**1. Introduction**

Prior to the current transition from fossil fuels towards renewable energy sources, there was more than one energy transition. From the use of biomass combustion to coal and fossils fuels, from coal to gas and electricity and today towards Renewable Energy Sources (RES). The transition to a sustainable society is the main challenge of this century, and finding renewable energy sources are now high on the political agenda. The 21st century’s energy sector will need to transition from fuel, gas and electricity to Renewable Energy Sources (RES). Understanding this energy transition is therefore of prime importance for policymakers and energy planners. However, the concept of ‘energy transition’ is an unsettled business among academics and experts, and many questions still remain.

The fact that many authors write and research the subject does not help. Different perspectives and background use the concept of energy transition in different ways, looking at multiple factors and indicators. As the Board of Whatever mentioned, there is “no consensus on the appropriateness of the current sets of indicators or the scientific basis for choosing among them”. Moreover, many environmental indicators do not have a long time series and are often not used in reports on energy transition (quote board of whatever). Social scientists mention government and institutional change as drivers of energy transition (quote those people) while most reports focus on economic data such as investment and renewable energy industry growth. Many authors agree that an energy transition is the transition from one state of energy system to the other (dico of energy). Still, some authors argue that a complete energy transition needs to show at different levels or places. Gailing and Box (apparently according to book X, PS: i’m not even sure of what these people are saying) argue that energy transition refers to 4 aspects: institutional change, material aspect, power and space. This exemplifies that a complete energy transition does not only concern the energy sector and energy production and consumption but rather that different aspects of society need to transition for a green energy transition to be successful.

Some reports measuring energy transition could use a broader perspective. As many authors argue, looking solely at the energy sector and the growth of the number of renewable energy companies is not enough. Although those numbers are extremely useful to identify trends in energy production and consumption, they cannot confirm that a complete energy transition. Let’s take a country A and say that one of the largest utility company of the country invests lots of money in renewable energy. This company attempts to lower its prices to sell its renewable energy to as many people possible within the country A. The production of energy production and consumption within country A rises. One could think that country A is ongoing an energy transition. However, renewable energy is not a topic on the political agenda of the government of country A. Moreover, citizens are only buying the renewable energy because it is cheaper and they do not care about their Greenhouse Gas emissions. A year later, the company raised its renewable energy prices as it lost money due to other bad investments. Consequently, citizens turned to cheaper energy supply and the company diminished its renewable energy production. The energy transition that country A failed and went backwards. To have a complete energy transition that keeps going forward, more aspects need to be in place. Which ones? That’s a good question.

This research aims at defining energy transition as a shift occurring at the multiple societal levels and not merely within the energy sector. It takes an interdisciplinary perspective to combine the different aspect brought up by scholars and experts on the topic so far. What is energy transition and how do we measure it? Can we even measure it? With an unsettled set of indicators in the literature, this task might be trickier than it seems.

This paper focuses its analysis on the European Union (EU), which has set itself one of the most ambitious goals in regards to energy transition. It’s 2050 Energy Strategy aims to reduce greenhouse gas emission by between 80% and 95% and ensure a global leading position in renewable energy production. This unique entity offers the opportunity to look at 28 countries and diminishes the discrepancies between them. These countries have similar policies regarding energy which is a competence of the Union and all countries have similar economies as they have to answer to some criteria linked to EU membership. This situation offers the possibility to look at energy transition and isolate factors that are truly influencing it. For example, a comparison between Germany’s and China’s energy transitions would hinder the research as they have significantly different developments. The similarities between EU member states allow factors truly influencing energy transition to show more easily.

In order to conclude on what energy transition is and how to measure it, several different factors as mentioned will be looked at. A combination of certain factors will then be taken into consideration to set measurement for energy transition. One subquestion will followingly also be whether there are geographical areas or groups of countries within the EU moving in the same direction, when looking at a certain combination of factors.

In the following section, the literature on energy transition will be outlined. A more thorough background of the concept of energy transition is presented and the advantages and shortcomings of the different approaches are emphasised. Section 3 and 4 will describe the data used in the analysis, including a critical assessment of the indicators used. Additionally, the methodology applied to answer the research question is outlined. The results will be presented and interpreted in section 5 and finally in section 6, the conclusion will list and discuss the implications and limitations of the study, as well as propose complementary research.

**2. Literature review**

Regarding the factors influencing energy transition, academics have reached some consensus but important questions still remain. Different factors that drive energy transition have been analyzed by:

1. Variety of factors:

[Who drives the transition to a renewable-energy economy? Multi-Actor Perspective on Social Innovation](https://www.mdpi.com/2071-1050/10/2/448)

How do various actors influence the transition? Author provides a conceptual framework derived from literature review and text-mining analysis. Methodology is a panel vector autoregressive(VAR) model to test complex dynamical relationships between government, public, markets, traditional energy and contribution of renewables to total energy supply.

Results: government and market directly promote the transition and traditional energy sector affects it negatively. Public has no direct influence, but government+public have positive indirect effects on transition by interaction with the market.

2. Public Policies

[Causality between public policies and exports of renewable energy technologies](https://www.sciencedirect.com/science/article/pii/S0301421512009482)

Sung et al(2013) investigated the causal relationship between public policies and

export of renewable energy.

Result: Increase in government R&D increases exports and there is a negative of

contribution of renewable energy to the total energy(CRES) supply towards exports, while exports have a positive effect on CRES.

3. Prices, access, local fuel availability

[The household energy transition in India and China](https://www.sciencedirect.com/science/article/pii/S0301421508003029)

Compares household energy transition in India and China to modern energy sources and derives key drivers like urbanisation, energy prices, energy access and local fuel availability.

Currently almost all major emitters have in place laws to control greenhouse gases and promote the production of renewable energy. The urgency to address climate change has lead to several intergovernmental conferences and conventions, and it is then domestic legislation that gives credibility to the promises made at the international arena (Fankhauser et al. 2015). Out of a practical policy perspective it is therefore of interest what kind of impact the passage of climate laws has on different aspects of energy transition.

Research has been made into what motivates new laws, many concluding with the main drivers for legislation being factors such as a strong executive and the adoption of a strategic approach to legislating (Nachmany et al.2014, Fankhauser et al 2015). There has however not yet been any attempt to explain in a statistical manner the environmental impact of individual laws, nor what the ideal level of climate change lawmaking could be. A number of climate laws and policies are arguably not perfect indicators of commitment to climate action, as expressed by Nachmany et al (2014), especially as a certain law can have a different impact in one country as compared to what it would in another.

Governmental strategies are often mentioned as important aspects of energy transition, as a way of changing the way the energy markets are organized (Guerry, 2016). Energy transition can also be seen as having a cultural change, such as citizens feeling responsible and taking action for managing their local energy strategy (Guerry, 2016) and the existence of legal channels to do this, permitting governments and citizens to influence energy policy.

The achievement of energy transition can thus be concluded as possibly being dependant on the participation of several stakeholders. In the next section, a number of possible factors will be isolated, and the data to look at these factors in the European Union member states will be described, in order to conclude which factors indeed are decisive.

Outline

1. Introduction
   1. Background to the problem: a sustainable society
   2. Defining energy transition
   3. Research question
   4. methodology
2. Literature review (What is energy transition
3. European Union (Why
4. What are the factors
5. Data ()
6. Hypotheses and analytical method (data also)

Later on

1. Empirical Analysis and Results
2. Conclusion and discussion