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Research article

Analysing stakeholders' perspectives towards a socio-technical change: The energy transition journey in Gela Municipality

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Abstract: This article investigates the perspectives of involved stakeholders in supporting niche empowering processes necessary for a sustainable energy transitions. It analyses these perspectives by focusing on a concrete example of an on-going transition from fossil fuel to bio-based technologies, namely the case of Gela (Italy). Based on semi-structured interviews conducted with private and public stakeholders, our findings allowed the identification of potential pathways in supporting the empowerment of the investigated energy niche. Among them we can recall: Information campaigns; scientific and technological collaborations, tax relief and production incentives; infrastructural investments; training courses for advanced biorefineries; simplification of administrative procedures.

Keywords: sustainable energy transitions; strategic niche management; AMP framework; biorefinery

1. Introduction

Finding an effective way to deal with current resources depletion and climate change will require soon a complete transformation of existing unsustainable energy systems [1]. However, socio technical processes able to spur such energy transition appear to be still too slow [2]. A key restraint on attaining a rapid transition to bio-based economies has been the fundamental challenges of managing socio-political aspects. Essentially, an effective energy transition will require a joint effort by all concerned parties; it will not be enough just to use biomass for industrial applications or to employ regenerative instead of fossil based materials. It is not only to combine environmentally friendly knowledge into existing expertise. To meet this challenge, a transition must take place also

from a social and governance point of view, stimulating awareness and common knowledge able to bring all involved stakeholders to a more conscious behaviour for better supporting and accepting innovations in social structures. Although its meaning could appear wide and varied, sustainable energy transition, at its core, is nothing short than concerned with the traditional energy issues (i.e. economic and environmental sustainability, social acceptance, etc.) that arise within and beyond the traditional channels of stakeholder relations [3,4]. As energy transition itself, social aspects and government actions show up differently in diverse contexts and countries so that views, strategies and policies are difficult to appraisal *a priori*, but necessitate sometimes, of in-depth investigations through empirical, and context specific analysis [5,6].

In this framework, the sociotechnical transition (STT) approach can provide a multidisciplinary framework to explain how new innovative technologies arise and diffuse within a sociotechnical regime [7,8]. Niche represents a protected space where innovations might become mature away from regime dynamics. Strategic Niche Management (SNM) seek to developed an analytical framework to understand the introduction and diffusion of very new sustainable innovations through societal experiments. Contributions from innovations studies and evolutionary economics put emphasis on the importance of three key mechanisms for supporting niche development, namely, (i) supporting learning processes, (ii) creating shared visions and (iii) facilitating collaborative networks of actors [9]. These mechanisms are recognized essential for the niche nurturing. However, for a transition to take place and spread out from the protected space the innovation niche must also be empowered through activities that makes niche innovations competitive through fit-and-conform or stretch-and-transform processes [10].

The theoretical grounds of processes and actors dynamics at the basis of energy niches empowering are still in developing phase [11]. This is because energy transitions face multiple barriers, lock-in, path dependencies and resistance to change which require effective policy actions to be overcome [12]. In this regard, it has been increasingly recognised that concrete measures towards the improvement of sustainable energy efficiency are capital subsidies, VAT reduction, tax credits, quota obligation, net-metering and feed-in tariffs [13]. However, each support mechanism offers pros and cons for both producers and collectivity requiring thus, new methods and tools for the appraisal of socioeconomic and environmental impacts of policy choices, based on complex systems and network analysis [14,15]. In this vein, Ponta et al. [16] employ and enrich the agent-based macroeconomic model and simulator *Eurace* to devise the most effective policy combination that improves the long-term benefits with respect to the short-term costs for the macroeconomy as a whole. Markandya et al. [17] use a computable general equilibrium model to analyse the trends and polices of the biofuels in three major regions (USA, European Union and Brazil) under different instruments and volatility in supply due to weather and other factors. Falcone et al. [18] perform a fuzzy inference simulation based on a causal-effect map drawn from experts' knowledge to identify the most effective instrument mix for the development of the Italian biofuel niche.

This paper seeks to add to the spare literature on this area, drawing on innovative empirical insights concerning the case of Gela (a small city located in the south east of Sicily, Italy) biorefinery, a concrete example of an on-going energy transition from fossil fuel to bio-based technologies. Indeed, Gela represents an open-air laboratory for the application of the most advanced environmental and renewable technologies and is candidate to become a "bioeconomy model" not only for Italy but also for the whole EU. In this framework, and focusing on the transitions literature on SNM, we aimed at understanding the role and perspectives of involved stakeholders in supporting

niche empowering processes necessary for a sustainable energy transitions. In adopting this focus, the paper builds upon an in-depth case study following the AMP[1] framework of institutional change since it provides a useful empirical direction for studying those aspects of niche characterization.

The rest of the analysis is organized as follows: Section 2 details the theoretical framework and the research aim; Section 3 presents the case-study; Section 4 sets out the methodology employed; Section 5 provides findings and discusses implications of this investigation; Section 6 concludes.

2. Theoretical background

The socio-technical transition towards more sustainable modes of production and consumption has stimulated the interest in how sustainability shift could be proactively shaped and facilitated [11]. Kemp et al. [19] conceived the socio-technical transition as a bottom—up process, in which promising technologies emerge in protected spaces where they are able to mature and develop so as to achieve the market niches and then, under some circumstances, replace the incumbent regime. In this context, the topic concerning how to promote and steer the successful emergence of a technological niche has gathered growing interest among scholars, practitioners, and policymakers [20–22]. Building on the SNM approach Smith and Raven [10] identify the effective niche protection as having three properties in wider transition processes: Shielding, nurturing and empowering. Specifically, the function of *shielding* is to avert destabilizing pressures coming from the incumbent regime providing thus, protected space for experiments. It is possible to distinguish between passive and active shielding. The former is about the mobilization of spaces not strictly related to the specific innovation but who provide some shielding for the niche. The latter entails the direct creation of protected spaces by means of demand and/or supply side supporting measures for a specific innovation. Once shields are mobilised or established, the space that becomes available provides an opportunity to nurture an innovative niche [10]. The existing literature on the role of niches concentrates on "experiments" as key arenas for nurturing [19]. Basically, the function of *nurturing* supports the development of path-breaking innovation through the development of shared, positive expectations, social learning, and actor network formation. However, for an innovative niche to "break through" and determine a regime shift, innovations must be empowered making them competitive. Although, empowerment is considered in current niche literature the least developed property of niche protection, it is commonly acknowledged as having a key role [23,24]. As proposed by Smith and Raven [10], empowering processes could be seen as both processes that make innovative niche competitive within the incumbent regime (fit-and-conform) or processes able to change the mainstream selection environments to better fit with the innovative niche (stretch-and-transform). In this vein, ascertaining how different stakeholders might have a proactive role in supporting such processes is a relevant topic for the niche literature. In the form of "fit and conform" empowering process, activities are expected to make innovation niche competitive within the socio-technical regime without on-going support [11]. They could be categorized as research and development, training for stakeholders, or policy aimed at shielding (e.g. subsidy) [25]. With reference to the "stretch and transform" empowering process, activities are directed to trigger substantial changes by means of political narratives accompanying institutional reform and

[1] The AMP acronym highlights three key variables to which the framework relates: Awareness, Motivation and Pathways.

regulations or implementing long term policy aimed at removing potential obstacles for the niche development [26]. Approaching empowering processes for the development of an innovation is basically influenced by socio-political landscape dynamics as well as regime stability [26,27]. Basically, the stakeholders contribution to empowering processes has not a stable nature being influenced, over time, by socio-political aspects and context specific factors [10]. Also the political narratives employed by actors to build legitimacy might gather different interest from policy makers and politicians based on actor's reputation and network of relations used for narratives to diffuse [10]. Understanding the role and perspectives of actors towards the niche empowering processes is an important topic within the socio-technical transitions literature [22] requiring in-depth investigations through empirical and context specific analysis. Moving along this research strand, the present paper tries to complement the recent interest on niche empowerment by investigating how local stakeholders perceive and support the empowering processes at the basis of the reconversion process of the Gela refinery.

3. The biorefinery transition: the case of Gela

The last decade has represented a particularly delicate period for the refining sector in Italy. In 2007, with the great economic recession, the traditional refining industry has entered a phase of "overcapacity" due to a stagnant domestic demand. At the same time, social challenges (e.g. climate change, the rapid depletion of natural resources, the increase in the global population and the pressure in terms of food security), have given impetus to the production of biofuels also through the use of second generation biomass (i.e. not in competition with food uses). In this context, the reconversion of a disused refinery in gulf of Gela (South of Italy) into a second generation biorefinery represents a concrete example of an on-going transition from fossil fuel to bio-based technologies that is originating in a small urban context.

Figure 1. The Gela municipality (Source: Own elaboration).

Gela is a southern Italian city with a population of about 75,000 peoples situated in the Sicily region in the province of Caltanissetta. It is among the largest and densely populated area of the island, being the only Italian municipality with a population and area exceeding those of the province's capital (Figure 1).

In the second part of the last century, the gulf of Gela with the construction of a huge petrochemical complex becomes the core of the Italian chemical and petro-chemical industry bringing enormous socio-economic benefits as well as relevant landscape environmental impacts for the whole area. In March 2014, a dramatic fire damaged a significant part of the plant, forcing the ownership to stop the refining activities. In the following months the production processes could not be resumed due to the intervention of the judiciary authority, which ordered to stop the activities for gathering useful elements for the investigation. Few months later, arrived the official declaration by an Eni executive of not wanting to reopen the plants, given the adverse market conditions. The consequences of these events led to the suspension of 700 million € investment plan and the threat of the definitive closure of the plant with the dismissal of 3,000 direct and indirect workers. After the announcement on the withdrawal of the investment plan and the local protests and mobilizations that followed, the Eni management proposed a new investment plan of 2.2 billion € for a large reconversion project.

The relaunch of the industrial area, through the reconversion of the petrochemical plant in "Green Refinery", formally begins with the Memorandum of understanding signed in November 2014 between Eni and all the institutional actors involved, including the Ministry of Economic Development, the Trade Unions, the Autonomous Region of Sicily, the Gela Municipality and Confindustria. The first phase of the project, which involves the reconversion of existing refining plants, started in April 2016. In light of the recent Ministerial authorization, the construction of a new hydrogen production plant will shortly be launched so as to allow the production of biofuels by the end of 2018 and, with the completion of the second plant for the pre-treatment of biomass by the end of 2019, will be possible the use of second generation raw materials.

When completed, the Gela biorefinery will be able to process first and second generation raw materials including palm oil, food waste, animal fats and used frying oils with a production capacity of about 530 thousand tons per year of biofuels. Compared to the traditional refining process, the production of biofuels will significantly limit the environmental impacts and will help to better comply with the requirements of the European RES (2009/28/EC) aimed to increase the average level of energy derived from renewable resources for public transport by 2020.

The reconversion path of the Gela refinery meets the vicissitudes of the main power company intertwined with the economic, social and environmental context of the local territory highlighting potential conflicts between environmental sustainability, energy security and socio-economic development. Due to these sometimes opposing dimensions the case of Gela biorefinery represents an interesting case of investigation for understanding socio-political dynamics pathways based on actors' awareness and motivations to support a radical forms of energy transition.

4. Methods

This investigation builds upon a single in-depth case study to gather insights from a variety of local stakeholders, who are taking part to the course of socio-institutional reconfiguration of the urban environment, for supporting empowering processes of the ongoing sustainable energy

transition in Gela. A local stakeholder analysis has been performed for identifying actors potentially influencing the socio-political system with the aim of eliciting, in a subsequent stage, their perceptions towards the biorefinery reconversion processes, by means of semi-structured interviews. Actors were identified by employing a triangulation-based strategy [28] which allows providing robustness to our results. Specifically, we first carried out a face to face ex-ante interview with a local expert journalist and blogger with a long-term interest in energy security and environmental sustainability of the Gela petrochemical plant. Then, we refined the information obtained by adding supplementary details gathered by means of the "*grey literature*"—namely, websites, technical reports, *fora*, guidelines, blogs etc. A preliminary list of stakeholders was thus derived and administrated for robustness check to a local policy-makers (Vice-Major of the Gela Municipality) during the international Workshop on the "Future of Biorefineries in Europe" held at Gela in May 2017. Starting from this list, interviewees were selected with the aim of representing the range of local actors involved in the socio-political energy sector governance. More specifically, the pool of stakeholders taking part in the survey belonged to: a power company involved in the biofuel production; a local policy maker with responsibility for the reconversion process; two academicians (a commodity scientist and an agricultural economist) with wide and recognised expertise in renewable energy; a representative of a consumer association; and a member of a local environmental association. Although it might appear a limited number of interviews to conduct a solid analysis, given the small size of the Gela energy community (only one power company within a little geographical area) our sample seems to be adequate for embedding main actors pertaining to the local context. The six interviews were conducted, through Skype video-call feature, over the period September–December 2017 and lasted approximately from fifty minutes to one hour and a half. Each interview was recorded and then transcript. Data analysis has been performed by means of QDA Miner 5.0 software package [29] that allowed performing a qualitative assessment of the text in which relevant keywords appeared. This was followed by the characterisation of related narratives linking concepts and sentences to perspectives surrounding the reconversion process in Gela municipality.

Following the approach applied by Holley and Lecavalier [30] open questions were thought to adhere to each respondent's specific expertise and examined with reference to the AMP framework of institutional change. Bearing this in mind, some common key questions are:

(1) What are the drivers and barriers towards the socio-institutional change of the energy sector in Gela?
(2) How local authorities should play a strategic coordination role for the development of the reconversion process?

The AMP abbreviation results from the relation of three important factors able to trigger an overall pro-environmental behaviour: Awareness, Motivation and Pathways. As stated by Petersen et al. [31] obtaining awareness by means of a change in sensibility strengthens a specific motivation towards sustainability, and this in turn provides the impulse for acting within an effective pro-environmental pathway. Such approach has been used in recent empirical investigations aimed at exploring stakeholders' behaviours and perspectives in the context of energy security and environmental sustainability, climate change and socio-environmental issues [30–33]. In a nutshell, AMP represents a practical tool to understand the triggering conditions able to promote socio-institutional changes for a sustainable energy transition. As a research case, our article builds upon this theoretical framework for analysing drivers and barriers of an effective energy niche

empowerment. Specifically, the following research questions are addressed: How do stakeholders perceive challenges and opportunities in the reconversion process of the Gela refinery? And what can we learn from this experience in terms of policy strategies capable of managing socioeconomic and environmental contexts?

5. Results

The interviews scrutiny allows the identification of the most significant pathways (i.e. the possible course of policy actions) taking into account the stakeholders awareness (i.e. their understanding of the sustainability issues of the reconversion processes) and related motivations (i.e. underlying incentives to chase a sustainability transition). Figure 2 reports a summary of the empirical findings emerged from the interviews.

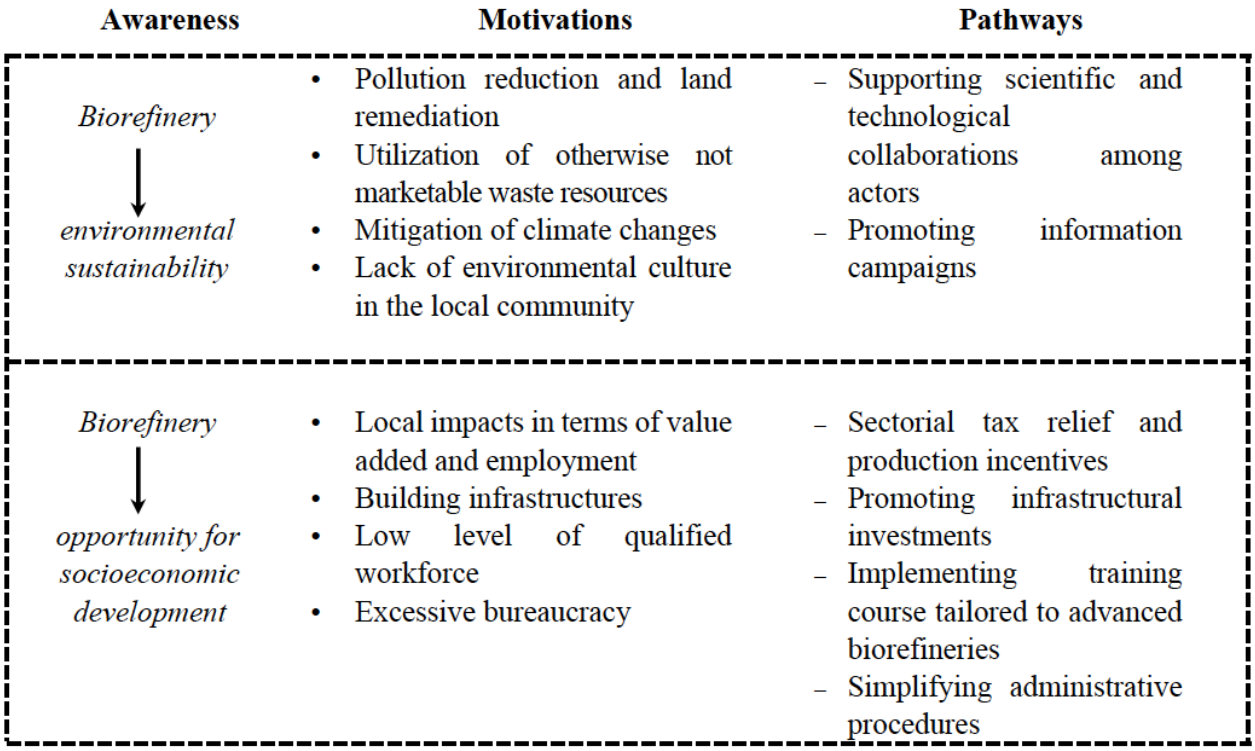

Figure 2. The AMP framework of socio-institutional change for the energy transition in Gela (Source: Author elaboration).

This analysis revealed an overall stakeholder awareness about the socio-economic and environmental issues associated with the rising of the biorefinery. However, the occurrence of conflicting motivations as well as the current deficiency of practical pathways could represent important obstacles for the effective energy transition. In this vein, according to interviewees' perceptions and building on motivations, different potential pathways could ensure the empowerment of the energy niche as discussed in the next section.

5.1. Awareness, motivation and pathways for the energy transition in Gela

As already outlined, the AMP framework allows identifying relevant aspects and their inter-relationship in order to design a punctual set of possible actions able to catalyse the sociotechnical transition. Based on their knowledge, awareness represents stakeholders' understanding and perceptions on the topic, namely the energy transition towards sustainability. Looking at the interviews data, it was evident the general tendency to relate the concept of biorefinery to those of "*environmental sustainability*" and "*socio-economic development*". However, the way respondents frame the role of biorefinery towards socio-economic and environmental aspects of sustainability assumes a different level of significance, forming accordingly different perceptions. More specifically, the totality of respondents firmly recognized the need to address local pollution and land remediation in the Gulf of Gela to face the huge environmental damages resulted from the construction and functioning of the old petrochemical plant. Indeed, as recognized by an exponent of the power company, the reconversion processes have already started with several operations of environmental rehabilitation of plants and interested areas for a total investment of about 200 million €. Moreover, few respondents outlined the environmental sustainability of the biorefinery also in more global context as a possible mean for mitigation of climate change. With the installation of a biomass pre-treatment plant, the biorefinery could ensure the reduction of greenhouse gas emissions up to 60% throughout the supply chain and is technologically able to process up to 100% of its processing capacity using second-generation raw materials derived from non marketable waste. However, interviewees also provided a competing motivation which pointed to the lack of well diffused environmental culture in the local community as a possible obstacle of social acceptability of the plant. In this context, finding possible strategies able to influence and support stakeholders' behaviour towards the energy transition (i.e. pathways) seems to be the main challenge. As emerged from the investigation, there are no well-defined "best" options for supporting the further development of the biorefinery. However, promoting information campaigns for local population and supporting scientific and technological collaboration among actors, along the whole supply chain could ensure both environmental sustainability and social inclusion.

Although all the respondents recognized the proactive role of biorefinery in providing a greater environmental sustainability, a different level of priority emerged with respect to the need of socio-economic development. More specifically, energy transition was merely considered one among possible actions to address socio-economic issues (i.e. unemployment, criminality, social care, etc.). As stated by the local policy maker, "*the development of the biorefinery is not a formal responsibility for policy makers and, although it is desirable, has to be pursued only when other political duties (i.e. social care) have been fully satisfied*". The scarcity of resources accompanied with the lack of political priority towards the process of energy transition could represent key issues inhibiting the potential strategic role of local policy makers in designing effective policies for the niche empowerment. A number of different and sometimes competing motivations shaped actors' perspectives to pursue a change towards energy sustainability. One key incentive is generally recognized in terms of potential socio-economic benefits. Increasingly substituting traditional imported fuels with locally produced bioenergy give rise to a number of value chain phases, occurring at regional level, which can have beneficial effects on local value added and employment. However, such positive effects can be seriously hampered by inconsistent framing conditions which, as discussed by respondents, reflected in inadequate infrastructures, low level of skilled workforce

and professionals, and the excessive administrative bureaucratization. Given the concrete socio-institutional limitations reported by respondents, a conceivable scenario for the empowerment of the energy niche in Gela municipality should build upon a concrete and long-term engagement at all levels of government. Policy pathways should aim at: (i) providing a direct support to the initial phase of bioenergy production by means of tax relief and production incentives; (ii) promoting investments in infrastructures; (iii) implementing training course for professionals tailored to advanced biorefineries; (iv) reducing the administrative burdens of the bureaucracy.

5.2. Catalysing the transition towards a sustainable energy niche

For an innovative niche to develop and determine a regime shift, innovations must be empowered making them competitive within the incumbent regime. In this context, understanding the role and perspectives of involved actors towards the niche empowering processes is paramount to provide adequate policy actions.

Going back to our research questions, several challenges and opportunities in the reconversion process of the Gela refinery have emerged. According to respondents' opinions, and building on these motivations, the study identified the following pivotal strategies in managing socioeconomic and environmental contexts so as to trigger the energy niche transition:

(1) *Supporting scientific and technological collaborations* directed at favouring R & D activities among involved actors. The relevance of this measure is related to the fact that a transition towards a new model of energy production often necessitates research and technological transfer among different value-chain actors. As stressed by a respondent (i.e. commodity scientist), one of the main problems is the lack of synchronization and integration of all supply chain functions which would allow to manage the complexity and the yearly fluctuations in demand and supplies of raw materials. At regards, private investments are hampered by both economic and institutional issues such as high transaction costs, particularly when the technology is complex and involves uncertain components [34] and imperfect appropriability of R & D outcomes.

(2) *Promoting information campaigns* increase the degree of social awareness and provide motivation for action. An adequate flow of information would be paramount to achieve sustainability goals, avoiding any misinterpretation and providing sufficient social awareness to adopt the innovative behaviours [35]. As noted by a representative of a consumer association, in Gela, there is a clear need to spread out valuable information to the various categories of stakeholders (e.g. by means of social media campaigns, web sites, reporting, workshops and seminars) in order to deal with the overall lack of environmental culture in the local community.

(3) *Sectorial tax relief and production incentives.* Despite having adopted policies in support of renewable energies sector a few years ago, Italy shows a gradually increasing energy dependence trend with a strong sensitivity to the dynamics of political and economic development of the main supply markets [36]. According to the representative of the power company, the decreasing domestic production of biofuel is due, in whole or in part, to the removal of any excise exemption in the Italian biofuel market since 2011. In this vein, a multi-year approach towards tax relief and biodiesel incentives would support the initial production phases by driving new investments and establishing greater market certainty for farmers, producers, blenders and fuel retailers.

(4) *Promoting infrastructural investments*. This action includes donor funds aimed at the installation of new environmentally friendly plants (i.e. biofuel plant, R & D centre), infrastructural subsidies (e.g. storage platforms biomass serving biofuel producers) and long term assets (i.e. transportation, energy and social infrastructures). An example provided by respondents help to clarify the importance of investing in infrastructures for a successful energy transition. As noted, large infrastructural investments can foster local economic development, along the whole biofuel supply chain, by increasing the firms' economic performance. This finding is supported by the literature [37]. Moreover, increasing profitability in biofuel sector is expected to have positive effects on local employment; as such, infrastructure investments are likely to impact on quality of life and well being.

(5) *Implementing training course tailored to advanced biorefineries.* This include any planned activity towards the transfer or accumulation of knowledge, skills, and experiences by means of learning practises to acquire the adequate level of competence in order to promptly react to the changing conditions at the basis of new innovative technologies. As stressed by the power company representative, given the low level of skilled workforce and professionals in the investigated context, the implementation of policies based upon training courses and incentives tailored to advanced biorefineries and related industries is perceived as an important long-term strategy. In line with this viewpoint, several initiatives (i.e. training course on: (i) "*Emerging biotechnologies for sustainable waste management and biorefinery development*" at University of Naples "Federico II", Italy; (ii) "*Advanced biorefinery*" at Wageningen University and Research Centre, Netherlands).

(6) *Simplifying administrative procedures* to reduce bureaucracy burdens should be a political priority. Indeed, entrepreneurs face different bureaucratic systems that affect more or less the interest in investing in certain regions [38]. In Italy, the excessive bureaucracy has caused a competitive disadvantage with other EU countries in attracting investments. As explained by the local policy maker, there are a number of reasons why excessive bureaucracy drives the investors away from the local energy sector. Specifically, the presence of several taxes combined with the long time required for their payments, the diffusion of corruption in some bureaucratic institutions, and the number of authorizations required to open a business as well as the time spent to obtain them, represent the main bureaucratic challenges for policy makers. In this context, strategies should be implemented at national level to: Review the stock of regulations; reduce the administrative burdens; promote transparency; simplify the administrative procedures; and introduce, on a large scale, the e-government services [39].

All identified policy strategies bring, from different angles, to a similar deduction—i.e. in order to implement effective actions to catalyse the transition towards a sustainable energy niche, a policy mixes strategy should be employed with the aim of simultaneously addressing different niche criticalities [18].

6. Conclusions

The present study investigates the role and perspectives of local stakeholders in influencing and supporting the empowering processes at the basis of the reconversion process of the Gela refinery. To this end, the paper builds upon an in-depth case study whose data have been analysed and coded following the AMP framework of institutional change.

Our empirical results showed a general stakeholder awareness about possible socio-economic and environmental benefits related to the local bioenergy transition. However, different and sometimes conflicting motivations emerged as structural incentives for shifting stakeholders' behaviour and addressing policy interventions. The empirical findings seem to highlight the necessity for policy makers to go beyond a simple "best option" approach. In this vein, from a range of local stakeholders, our approach allowed the identification of potential pathways in supporting the empowering processes of the investigated energy niche. Among them we can recall: Information campaigns; scientific and technological collaborations, tax relief and production incentives; infrastructural investments; training courses for advanced biorefineries; simplification of administrative procedures.

The overarching result of this analysis highlights the complexity of processes at the basis of the energy transition, clearly showing that policy interventions are very context-dependent. This suggest that policy makers should take stakeholders' perceptions into due consideration when trying to design a well suited and balanced policy intervention.

The main limitation of this approach is based upon the qualitative characterization of the AMP framework. Consequently, although AMP represents a good instrument for policy design, it is ineffective for policy engineering (for example the appraisal of the optimal financial support for each proposed policy strategy). Our methodological approach and results are intended to provide ideas for future analysis aimed at exploring these topics from different angles and geographical contexts.

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Conflict of interest

The author declares that there is no conflict of interests in this paper.

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