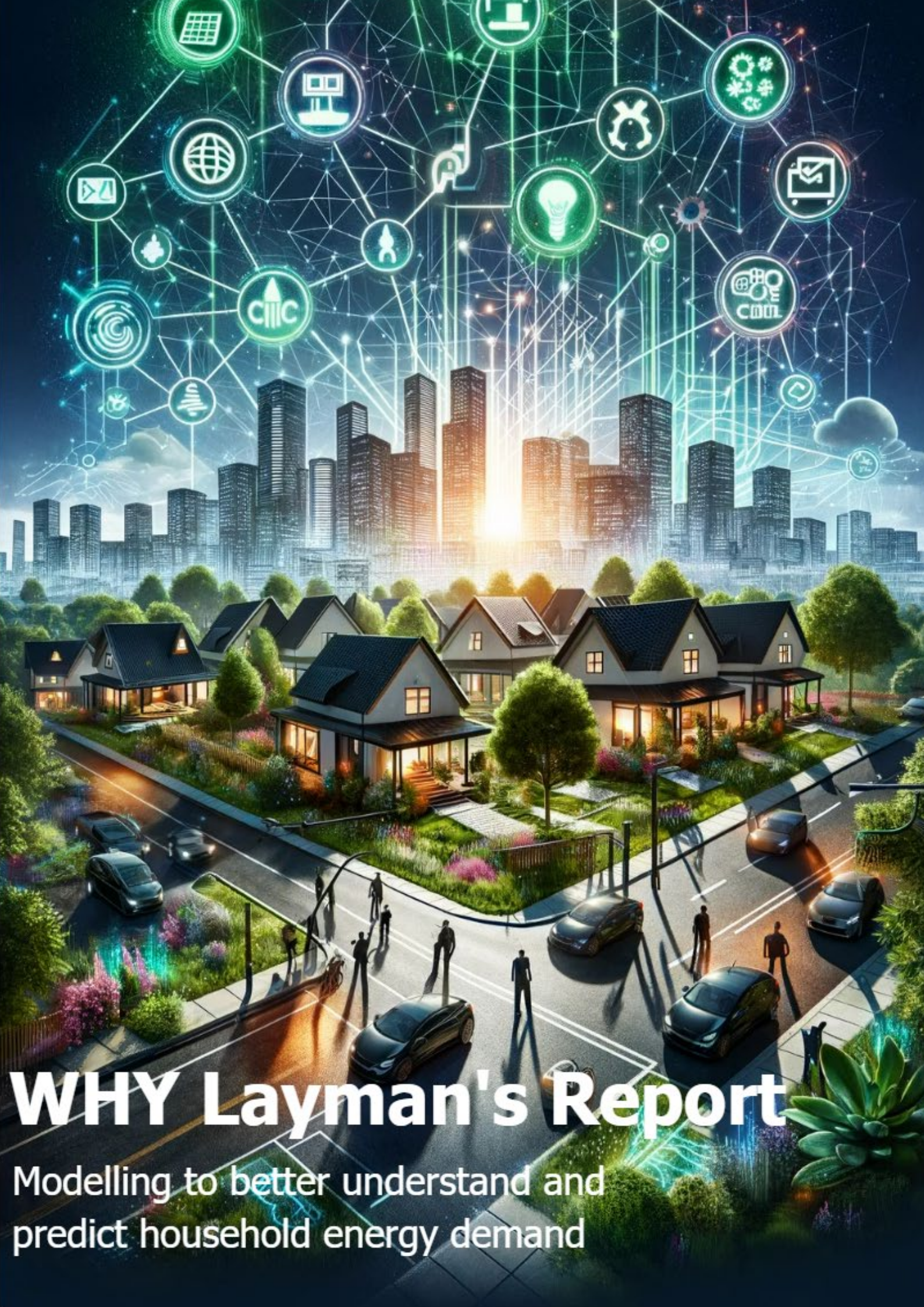

WHY Layman's Report

Modelling to better understand and predict household energy demand

What are the reasons that lead citizens to participate in the energy transition?

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Energy system models (ESMs) are a set of mathematical equations that describe the energy system.

Energy experts use these models to describe the medium and long-term impacts of different scenarios that introduce changes in energy systems. While ESMs have been quite useful in modelling energy supply, they currently do not accurately simulate energy demand, especially in the residential sector, because of the diverse range of dwellings and the disparate ways the citizens consume energy.

To solve this problem, during the WHY project[1] a causal model has been developed to quantitatively analyze people's daily decisions regarding energy consumption and their reactions to interventions and policies such as tariff changes, new taxes, different types of incentives, etc. These tools are used to improve a) the quality of the main ESMs currently used by EU policy makers, b) the operation and planning of the energy generation and distribution system and c) the assessment of household electricity consumption trends. The project recommends including user behaviour when modelling the energy system and puts these tools at the disposal of the modelling community.

[1] https://www.why-h2020.eu/materials

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WHY

This briefing contains the main results of the WHY project and meant to inform all who are interested in learning about the energy transition and policies related to it. The briefing will contain the results of different experiments/use cases in the form of recommendations related to the energy transition and improving the trust in the administration's policies that are being implemented by the different public authorities. In particular it includes information about:

How can a group or individual person participate in the energy transition (e.g. by reducing their energy consumption, contributing to the deployment of distributed renewable energy in the system or at least by consuming energy more responsibly)**?**

How can local administrations improve planning for sustainable neighbourhoods?

How do improved models help to define more efficient and just EU energy policies?

How can energy cooperatives improve the way they support the creation and operation of energy communities?

Energy system models (ESMs) are a set of mathematical equations that describe the energy system. Energy experts use these models to anticipate the long-term impacts of different scenarios that introduce changes in energy systems. Although ESMs have produced useful results in energy supply modelling, current ESMs lack accuracy in simulating the residential sector. The main reason for these inaccuracies is the large diversity of dwellings and the disparate ways the citizens consume energy, which produce a wide spectrum of consumption patterns.

To address this problem, the EU funded project WHY has developed a causal model to quantitatively analyse people's day-to-day decisions regarding energy consumption and their reactions to interventions such as tariff changes, new taxes, different types of incentives, etc.

These tools are used to improve:

- the quality of the main ESMs used by European policy makers,
- the operation and planning of the energy distribution system and
- the assessment of household electricity consumption trends.

This briefing presents the main recommendations stemming from the project, aspects like best suited citizen behaviours to foster the energy transition, the tools provided to local public administrations and energy communities to improve their activities and the results of the impact that EU legislation will have.

The use cases of the project focused on:

- The Fit for 55 and REPowerEU strategies using the WHY toolkit integrated with the PRIMES Energy system model widely used for energy policy impact assessment by the European Commission.
- The global energy system developments, with a focus on Africa and Europe, in line with SDG 7.
- Tools to foster the creation and management of energy cooperatives and energy communities that contribute to SDGs 7, 11 and 13.
- Tools to size and manage microgrids at a local level. This has been identified as a priority for sustainable cities and is an important driver for the electrification of off-grid areas (contributing to SDG 7).

MAIN RECOMMENDATIONS

How can a group or individual person participate in the energy transition (e.g. by reducing their energy consumption, contributing to the deployment of distributed renewable energy in the system or at least by consuming energy more responsibly)**?**

Individuals can actively contribute to the deployment of renewable energy and promote responsible energy consumption through various strategies.

One impactful approach is to join or support renewable energy cooperatives. By becoming a member of these cooperatives, individuals can participate in community investments and initiatives focused on reducing energy consumption (energy efficiency, energy sufficiency) and on increasing the use of energy from renewable sources.

Another effective way is to embrace self-consumption systems, such as residential solar panels. Investing in such systems enables individuals to generate their own renewable energy, reducing reliance on conventional energy sources and contributing to an overall increase in renewable energy capacity.

Adjusting energy consumption patterns is also key. Consuming energy during central hours of the day (solar hours) or at night, when stored energy can be utilised, maximises the use of clean energy. This might involve running major appliances or charging electric vehicles during peak solar production times.

Implementing energy-efficient practices and technologies at home is another crucial step. This includes using energy-efficient appliances, improving insulation, and adopting smart home technologies to optimise energy usage.

How can local administrations improve planning for sustainable neighbourhoods?

The needs of the energy system are becoming an ever more relevant aspect of urban planning at neighbourhood scale. As decentralised energy sources, battery storages and other technologies gain importance, a more detailed consideration of consumption behaviour is necessary. But why is that the case?

1. The time at which the energy is consumed is getting more relevant, since consumption of local generation and a reduction of the strain on the power grid will be of great importance to achieve the green transition where all the energy produced comes from renewable energy sources.
2. Standardised load profiles do not reflect the individuality of households, which is not an issue if you look at large numbers of households, but in the planning of neighbourhoods, this becomes an issue.
3. Households with the potential and motivation to adapt their load behaviour are not considered, when using standardised consumption profiles.

Source: Adobe Stock - mattegg (created using AI)

This situation initiated the analysis of the “Maintal-Use-Case” in the WHY-project, where the city of Maintal in Germany had contracted a technical bureau in mid-2023 with planning of a new neighbourhood in collaboration with the WHY consortium. With information on the expected inhabitants of the new flats, the WHY Toolkit was used to simulate detailed electricity, heat and water consumption data for the neighbourhood.

So, what does a better planned neighbourhood do for you as an individual?

It allows adapting the energy infrastructure within the neighbourhood to actually suit your individual situation and behaviour. Ultimately this should contribute to reducing your energy system costs as the infrastructure is suited to the requirements in the best possible way.

How can energy cooperatives improve the way they support the creation and operation of energy communities?

Energy cooperatives are actively enhancing their support for the establishment and growth of energy communities through diverse strategic initiatives.

Primarily, there is a significant focus on engaging and educating the community. Energy cooperatives conduct outreach programs, workshops, and information sessions to inform residents about the advantages of renewable energy, energy efficiency/sufficiency, and the cooperative model. This approach aims to raise awareness and garner support for community-led energy projects.

Another crucial aspect is fostering community participation. Energy cooperatives actively include community members in democratic decision-making processes, enabling them to play a vital role in shaping the energy future of their neighbourhoods. This empowerment strengthens community ownership and commitment to sustainable energy initiatives.

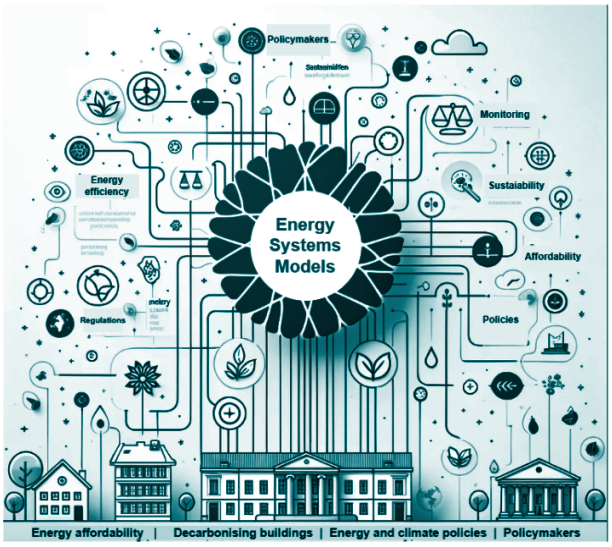
Financial backing and funding constitute essential elements of energy cooperative endeavours. Cooperatives strive to secure grants, subsidies, and partnerships to make energy efficiency and renewable energy projects financially viable. Additionally, collective investments from cooperative members contribute to funding renewable energy infrastructure.

Some energy cooperatives are delving into local energy trading platforms, enabling community members to directly buy and sell excess energy. This decentralised approach fosters community-driven energy markets, often facilitated by blockchain technology to ensure secure and transparent transactions.

Active engagement in policy advocacy is yet another strategic avenue. Energy cooperatives collaborate with policymakers at different levels to create a supportive environment for community energy projects. This involves advocating for regulations and incentives that bolster the growth of energy communities.

How do improved models help to define more efficient and just EU energy policies?

The enhanced Energy System Models integrating the modelling advancements of the WHY Toolkit will offer an improved understanding of the household energy consumption and the potential effects of policy interventions. The enhanced models are used to provide novel insights into the Fit for55 package as well as the EU's climate neutrality goal by 2050.



The model-based analysis highlights that energy efficiency, combined with transitioning to low-carbon energy sources, is an essential enabler of decarbonising buildings.

Decarbonising European homes will require national governments to ensure clear and supportive policies to establish, monitor and enforce effective energy efficiency building regulations.

Energy and climate policies should consider the national circumstances to be effective and just, as exemplified by the detailed analysis conducted for Greece and Sweden, two countries with very different socioeconomic contexts, climate conditions and technology uptake (e.g. much higher heat pumps uptake in Sweden).

By using smart redistributive policies, policymakers should ensure a just net zero transition reducing energy poverty and improving energy affordability for European households, e.g. through directing the revenues from carbon pricing to low-income households and other vulnerable groups in the form of lump-sum transfers.

CONCLUSIONS

Through the research carried out in the WHY project we have assessed the most relevant actions that citizens can take to fight climate change.

In particular, we have found that engagement in actions like energy cooperative / energy communities are an enabler not only to foster behaviour change (improvements in energy efficiency or participation in demand response actions) but also to trigger investments in technologies related to the energy transition.

Nevertheless, in the other direction we have also assessed the best tools that energy cooperatives / communities can use to increase their uptake. Actions like fostering community participation, increasing their education activities, and actively participating in policy advocacy seems to be the most payoff activities.

In addition, we have developed tools for policy makers at local and regional level to not only define strategies to foster engagement but also to improve the urban planning taking into consideration these new behaviours and investments.

Finally, we have assessed these results in the wide EU context to provide insight to European policy-makers related to the best strategies to decarbonising European households ensuring a just net zero transition while reducing energy poverty and improving energy affordability for European households.

References

WHY dissemination strategy is based on three pillars: academic dissemination, skills workshops in the ECEMP annual conference and open science practices. For academic dissemination, WHY partners have already participated in several conferences, published journal articles and more are in different stages of preparation. Moreover, all the deliverables are available to the stakeholders and policymakers. On the other hand, throughout the project, several skill workshop sessions were organized, where training on the use of our tools for students and early-career researchers via the ECEMP conference was provided. Finally, WHY has followed a broad amount of open science practices. For example, co-creation activities with stakeholders were carried out to capture requirements, define scenarios, build different types of models, plan experimental designs or carry out detailed assessments of the results.

WHY project resources

Local Policy Recommendations - WHY Local Policy Brief

EU Policy Recommendations - WHY EU Policy Brief

Set of videos on the WHY YouTube Channel

Events and Presentations

Scientific Papers and Publications

Press Area

Teaching resources

Deliverables and Reports

Flyer and Posters

Datasets

Technical Documents

Software and Toolkit

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With a long and well established tradition, founded in 1886 as a higher education institution, UD has a mission and educational goal firmly grounded in academic excellence and social responsibility, aiming at generating economic sustainable growth and making positive contributions towards the construction of fairer and more inclusive and humane societies. Four research units from the university participate in the project: a) DeustoTech, the research institute of the Faculty of Engineering. It conducts applied and basic research for the development of novel ICTs applications. b) The Center of Applied Ethics (CAE) a multidisciplinary centre that seeks to analyse and foster individual and collective practices that promote social justice, peaceful coexistence, dignity, and the right of people to fully participate in the social, political and economic life of their communities. c) DeustoKabi, the Innovation and Entrepreneurship Unit. Its main objective is to support people throughout their lives, encouraging an entrepreneurial and innovative culture inside and outside the University. And d) is the Orkestra-Basque Institute Of Competitiveness that conducts transformative applied research oriented towards gaining knowledge about sustainable regional competitiveness, with a special focus on the Basque Country.

4ward Energy
Research GmbH

The research facility 4ward Energy Research GmbH was founded in 2010 and is a non-profit organisation in the sector of energy research, both at the national and international level. The fields of activity are manifold and cover amongst others the fields of renewable energy sources, energy efficiency, smart grids and microgrids, smart cities, energy storage technologies, simulations, etc. The staff was and is involved in numerous scientific R&D projects. The range of technical topics treated by 4ward Energy Research GmbH also translates to the specific task within projects, ranging from answering technical questions (simulations, modelling), creating economic solutions (business cases and models) to end-user involvement (workshops, co-creation processes) and dissemination and exploitation panning and activities.

E3-Modelling is a private capital company, established in Greece, as a knowledge-intensive consulting company spin-off inheriting staff, knowledge and software-modelling innovation of the laboratory E3MLab of the National Technical University of Athens (NTUA). The company specialises in the delivery of consulting services based on large-scale empirical modelling of the nexus economy-energy-environment. The experience goes back to 1990 and includes internationally renowned milestones, such as the models PRIMES and GEM-E3 and the support of major impact assessment studies and scenario building of the European Commission. The modelling and consulting services have also served numerous studies for European Governments, professional associations, and large-scale companies in the energy field. The consultation expertise of the group focuses on the design of transition in the energy market and systems, both in the demand and supply of energy, towards green and climate-friendly

structures and technologies. Thanks to the modelling, the group assesses the transitions from economic, policy and implementation perspectives putting emphasis on the functioning of the system and the markets as a whole when policy instruments influence behaviours and market outcomes.

TNO (Nederlandse Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek) is one of the major applied research and technology organisations in Europe. With a staff of approximately 3000 and an annual turnover of close to a billion Euros, TNO is carrying out applied R&D on, among others, healthy living, industrial innovation, traffic & transport, buildings & infrastructure, circular economy, energy technology, and safety & security. TNO is involved in many international programmes, including especially EU-funded collaborative projects. The Energy Transition Studies group of TNO employs about 80 researchers who cover a wide variety of academic disciplines. Energy Transition Studies focuses on the political, economic, and social aspects of energy technology implementation. It possesses a broad range of different modelling tools, mostly developed in-house. These include e.g. simulation, optimization, and management models. Its EU models cover electricity markets, renewables, power generation, and fossil fuels, and enable investigating a broad range of scenarios and policy instruments, among which GHG emissions trading.

Forschungszentrum Julich pursues cutting-edge interdisciplinary research on pressing issues facing society today. With its competence in materials science and simulation, and its expertise in physics, nanotechnology, and information technology, as well as in the biosciences and brain research, Julich is developing the basis for the key technologies of tomorrow. In this way, Forschungszentrum Julich helps to solve the grand challenges facing society in the fields of energy and the environment as well as information and the brain. The Institute for Energy and Climate Research – Techno-economic Systems Analysis (IEK-3) we are investigating how a sustainable energy system can be achieved and how it would look like. To this end, we develop diverse techno-economic models with which we take an integrated view of the global energy systems in order to identify possible solutions for energy system transformation. The main focus of the department is the development of energy system models for the analysis of the transformational processes taking place in the supply and use of energy in Germany and beyond, in accordance with the political framework.

GOIENER is a non-profit citizen cooperative dealing with 100% renewable electric energy commercialization. GOIENER is concerned with the generation and consumption of renewable energy, and with the objective of reclaiming energy sovereignty. Currently GOIENER counts with around 17.000 associates and manages more than 21.000 contracts. GOIENER wants citizens to regain control over the energy and to make them aware of its importance, thus promoting responsible and sustainable consumption. The way GOIENER wants to reclaim energy sovereignty for citizens is by entering the electricity sector, which has recently been liberalised. Our activities include marketing (buying) and generating energy, since transport and distribution are still regulated by the government. Despite that being his main activity, it is not limited to that field; research is being carried out continuously at GOIENER related to finding out investment options for the deployment of renewable energy solutions.

The Renewables Grid Initiative is a unique collaboration of NGOs and TSOs from across Europe. We promote transparent, environmentally sensitive grid development to enable the further steady growth of renewable energy and the energy transition. RGI Members (23 as of today) originate from a variety of European countries (12), consisting of TSOs from: Belgium (Elia), Croatia (HOPS), France (RTE), Germany (50Hertz, Amprion and TenneT), Ireland (EirGrid), Italy (Terna), the Netherlands (TenneT), Switzerland (Swissgrid), Norway (Statnett) and Spain (REE); and the following NGOs: BirdLife Europe, Climate Action Network-Europe (CAN), Friends of the Earth Ireland, Fundación Renovables, Germanwatch, Legambiente, the Royal Society for the Protection of Birds (RSPB), NABU, Natuur&Milieu, Transport & Environment, WWF International and ZERO. RGI was launched in July 2009.

Climate Alliance is the largest European city network dedicated to climate action. Through the Climate Alliance, some 1,700 member municipalities and districts covering 26 European countries as well as a variety of regional governments, NGOs and other organisations are actively working to combat climate change. The city network was founded in 1990 with the mission to elaborate and implement local climate protection measures especially in the fields of energy and mobility and to cooperate with indigenous people to protect the tropical rainforests. Climate Alliance members commit to reduce greenhouse gas emissions by 10% over 5 years and halving per capita emissions by 2030 (baseline 1990). Co-coordinating the Covenant of Mayors Office, Climate Alliance plays a key role in technical and administrative support for European local authorities carrying out methodological work, capacity building, guidelines, and monitoring. Outside Europe, the Climate Alliance European Secretariat is also active in helping to spread the successful examples and lessons learned via the Covenant of Mayors.

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