Energy Efficiency Vision 2050: How will new societal trends influence future energy demand in the European countries?

Heike Brugger, Wolfgang Eichhammer, Nadezhda Mikova, Ewa Döniz,
Fraunhofer Institute for Systems and Innovation Research
NewTrends project, www.newtrends2020.eu

Abstract

New societal trends, such as digitalization, sharing economy and consumer awareness, will highly influence future energy demand and, depending on their realization, enhance or counteract projected energy efficiency gains. Therefore, these trends have to be accompanied by policies with a strong focus on reducing energy demand (including Energy Efficiency First). This work analyzes quantitatively for all sectors how new societal trends interact with energy efficiency (policies). An extensive consultation with European experts identified 12 new societal trends that are likely to shape future energy demand. Based on these, four energy demand scenarios were developed for 2050. The results show that new societal trends can have a crucial impact on future energy demand beyond mere techno-economic potentials. In the best-case scenario, "New Trends Efficient", they can reduce final energy demand by 67% compared to the EU "Baseline" scenario in 2050. While in the "Worst Case" scenario, they could increase final energy demand by 40%.

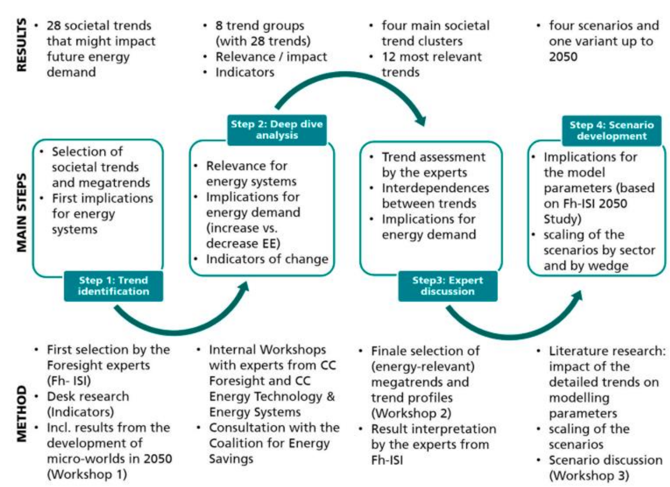
The European Commission emphasizes the role of new societal (mega) trends in their "A Clean Planet for all" communication (European Commission, 2016a) and particular in their corresponding long-term strategic vision (European Commission, 2018). Therefore, it is not surprising that many studies analyze the effect of these new societal trends on future energy demand. Yet, most existing studies concentrate on a single or very few trends or only cover specific sectors (one valuable and recent exemption is provided by Grubler et al., 2018). However, new societal trends have (1) the potential to shift energy demands between sectors[1] and (2) might reinforce or diminish one another when they occur at the same time. Therefore, the here provided approach – starting from a systematic foresight analysis of new societal trends and investigating the potential impact of such trends on future energy demand in a systemic manner – provides an important addition to the recent emerging literature in this area. The main research question is:

How may new societal trends influence energy demand in different sectors in the European Union until 2050?

This study was performed in four consecutive methodological steps (see Fig. 1): (1) trend identification, (2) deep dive analysis, (3) expert discussion and (4) scenario development and model-based analysis.

[1] For example increasing online sales leads to a shift of energy demand away from the tertiary sector towards the transport sector or the trend toward more home office inducing a higher energy demand in private households while at the same time decreasing energy demand in the transport sector.

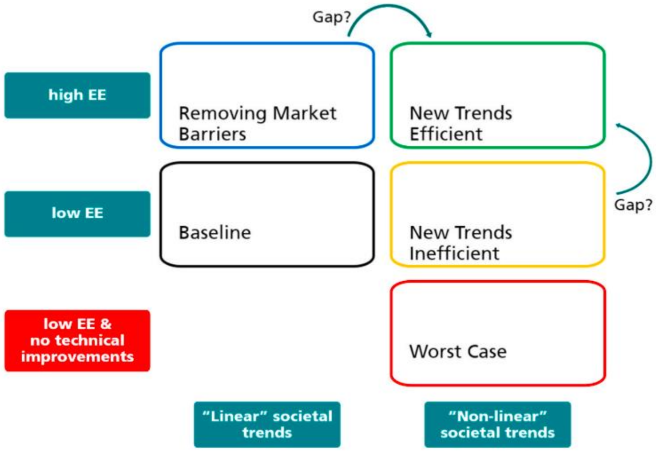
Figure 1. Methodological approach



Scenario development

Four scenarios to 2050 were developed with expert consultation (see Fig. 2). They were designed in comparison to a "Baseline" scenario. The left-hand side of Fig. 2 describes two techno-economic scenarios, which are distinguished by the impact and strength of energy efficiency policies (high/low efforts). New societal trends are present but rather as a linear extrapolation of past trends. The right-hand side of Fig. 2 represents three scenarios with strong (non-linear) societal trends which may either lead to increasing demand or be strongly influenced by energy efficiency policies, leading to a decreasing demand.

Figure 2. The scenarios developed for the analysis of new societal trends



The "Baseline" scenario[2] is based on the PRIMES projections from 2016 (European Commission, 2016b). This scenario provides the reference for the development of drivers of energy consumption. New societal trends happen in this scenario but as a rather smooth continuation of previous trends (linear societal trends).

The "Removing Market Barriers" (or "Techno-Economic") scenario focuses on the realization of economic and near economic potentials for energy efficiency, mainly based on technical solutions. As in the "Baseline" scenario, new societal trends are included, but as a rather smooth continuation of previous trends (linear societal trends).

The following two scenarios are based on the "Removing Market Barriers" scenario. In these scenarios, the economic and near economic potentials for energy efficiency are realized such as in the "Removing Market Barriers" scenario, and, additionally, the potentials are either reduced or enhanced due to new trends.

The "New Trends Inefficient" scenario is characterized by strong non-linear societal trends due to penetration of the shared and digital economy and strong rebound effects, i.e. energy-increasing impacts of the new societal trends. By "non-linear" we mean that those trends, although they may have been around in small niches for quite some time, suddenly receive a strong push and become part of society's mainstream.

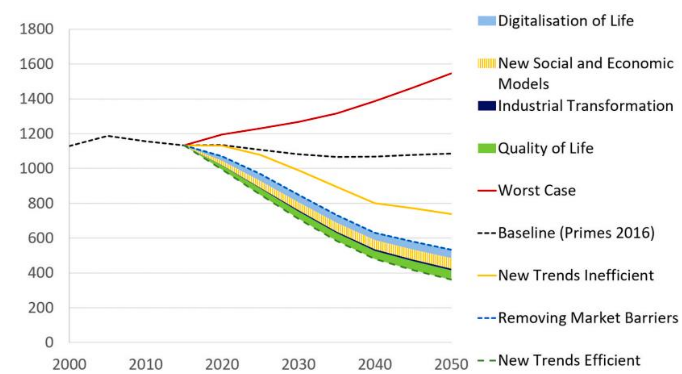
The "New Trends Efficient" scenario is also characterized by strong non-linear societal trends. In this scenario policies are developed which act upon the new societal trends, guiding them strongly to bring forward the energy reducing impacts.

The "Worst Case" scenario has been developed in a way that new societal trends (in their increasing form) operate directly on the "Baseline". This means that in the "Worst Case" scenario economic and near economic energy efficiency potentials are not (fully) tapped by policies, while at the same time the new societal trends increase energy demand.

Assessment of the overall saving potentials

Fig. 3 shows the overall final energy demand within the various scenarios. In addition, Fig. 3 indicates to which extent the four main societal trend clusters contribute to the decreasing final energy demand from the "Removing Barriers" scenario (mere techno-economic potentials) to the "New Trends Efficient" scenario. Note that for example the low impact of the industrial transformation is due to the fact that most changes within this transformation are (nearly) cost-effective techno-economic changes, and thus already included to a large degree in the "Removing Market Barriers" scenario.

Figure 3. Final energy demand (EU28) in the four scenarios and the baseline (in Mtoe) and the contribution of four main trend clusters in the case of the "New Trends Efficient" scenario.



The main findings from the analysis of the total final energy demand are the following: new societal trends without any accompanying strong energy efficiency policies ("New Trends Inefficient" scenario) could diminish the effect of the realized techno-economic potentials for final energy demand to a 32% reduction (as compared to the "Baseline" in 2050). If, on the one hand, the new societal trends were to manifest the energy increasing trends without the realization of the techno-economic potentials ("Worst Case" scenario), the final energy demand could be strongly increased by up to 42% above the "Baseline". On the other hand, new societal trends supported by strong energy

[2] The "Baseline" scenario is based on the most recent projections of the European Commission with the PRIMES model (at the time this study was conducted), for the sectors as well as for the overall final energy demand.

efficiency policies ("New Trends Efficient" scenario) could decrease final energy demand further (decrease by 67% compared to the "Baseline" in 2050).

The four trend clusters hereby describe the difference between the "Removing Barriers" and the "New Trends Efficient" scenarios. "Digitalization of Life", "New Social and Economic Models" as well as "Quality of Life" each contribute to this further reduction of 172.5 Mtoe with a share of approximately 30%, while the "Industrial Transformation" only contributes with a reduction share of 5% (for more details see Table 6 below).

The resulting gross inland consumption and CO2-emissions within the four scenarios are visualized in Fig. 4 and Fig. 5.

Figure 4. Gross inland consumption (in Mtoe) in the four scenarios and the baseline (EU 28).

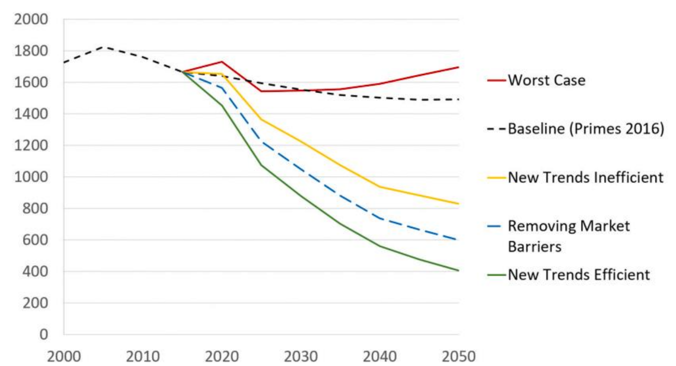
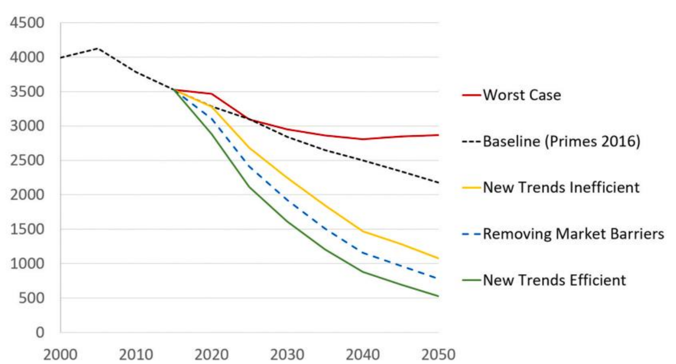


Figure 5. Energy-related GHG emissions (in Mtoe) in the four scenarios and the baseline (EU28).



Policy recommendations

This study aimed at opening up the discussion of how energy demand might change through new societal trends. Based on these trends, it analyzed four energy demand scenarios developed for 2050 ("Baseline", "Removing Market Barriers", "New Trends Efficient", "New Trends Inefficient" and "Worst Case"). As the various scenarios depict in a stylized manner, new societal trends could unfold in a way that would further substantially decrease energy demand beyond merely realizing the techno-economic potentials if strong energy efficiency policies, expressed through the Energy Efficiency First (EE1) principle, guide individual and policy decision-making in a beneficial way. However, the effects of the new societal trends could also counteract efficiency gains in a way that leads further away from achieving the EU goals for energy efficiency and climate neutrality in 2050. The EU proposed EE1 as a fundamental principle applied to policymaking, planning and investment in the energy sector. The EE1 principle is now gaining increasing visibility in European energy and climate policy (European Climate Foundation, 2016). Put briefly, the concept of EE1 prioritizes investments in customer-side efficiency resources (including end-use and supply side energy efficiency and demand response) whenever they would cost less, or deliver more value, rather than investing in energy infrastructure, fuels and supply alone (ENEFIRST, 2020; European Commission, 2016a). Although the Energy Union Strategy has recognized energy efficiency as a resource in its own right at the same level as generation capacity and the EE1 as a guiding principle has been brought forward, previous studies suggest that numerous barriers still impede this principle from being streamlined and the benefits of energy efficiency from being adequately taken into account in financial and political planning and decision-making (BMU/Fraunhofer ISI, 2012; Fraunhofer ISI, 2009; Schleich, 2009; Schleich and Gruber, 2008). The results of this study show that the path that final energy demand will take in the years to come is less than certain and will depend not only on the realization of techno-economic potentials, but also to a vital degree on how societal trends will unfold. These trends can have an impact on energy efficiency improvements and contribute to a decrease or increase of energy consumption beyond the linear trends. In particular, an increase in energy consumption might be the result of new societal trends that are not accompanied by policies strongly implementing the EE1 principle. While the current paper aims at raising awareness of the large effects that the new societal trends might have on future energy demand, it will be crucial to further intensify the endeavor of studying not only the cost-effective potentials, but also to further quantify the effects, including cross-sectoral effects, that societal trends will have on future energy demand. This might ultimately inform policy-makers how European policies have to be designed in order to shape political, commercial and individual decision-making in a way that further decreases energy demand rather than counteracts efficiency gains.

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