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Theoretical Considerations about Energy Transition in Luxembourg †

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Abstract: The energy transition is a certain phenomenon in the future which as of yet has no agreed definition. It involves a shift in the dominant 'rules of the game'—a transformation of established technologies and societal practices and movement from one dynamic equilibrium to another, typically stretching over several generations. The study aims to explore some salient features of this transition that Luxembourg will face using a theoretical approach. The study was limited to the transportation sector, residential sector, and public dimension. it has been shown how the availability of different contextual factors in Luxembourg will raise the need for new pathways to move towards this transition. The alternative pathways have been argued, too.

Keywords: energy transition; theory of transition; Luxembourg; future; demand-side

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1. Introduction

Transitions are understood as processes of structural change in major societal subsystems. They are multidimensional as they entail changes in organizational, institutional, and technological structures. The future issue is known as "Wicked Science" [1]. A wicked problem is a complex issue that defies complete definition, for which there can be no final solution. The first feature of wicked science is that there is no defined problem in this domain. Therefore, searching for questions and responses should be carried out simultaneously [2]. Rather than following the fixed trajectories of pre-existing research pathways, addressing wicked problems involves the inquirer and decision-maker in exploring the full range of investigative avenues [3]. Simply, patterns of thought of a previous era can create serious problems for the future.

In a practical sense, imagination has been central to the work of anyone who is involved in change in the society in which he lives. Indeed, imagination is associated with creativity, insight, vision, and originality; it is also related to memory, perception, and invention [4]. Accepting a fundamental role for the imagination does not mean that we abandon standards for assessing the validity and reliability of the generated knowledge. Rather, it indicates the potential for change and shows us where to look. Imagination is the living power and prime agent of all human perception [5]: 'It dissolves, diffuses, dissipates to re-create' [6]. One hundred years later a similar interpretation has been attributed to Einstein: 'While knowledge defines all we currently know and understand, imagination points to all we might yet discover and create' [7].

Paying attention to two points reflects the significance of the issue. These are applying the methodology in arguing about this transition studying these issues in the context of Luxembourg. As expected, imagination plays an important role in theorizing the future or

in the decision-making process in complicated problems. Imagination in this study is equal to exploring the public's considerations in the survey methodology and could be applied in generating scenarios. Therefore, two procedures were applied for the issue: collecting data by running a survey, which is translated as exploring the imagination and consideration of people, and generating scenarios, which could be interpreted as reflecting the imagination of experts.

The purpose of this study was to highlight some future challenges of the ongoing transition in the transportation sector, residential sector, and public dimension. Ideas for solutions to a wicked problem can emerge from each of the separated knowledge compartments, with little consideration of how the different contributions fit together (even though each may make a major contribution in its own right). It should be noted that the built theories were justified by the collected data by survey methodology or generated scenarios.

The remainder of the paper is organized into four sections. In the next section, the methodology is applied in the transportation sector to argue the challenges. Later, the procedure is used to explain the issues on the public dimension and, at the end; the achievement of the method is described in the residential sector. Finally, the conclusion summarizes our results.

2. Theorizing the Spreading of Electric Vehicles in Luxembourg

In the first publication, the impacts of contextual factors on the growth of electric vehicles (EVs) were explored in ten European countries with the highest number of EVs [8]. Indeed, arguing the proper time to realize the spreading of EVs in each region has been a neglected topic. Therefore, the theory of the growth of electric vehicles concerning this measure, and particularly regarding local factors in Luxembourg and findings in other countries, was characterized. Justifying the theory was achieved by the generation of possible scenarios. Investigating the function of two contextual factors in each region on the growth of EVs was the focus of this study. Low carbon electricity generation and greenhouse gases emissions were the selected parameters, and these were studied in the context of nine European countries (besides Luxembourg) to determine their impacts on the issue. These countries have the highest shares of EVs in their energy systems. The achieved results were applied to the case of Luxembourg to evaluate how different contextual factors may have hindered the growth of EVs here. In the next step, an analogy between the spreading EVs in Luxembourg and leapfrogging different technologies in the world was made to build a theory of the development of EVs. The theory translated the spreading EVs in Luxembourg as a leapfrogging energy technology to adopt new technology. It was concluded that the development of EVs has a normal priority in Luxembourg.

The noticeable issue here is to highlight the need for the different paths in supporting the spreading of electric vehicles in Luxembourg, as compared to other countries, in order to decarbonize the transportation sector. The proposed pathways are shown in Figure 1.

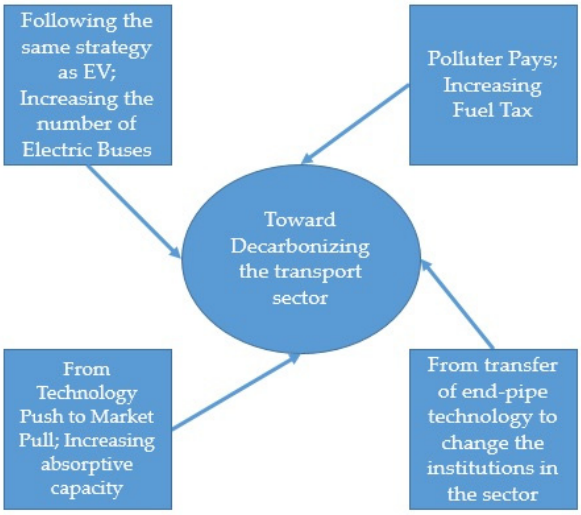

Figure 1. Different pathways to address decarbonizing the transportation sector in Luxembourg.

3. Characterizing the Theory of Transition on Public Dimension in Luxembourg

In the second publication, it was theorized that people are not ready to suffer changes for the purposes of energy transition [9]. The importance of the built theories can be found regarding the concept of the theory of truth. Based on this theory, the future emerges based on what people understand or believe its correctness. Alternatively, people's considerations will construct the future. Therefore, the study was conducted to explore the public viewpoints about energy issues and fill in the gap of knowledge.

To justify the built theories, it was necessary to collect empirical data as much as possible. Thus, a survey was arranged. Public groups in a variety of job statuses were invited to take part in the survey. The employed method to analyze the data was a combination of qualitative analysis with the pragmatic theory of truth. Overall, the number of collected responses reached 96. Notably, people did not see the future differently. They revealed a lack of optimism in the future. The findings confirm that the necessity of energy transition is objectively far from people's considerations. Simply put, people conceive transition as having low priority, and not as something to be implemented urgently. It was discussed to what extent the found viewpoint could negatively affect future policy in the field.

4. Characterizing the Theory of Transition at Residential Sector in Luxembourg

In the third manuscript, the transition in the residential sector was studied [10]. It was a theory-driven study, which was intended to shed light on the growth of energy consumption and emerging technologies in the residential sector. The theories were developed to highlight some future concerns. The first theory was about the role of dwelling types on the growth of energy consumption and the spreading of renewable energy technologies. The results showed that there is a bi-directional pathway. In one direction both energy consumption and the possibility of applying renewable technologies are increased. In the other direction, it is led to reduce the consumption of energy and penetration of renewable technologies. The second theory was about the role of new constructions to conduct future energy concerns. It was shown that energy projects should be a part of new construction projects since energy reasons are not strong enough to drive changes. Finally, the third theory was intended to raise the priority of thinking about managing the changes in residential buildings due to the lasting impact of changes in this sector. Justification of these theories was accomplished with an analytical approach that relies on historical data and explores different futures. The resulted picture of the future highlights the urgent need for attention. The growth of the population in the future was reflected in the increase of number of residential units.

The goal in this study was to highlight how the contextual factors in the residential sector affect the increase of energy consumption and the capacity to host different renewable technologies. It is a matter of directing the transition toward decarbonization in the residential sector or increasing the share of renewable energy. It was shown how macro targets could be affected by the inherent characteristics of the sector.

5. Conclusions

The purpose of the study was to highlight the performance of the theoretical approaches to raise challenges, which face the ongoing transition. It was shown how the availability of specific contextual factors in Luxembourg highlights the need to determine different pathways to reach the considered targets. The study argued the priority of focusing on contextual factors to adopt the needed changes in the available strategies to address this transition. It was shown how ignoring the local differences could result in bias in the considered targets. Moreover, the need was emphasized to a new methodology to discuss future issues, entangled with uncertainties. Therefore, a theoretical approach was applied to explore different possibilities in the future. Built theories were justified with generating scenarios and collecting data with the survey methodology. Building theories to address scientific issues have been common in social sciences. However, to the best of authors' knowledge, there is no published research, which applied the procedure to argue the challenges of transition.

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