Research Proposal

A design case study

In partial fulfilment of the requirement for the degree of

MASTER OF SCIENCE

in

Human Computer Interaction

by

Yanwei Miao

(1627738)

Under the supervision of

Prof. Dr. Gunnar Stevens

Dr. Songmin Yu

January 2023

ABSTRACT

Text...

Contents

List of Figures

List of Tables

Notations and Abbreviations

EU European Union. 1, 2, 12

GHG greenhouse gas. 1

Chapter 1

Introduction

Human-induced climate change is causing dangerous and widespread disruption in nature and affecting the lives of billions of people around the world [IPCC, 2022]. To tackle climate change and its negative impacts, the historic Paris Agreement sets long-term goals to guide all nations to substantially reduce global greenhouse gas (GHG) emissions to limit the global temperature increase to 2 degrees Celsius in this century [UNFCCC, 2015]. On European Union (EU) level, "Energy 2020. A strategy for competitive, sustainable and secure energy", published in November 2010, and "Energy Roadmap 2050", published at the end of 2011, are the most important strategy papers currently, pointing the direction for energy developments in the EU [Langsdorf, 2011]. The aim is to confirm Europe's commitment to lead in global climate action and to present a vision that can lead to achieving net-zero GHG emissions by 2050 through a socially-fair transition in a cost-efficient manner [European Commission, 2018].

To achieve these goals, two central strategies are pursued by the EU and its Member States concerning the energy system [Brugger et al., 2021]:

1. Enhancing energy efficiency (EE).
2. Decarbonizing energy supply, in particular via large diffusion and wide-use of renewable energy sources.

1.1 Energy shift

In 2019, 80.9% of our total energy supply still depended on burning fossil fuels, namely 26.8% coal, 30.9% oil and 23.2% natural gas [IEA, 2021]. Nonetheless, investments into low-carbon power generation accounted for 15% recently are expected to rise to more than 30% by 2030, corresponding to a quadrupling in absolute volumes [Bertram et al., 2021]. Solar, wind, and the investments for enabling the integration of these technologies to the grid dominate the investments into low-carbon power generation [Bertram et al., 2021].

1.2 Societal trends

Previous research has shown that in many areas energy efficiency gains were counteracted by societal trends that increased corresponding activities, leading to much smaller decreases (or even increases) of energy demand than technologically feasible [Brugger et al., 2021]. Therefore, it is important to access current and (foreseeable) future societal trends concerning the impact that they might have on future energy demand [Brugger et al., 2021].

Climate change can only be tackled if people actively engage, as consumers and as citizens [European Commission, 2018].

Chapter 2

The newTRENDs Project

The aim of NewTRENDs is to increase the qualitative and quantitative understanding of impacts of New Societal Trends on energy consumption and to improve the modelling of energy demand, energy efficiency and policy instruments [Fraunhofer ISI, 2023].

2.1 Concept

With increasing renewable generation integrated into the power system, supply-side fluctuations must be balanced by demand-side flexibility. Electrification and demand response (DR) are becoming increasingly relevant to the heating transition of buildings, which demands the diffusion of

- heat pumps (HPs),

- photovoltaic (PV) and energy storage (e.g., battery and hot water tank),
- smart energy management systems (SEMSs).

Combining the three technologies is also beneficial from an individual household (or building) perspective. The household can optimize the heat pump operation to reduce energy costs by saving energy in the tanks or pre-heat the building when the electricity price is lower. Besides, the energy-saving benefit could be further increased with PV and battery system. From a market perspective, DR flexibility and PV generation also facilitate the concept of "energy community". The households can trade electricity with each other (peer-to-peer, P2P) within a local micro-grid or even trade with the other side of the country through the national grid, depending on the infrastructure, business model, and policies. In addition, households can also buy the services from an "aggregator", who bundles and manages the flexibility of small consumers and producers and participate in the market activities (Kerscher and Arboleya 2022). Promoted by the declining costs of technologies and support policies, more and more household "consumers" are expected to become "prosumers" (with PV) and "prosumagers" (plus energy storage and SEMS) (Fereidoon Sioshansi 2019).

2.2 FLEX models

The FLEX-Operation and FLEX-Community models were built to improve the building modeling suite and to analyze the societal trends of prosumaging and energy communities.

2.2.1 FLEX-Operation

FLEX-Operation calculates the energy consumption of each representative building, including operation of technologies (e.g., battery, PV, heat pump, etc.) and load profiles in hourly resolution.

2.2.2 FLEX-Community

FLEX-Community can be applied to support the aggregators designing and evaluating business models, as well as making investment decisions, for example, the self-owned battery, PV panels, etc.

2.3 Motivations

An opportunity to encourage European residents to switch to greener energy options. That actually do benefits for not only the environment but also for the planet.

2.4 Research questions

This paper focuses on investigating European resident's profile types, in order to provide easy, accurate and explainable predictions and suggestions for them.

- Residents profiles?
- Be explainable?

Chapter 3

Methodology

Introductory lines...

3.1 Section-1 Name

Some text here ...

Chapter 4

Supervision agreements and time planning

Introductory lines...

4.1 Justification for 30 ECTS

Some text here ...

4.2 Supervision

This master thesis project will be supervised by Prof. Dr. Gunnar Stevens (Gunnar.Stevens@uni-siegen.de) and Dr. Songming Yu (songmin.yu@isi.fraunhofer.de).

4.3 Time planning

Text here...

Appendices

Bibliography

[Bertram et al., 2021] Bertram, C., Riahi, K., Hilaire, J., Bosetti, V., Drouet, L., Fricko, O., Malik, A., Nogueira, L. P., van der Zwaan, B., van Ruijven, B., van Vuuren, D., Weitzel, M., Longa, F. D., de Boer, H.-S., Emmerling, J., Fosse, F., Fragkiadakis, K., Harmsen, M., Keramidas, K., Kishimoto, P. N., Kriegler, E., Krey, V., Paroussos, L., Saygin, D., Vrontisi, Z., and Luderer, G. (2021). Energy system developments and investments in the decisive decade for the paris agreement goals. *Environmental Research Letters*, 16(7):074020.

[Brugger et al., 2021] Brugger, H., Eichhammer, W., Mikova, N., and Dönitz, E. (2021). Energy efficiency vision 2050: How will new societal trends influence future energy demand in the european countries? *Energy Policy*, 152:112216.

[European Commission, 2018] European Commission (2018). A clean planet for all. a european long-term strategic vision for a prosperous, modern, competitive and climate neutral economy.

[Fraunhofer ISI, 2023] Fraunhofer ISI (2023). Newtrends: New trends in energy demand modeling.

[IEA, 2021] IEA (2021). Key world energy statistics.

[IPCC, 2022] IPCC (2022). Climate change: a threat to human wellbeing and health of the planet. taking action now can secure our future.

[Lacal Arantegui and Jäger-Waldau, 2018] Lacal Arantegui, R. and Jäger-Waldau, A. (2018). Photovoltaics and wind status in the european union after the paris agreement. *Renewable and Sustainable Energy Reviews*, 81:2460–2471.

[Langsdorf, 2011] Langsdorf, S. (2011). EU energy policy: from the ecsc to the energy roadmap 2050. *Green European Foundation: Brussels, Belgium.*

[UNFCCC, 2015] UNFCCC (2015). Paris agreement. In *Paris Climate Change Conference*.

[Yu et al., 2022] Yu, S., Mascherbauer, P., and Kranzl, L. (2022). New trends in energy demand modeling.