

# Moving Forward on Sustainable Energy Transitions: The Smart Rural Model

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## Abstract

*Among the different aspects that promote Sustainable Development, energy is a critical concern to meet the needs of present and future generations in a global-scale and long-term vision. Going beyond the emergence of local responses such as “Nearly Zero-Energy Buildings” or “Smart Cities” models, a more comprehensive view on sustainable energy planning, which involves urban and rural areas as an energetically balanced whole, has to be promoted. Central to this approach is the concept of transition which urges to be conceived in a broader and incremental change of society as pleaded by Rob Hopkins in Transition Towns. Spatial planning is able to manage the complex relationships between environment, economy and society and can represent the driver to implement integrated approaches and adaptive strategies towards the transition from “the actual fossil fuels system” to “a future net zero fossil fuels system”. This paper presents how such questions are being addressed and developed within the field of the doctoral thesis entitled “Smart Rural: energy efficiency and renewable energies in rural areas”. The interdisciplinary research design flow and expected results that support the Smart Rural model are presented in order to debate the thesis statement : “Can an integrated planning process for energy efficiency and renewable energies in rural areas, support the “Net-Zero Energy” balance at the municipal scale?”*

**Keywords:** Sustainable energy; transition towns; smart rural; energy efficiency; renewable energies; energy balance.

## 1. Introduction

Sustainable Development is a paradigmatic concept that from its first definition in “Our Common Future” (1987) has evolved over the past two decades in favour of more contemporary understandings of the three pillars: society, economy and environment (Strange & Bayley, 2008). There is no end, no defined schemes for these three agents just a cumulative directionality toward further dynamic progresses. This places sustainable development in a process that moves from a less sustainable to a more sustainable state that has to deal with a large number of changing dimensions (Ashby, 2015). Among the different aspects that promote sustainable development, energy is a critical concern to meet the needs of present and future generations in a global-scale and long-term vision. In the frame of actual energy consumption paths, cities account for the great majority – between 60 to 80% – of energy production worldwide and for a roughly equal share of global CO<sub>2</sub> emissions (Kamal-Chaoui & Robert, 2009). Going beyond the emergence of local responses such as “Nearly Zero-Energy Buildings” (NZEB) (Li, Yang, & Lam, 2013) or “Smart Cities” models (European Parliament, 2014), a more comprehensive view on sustainable energy planning, which involves urban and rural areas as an energetically balanced whole, has to be promoted (Poggi & Amado, 2014). Central to this approach is the concept of transition which urges to be conceived in a broader and incremental change of society as pleaded by Rob Hopkins in Transition Towns (2014). Within the extraordinary opportunity to reinvent, rethink and rebuild the world according to a process of adaptation to energy descent, it is essential to understand the scale and the way forward for this transition (Hopkins, 2014). In line with Hopkins’s thinking,

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models of transition towns and communities such as, for example, Kinsale in Ireland and Findhorn in Scotland have emerged. As a result, these two models behave in ways that are self-organizing, self-reliant and resilient by focusing on various topics: local food production-distribution networks; organic and seasonal eating; ecological building; renewable energies; energy efficiency in buildings and transports; sustainable water and waste strategies (FEC, 2005; Tinsley & Heather, 2006). In a similar shift in thinking, the transition model can play an important role on the understanding of territories as a support for sustainable energy. Indeed, the value of this perspective depends upon the concept of energy self-reliant territories and thus how urban and rural areas can address an energy balance. In line with the NZEB model but looking beyond the individual building, the “Net Zero Energy” balance is an effective approach to improve energy performances at the city scale (Amado & Poggi, 2014b). Nevertheless, the increase in both the number and size of cities calls for greater attention to issues of local government and municipal management (United Nations, 1992). In addition, the actual centralized energy system, based on large-scale production of fuels and electricity is moving to a more decentralized renewable energy system (European Parliament, 2010). Rural areas, with their geographical location, land use activities, low density and high production potential in terms of renewable energy sources, offer the capacity and condition to be turned into green energy exporter areas (Blaschke, Biberacher, Gadocha, & Schardinger, 2013). It is evident as this framework calls for a more integrated planning process which ensures sustainable development principles, integrating the objectives of strategic energy programs such as, for example, the Europe 2020, the EU 20-20-20 targets by year 2020 and the most recent EU 2020 climate and energy package. Spatial planning is able to manage the complex relationships between environment, economy and society and can represent the driver to implement integrated approaches and adaptive strategies towards the transition from “the actual fossil fuels system” to “a future net zero fossil fuels system”. This paper presents how such questions are being addressed and developed within the field of the doctoral thesis entitled “Smart Rural: energy efficiency and renewable energies in rural areas”. The interdisciplinary research design flow and expected results that support the Smart Rural model are presented in order to debate the thesis statement : “Can an integrated planning for energy efficiency and renewable energies in rural areas, support the “Net-Zero Energy” balance at the municipal scale?”.

## **2. Research Focus**

Economic, environmental and social systems must all be kept in relative equilibrium to ensure sustainable development and, to this end, energy is vital (Strange & Bayley, 2008). Current demographic, economic, social, and technological trends pose major challenges to the long-term security and sustainability of the global energy system (OECD, 2007). With the dual aim of reduce energy consumption and implement renewable energies, there has been a rise of strong energy-related initiatives that if implemented could support a resilient zero-carbon future globally (Wiseman, 2014). In this framework, three major elements characterize the sustainable energy pathway: governance, planning and management. First, energy consumption, security and sustainability are the three key aspects that have to be counterbalanced by government policies. Second, the complex and interrelated nature of the system: “society, cities and territory” require adequate planning and management to confront energy issues, resulting in more comprehensive and integrated approaches. Indeed, energy efficiency is the principal driver in ensuring the sustainable use of energy resources implying that its determined action focuses on the considerable potential for higher energy savings in buildings, transport, products and processes (European Union, 2012). Thus, it is evident as the society and cities offer the wider range of challenges and opportunities in the field of energy efficiency at various scales. On the other side,

the possibilities and chances of introducing renewable energies within urban areas actually produces tangible results with respect to solar energy whereas wind, biomass and hydropower can provide high renewable fractions outside the cities (Eicker & Klein, 2012; Amado & Poggi, 2014a). From this practical perspective, cities will never be energy efficient systems, without planning the boundaries for energy balance within the territory as a whole. On the face of it, the question which emerges behind the present research is “Can an integrated planning process for energy efficiency and renewable energies in rural areas, support the “Net-Zero Energy” balance at the municipal scale?” In this way, the Smart Rural model, launched in the present doctoral thesis, recognises that rural areas have to be turned into net zero energy systems by means of an integrated planning process, which is guided by three strategic objectives:

- The improvement of energy efficiency in rural settlement and farm activities;
- The implementation of renewable energies and smart grids in rural areas;
- The achievement of the net zero energy balance at the municipality scale.

Figure 1 presents the first stage of the doctoral thesis project embedding the research focus flow.

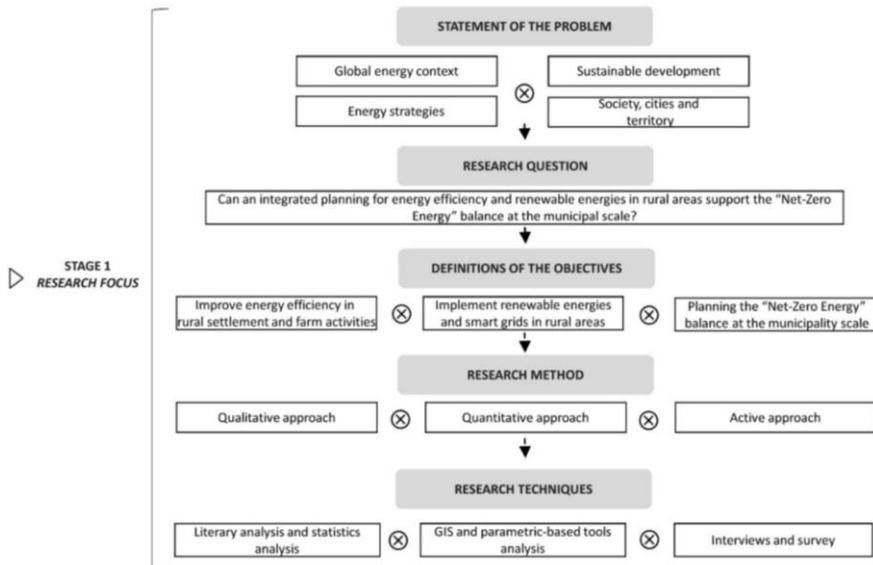


Figure 1: Research focus flow

Addressing three sensitive objectives at the same time, the present research focus requires the adoption of a mixed research method and adequate techniques. Relating different research methods can be a fairly stable strategy with each method secure in its ability to contribute to theoretical progress (Morgan, 2013). In this way, the combination of qualitative, quantitative and active approaches permits to support scientific understanding and operative actions in linked sustainable energy-planning perspectives and their active and continuous assessment and dissemination.

### 3. State-of-art Approach

The state-of-art approach combines different topics and disciplines looking to address the research question and the related objectives. This stage is characterized by three main areas of investigation: the notion of space; energy for the future and energy efficiency: a look beyond the

city (Figure 2).

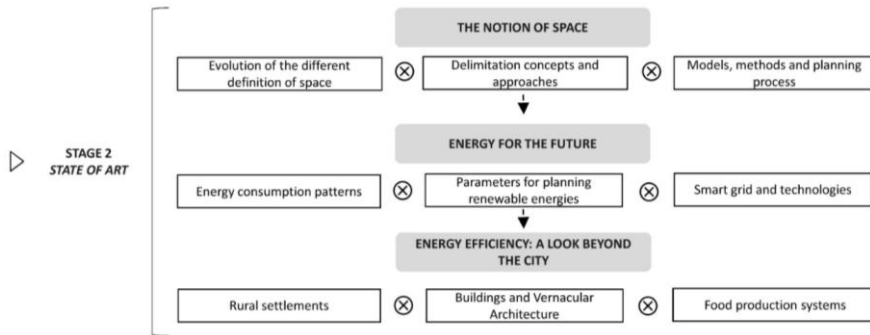


Figure 2: State-of-art flow

Recognizing the complexity of the question that the research is facing, the state-of-art is built on a sequential and hierarchic flow. This approach aims to have a complete understanding of the definition of space, what different delimitation concepts exist and what are the models, methods and planning process that have to be considered in order to propose a conceptual framework for the next stages of the research project. In the field of energy for the future, the statistical analysis on energy consumption patterns is central to gain some insight about urban and rural areas energy performances. On the other side, renewable energies literature analysis rather than presenting a descriptive treatment of the topic, aims to identify the parameters for planning the different renewable sources according to geographical, physical economic and environmental criteria. In the same way, smart grid technologies are investigated as considerable factor for planning. Energy efficiency is subsequently inherent to improve energy consumption in rural settlement, considering the territorial system and morphological factors. Moreover, buildings and vernacular architecture are explored to close the circle of the built environment within rural areas. Food production is also considered to demonstrate the opportunity that this sector aggregates to shape an equilibrate land-use and improve energy use at every step in the food chain.

#### 4. Theoretical Model: the Smart Rural

As result of the state-of-art, the theoretical model traces the concepts that support the intervention proposal. In this way, the Smart Rural emerges as an integrated approach to energy efficiency and renewable energy which focuses on the specific spatial pattern of rural areas (Figure 3).

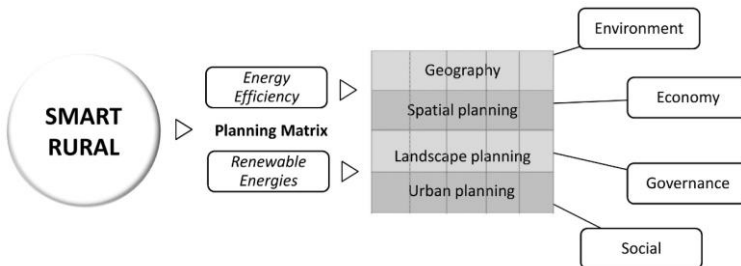


Figure 3: Conceptualising Smart Rural model

Sectorial approaches from either energy or environmental policies alone are not capable to manage essential aspects such as the severe impacts that renewable energies can instigate on

ecosystems and landscapes and the competition between bioenergy and food production (Palmas, Siewert, & von Haaren, 2015). From the interactions of different disciplinary approaches, the planning matrix aims to define a process to incorporate energy efficiency and renewable energies and correlate them to environment, economy, governance and social aspects, during the phases of the Municipal Master Plan elaboration and revision. In this context, the term “matrix” is used to highlight the relational and integrated nature of the proposed approach. Finally, the focus on the specific spatial pattern of rural areas is supported by an essential evidence: rural areas present a much lower energy consumption patterns when compared to urban areas and offer a higher degree of flexibility in the deployment of renewable energy sources (EREC, 2005). In this context, the implementation of energy efficiency must be considered as an opportunity and a target priority at various scales, as it is already the case for urban areas. The abovementioned principles distinguish the Smart Rural model from the other spatial process that are significant in land transformation and energy planning (Brandoni & Polonara, 2012).

### 5. Practical Application

The use of case studies to build and test theories is a procedure that makes use of an inductive approach for theory-building (George & Bennett, 2005). The practical application is thus a critical stage to implement and assess the steps and different components set out by the theoretical model. For this purpose, the Municipalities of Arraiolos and Sertã in Portugal have been chosen. The selection of these two case studies has been conducted in order to accomplish two fundamental aspects: apply the Smart Rural model to the process of Municipal Master Plan elaboration and revision currently in progress and cover the complexity of energy efficiency and variety of renewable energy sources at the municipality scale. Indeed, the Municipal Master Plan represents an effective instrument to support strategic planning and translate goals, programmes and actions into practice (Amado, Poggi, & Amado, 2014). In this way, the theoretical model is carried out in accordance with the current instrument of municipal planning and the global complexity of the territorial context linked to the sustainable energy challenge. Figure 4 briefly summarises how these steps are being used in practice.

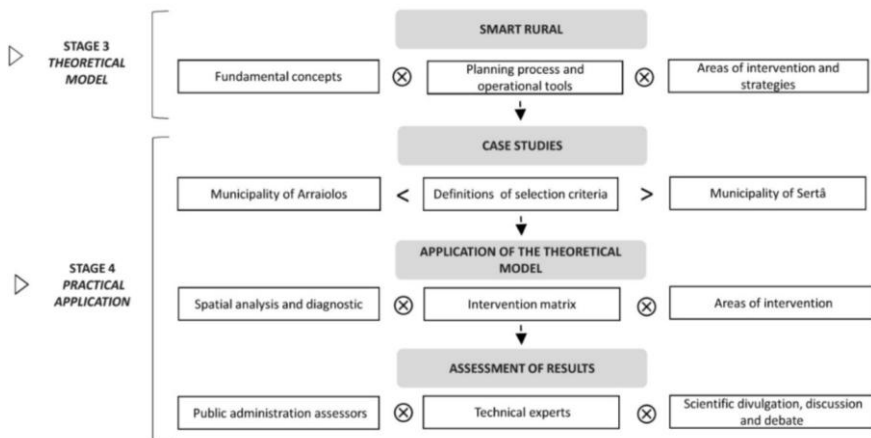


Figure 4: Theoretical model and practical application flow

The participation of public administration assessors and technical experts during the case studies planning process permits to assess the viability and reliability of the theoretical model and its

effects on sustainable development more generally.

## 6. Discussion and Conclusions

The doctoral thesis project described in this paper presents the theoretical bases that might allow for planning the “Net-Zero Energy” balance at the municipal scale. What is important in this approach is how rural areas can be green energy exporter areas satisfying their own internal energy needs and then supplying the territory as a balanced system. The provision of an integrated planning process that gives a complete understanding of potential energy efficiency and renewable energies implementation in rural areas is determinate for this purpose. Nevertheless, the practical application stage in the first case study (Arraiolos) is actually in progress and preliminary findings are reflecting the consistency of the research question and related objectives in the field of the municipal master plan strategies. From the analysis and diagnostic phase, the fragmented territorial system of rural areas and the sprawl nature of built environment emerged as important aspects to be faced in terms of energy efficiency. At the same time, the impacts that renewable energies can induce on ecosystems and landscapes and the need for providing a compromise between bioenergy and food production have to be evaluated in order to ensure a sustainable energy model. In the field of a doctoral thesis, the development of the Smart Rural is an important chance to recognize opportunities and weaknesses of the model and define new pathways for the research and the future of society. This is the more ambitious contribution that this project aims to leave behind.

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