in the process and refers to people and abilities needed to create a link between technological supply, and social demand. Points out the importance of interdisciplinary work and specific professional training (facilitators, connectors)
Identification of leaders	Positive leaders are essential to mobilize the processes

- The *personal-institutional* (what we can do in our everyday actions),
- *inter-institutional* (how to generate partnerships with each other to achieve synergy, greater efficiency and sustainability), and
- *Public policies* (how to expand the reach and impact of proposed actions in the territory).

As for the construction of the conceptual framework and the definition of critical factors, proposed strategies and actions apply to both renewable energy and technologies in general.

On relation to the actions and commitments that can be promoted to **institutional and personal levels**, i.e., inwards the institutions and in daily work of stakeholder-researchers, teachers, technicians and extension groups (target group of this study)-, the following were highlighted:

- *Development of new tools and practices for intervention in the territory:*
  - Establish interdisciplinary teams (social and environmental sciences, technical knowledge, popular knowledge, etc.).

  - Focus efforts on good territory diagnostics and participatory planning.
  - Promote co-construction processes of technology (problems, solutions, new knowledge).
  - Generate follow-up processes for the projects.
  - Improve communication. Be prepared for dialogue and negotiation with users and other institutions. Learn to listen. Work from each stake holder's potential, manage differences.
  - Seek local partners (schools, key referents, associations and other already organized entities, etc.)
  - Manage legal and judicial figures to facilitate joint work.
  - Creatively contribute and strengthen values in the interventions.
- Survey of successful and unsuccessful experiences, systematization and sharing of learning.
- Doing technical training on different themes: 'extension' (processes of socio-technical adequacy), culture and global view of the communities they are working with, new dynamics and motivations for the shared work.

This group of concrete strategies can be deployed from places where each one is found and act, so its feasibility and application levels are high.

At the **inter-institutional level**, or for building alliances, multiple proposals emerged. In this case, although they require special efforts, they are viable in short term, and, in some cases, are already rooted in practice:

- *Promotion of multiple areas for interaction among institutions:*
  - In the territory (multi-sectional): Focus more on integration of the institutions that are in the field. Begin to think about interventions from a socio-territorial focus [66], and not as isolated actions by each institution to solve certain problems according to their suitability in the subject. Encourage regular meetings of representative of the different institutions, on site, to reach agreements.
  - Topics: Create and strengthen thematic networks (e.g. renewable energy) and inter-institutional sectorial round table at local level (e.g. water and arsenic round table for the Chaco, Salta).
  - Integration and knowledge: It is important to know what each institution is doing, disseminate their actions and organizational forms, and sharing the learning derived from its practice.
  - Reflection: Give continuity to this type of meetings (with reference to the workshops held within the framework of this research), maintain announcement areas and promote debate on technology transfer.
- *Effective linking of institutions for action:*
  - Use available resources more efficiently and coordinated.
  - Promote greater organization of actions
  - Agree on roles and common areas of work
  - Generate new work abilities

In terms of agreed-upon proposals in the **public policy** area, there are general guidelines with possibilities of implementation in the long term. Despite their non-binding characters, they reflect a vital strategic vision to accompany changes generation from the individual and the institutional, and enhance inter-institutional partnerships and synergies. At least three strategic dimensions were identified:

- *Territorial perspective:* Overcoming the specific interventions and promoting a more comprehensive approach to addressing problems and solutions is important. The State can act in this regard through regulatory laws, specific financing and other incentives. These actions should focus on mechanisms for local development, equality and social inclusion. The strategic planning of territory should: include all stakeholders' visions, agree on a shared vision of the desired situation, define priorities for action and clarity the tools and means to achieve changes.
- *Institutional articulation:* Coordinated work between the institutions must be understood as a public mandate, which means making the articulation of them formal, to optimize resources and efforts. 'We cannot only depend on volunteers'– established institutional channels –, communication and interaction cannot be casual nor optional. For this, two priorities were mentioned: adapt institutional policies for the promotion of inter-institutional work; and recognize and accept the leading role of Science and Technology agencies at provincial and national levels. The articulation must also occur in relation to sectorial plans developed by the institutions (agriculture, industry, tourism, water, etc.). Each territory constitutes a unit, and the approach to its complexity requires a comprehensive and coordinated view.
- *Information and training:*
  - Generate efficient system to integration, access and exchange of information (e.g. virtual platforms, geographical information systems - GIS -, etc.)
  - Assess the non-formal learning spaces.
  - Encourage a comprehensive professional training with holistic vision, through the promotion of new careers and the incorporation of new educational perspectives such as constructivism or popular education in academia.
  - Prioritize educational projects to generate local technological service agents.
  - Perform technical training in local areas (installation, construction and maintenance of technologies).
  - Promote new evaluation mechanisms in academic and scientific systems. The implementation of proposed strategies implies, firstly, consistency between requested priorities and the way in which they are assessed.

With regard to **renewable energy**, in particular, the need to create a specific state policy for the creation of organizational structure, programs and specific regulations was established. These policies should be oriented to the generation of new instruments of financing and subsidy redirecting, so also as the comprehensive monitoring of projects. The participatory consultation about these policies and regulatory frameworks is also important.

5. Conclusions

This article presents a group of experiences of participation and consensus-building to improve the Science-Technology-Society interaction. Workshops allowed integrating the vision of researchers, extension workers, teachers and technicians that, from various areas and backgrounds were linked to the socio-technical adequacy processes of renewable energy and other technologies in rural habitats.

The interest, active participation and creativity put into play during the workshops showed that these spaces of interaction and collective construction are necessary and feasible for implementation. Through these spaces one may promote the paradigm shift and action that were raised as a challenge for this article. On the other hand, the wealth of reflections and generated consensus is found in an invaluable heritage of the participants' previous experiences and a genuine desire to improve the interactions and processes. In this sense, renewable energy projects, and

particularly solar energy ones, were key to encourage discussion, interaction and learnt lessons.

In relation to the construction of a conceptual frame of reference, the epistemological model called 'socio-technical adequacy' was adhered to and validated.

A set of determinants for the processes was identified from their own praxes and collective discussion. The multiple described factors were evidence of the complexity of the socio-technical adequacy processes, but also opens the possibilities for change at different levels of intervention. In this sense, the proposed actions and strategies referred to three viable areas: personal-institutional, inter-institutional partnerships and public policy, in general.

The exercise, in and of itself, of discussion, negotiation and consensus of the workshops, in addition to the effective implementation of the proposed actions, are valued in this article as a real breakthrough in viability construction. Social capital increases accordingly, from entrenched capacities for dialogue, cooperation and complementarily among co-responsible stakeholders for change.

Agreements are born and built in concertation legitimized spaces. While on one reduced scale, it is considered that the presented initiative aids in mobilizing small changes in the territory, on post promoting more inclusive and sustainable processes with renewable energy and other social technologies.

Acknowledgments

The research project was conducted with support from the following institutions: National Council for Scientific and Technical Research (CONICET), Research Council of the National University of Salta (CIUNSa), Research Institute on Non-Conventional Energies (INENCO) and National Institute of Industrial Technology (INTI).

The participation and contributions of each and every one of workshops attendees, who were the real leading roles of this article, is especially appreciated.

Also, special gratitude is given to our 'allies' for the organization of the ASADES workshops: Dr. Santiago Garrido (Institute for Studies on Science and Technology – National University of Quilmes), Arch. Jorge Mitchell (Laboratory of Human Environment and Housing - Mendoza) and, Arch. Maria Victoria Barros (Institute for Research and Policy of Built Environment – National University of La Plata).

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