Renewables Grid Initiative

Paris Agreement Compatible Scenarios for Energy Infrastructure

Next steps and open questions

PAC Paris Agreement Compatible Scenarios for Energy Infrastructure

Background to the PAC project and the development of the PAC scenario

The transformation of the energy system has an impact on all areas of human life. In addition to personal energy consumption and mobility, natural resources, landscape, flora and fauna are also affected. Therefore, the goal of the PAC Project was to provide a platform for a deeper exchange of civil society and energy system experts from industry and academia to think about an energy system for the future and the consequences of choices and preferences. In doing so, it has brought the quality of cross-sectoral engagement for which the Renewables Grid Initiative stands to new heights. Thanks to intense debates and exchange amongst the broad NGO community and with experts from the energy sector and academia, all sides could gain many new insights and expand their knowledge.

One of the ambitions of the PAC Project was to deliver a storyline developed by a broad coalition of civil society organisations as a contribution to the discussion about a desirable future energy system. The PAC Project has overdelivered here: Climate Action Network (CAN) Europe and the European Environmental Bureau (EEB) together with their extensive member networks have delivered their views and visions via an entire quantified scenario. The scenario was developed through a series of workshops with representatives of various NGOs, building on expert input from science and the energy industry. Around 150 different stakeholders were involved in the scenario building process, be it through participation in these events or through bilateral exchanges.

Furthermore, a series of Modellers' Exchange workshops organised by the Renewables Grid Initiative, served as a platform for exchange among energy system modellers to discuss modeling challenges they face and possible solutions.

The exchange of views and positions have contributed to increasing knowledge among all participants, continuation of such exchanges is therefore desirable.

About this document

The development of the PAC Scenario is a massive achievement. At the same time, the PAC Scenario remains a living document. It is a first comprehensive climate and energy roadmap for European policymakers drafted by a broad range of civil society organisations. Yet, many questions still need to be answered through the PAC Scenario modelling. This document includes some open questions which we hope to address in the near future. The PAC Scenario is presented in its full merit in a dedicated document accessible here. We believe that it is important to continue the dialogue that has begun between civil society, energy industry, academia and politics and to jointly search for answers in order to develop a broad-based, climate-neutral energy system.

1) Issues to be discussed in the field of capacity building and knowledge exchange

- How can the process itself be further developed?

The PAC Scenario foresees a very ambitious and fast RES expansion, it includes an active role of consumers. We assume a strong political and societal support for such a scenario; this support can be further substantiated in the presence of a regular comprehensive and broad dialogue with citizens and interested stakeholders. Thus, large capacity building and exchange events between civil society with energy system experts, grid operators and academia should be continued and ideally increased, as they provide a solid ground for learning for all involved parties. Representatives of industry must be involved more systematically.

- Speed of RES deployment and penetration of energy saving measures?

It is highly important to carefully discuss the question of future renewable energy expansion and the development of future demand as these two factors are determinant for the future energy system. Speedy deployment of both RES infrastructure and efficiency measures requires societal and political support. Changes from a social, regulatory and/or market perspective are also needed. A broad exchange is necessary to explore what is plausible and achievable under which conditions and timeframes, and which steps must be taken in order to develop favourable conditions.

2) Political and technical issues to be discussed

- Distribution of RES installations and Power-to-X plants

In a system which is based 100% on RES generation, the distribution of RES installations and flexibility assets should be optimised to reduce losses and maximise resources. Currently, optimisation of resources is largely left to market forces. In the future we will need to incentivise optimisation and plan the system accordingly and in an integrated manner, taking into account the locations of grids, large storage facilities, RES and consumption centers. Policy, regulations and markets will need to play a driving role in the optimisation process.

- Influence of decentralised resources on the network expansion

Decentralised generation, consumption and balancing and the resulting energy flows on the distribution level can only be represented in EU-wide models to a very limited extent (see also 'open questions of modelling'). The optimisation of supply, demand and flexibility at the distribution level will have an impact on the transmission level. It is therefore important, in future work to better understand how to optimise the use of existing infrastructure and reflect this in the planning/investment efforts.
Similarly, it is important to understand how producers and consumers, at all voltage levels, can help to increase the utilisation rate of the existing infrastructure, to reduce transformation costs and thus contribute to general social welfare.

- Transformation paths

The safe and efficient transformation from fossil to the renewable systems must be planned and taken into account in infrastructure planning; this will include considerations related to

the potential use of transition technologies that may be needed to speed up the transformation but that should be carefully assessed not to create new lock-ins.

- Energy imports within the EU

First model runs of the PAC scenario show that in countries with low RES potential and/or high energy demand, import dependency increases strongly. Technical and political solutions must be found for these countries to ensure that sufficient cross-border grid capacities are available and that security of supply of all countries is guaranteed at any time, even during extreme weather phases.

- Energy imports from outside the EU

It is an open question whether the EU should make targeted efforts to help neighbouring countries decarbonise their energy supply by including them in the European trade of renewable energy. We must gain a better understanding of the circumstances under which imports could lead to faster and cheaper implementation of climate protection goals both in the exporting country and in the EU. The aspired future role of energy imports in geopolitics and peace policy needs to be determined. In case of future energy imports, the question of how to guarantee that imported fuels and imported electricity actually meet all sustainability criteria must be addressed and will require the development of standardised robust methodologies.

3) Open questions in modelling of grid infrastructure

Grid infrastructure planning is a complex and time-consuming effort. In the course of the last years, major new innovative approaches have been developed and energy models have become better able to represent the complexity of the energy system. However, it remains difficult to model the many and very complex ongoing changes. Ongoing innovation and increasing computing capabilities will allow new layers of complexity to be represented in models. We commissioned the Öko-Institut to make an initial model run of the PAC Scenario. Below we describe some of the features that could not be included in the PAC model run due to lack of resources or due to lack of tools. We hope to address most of these issues in the near future.

- Mapping heat demand

When modelling the PAC data, the heat demand could, so far, not be included. The heat sector has a great potential for flexibility, as heat can be stored relatively easily and cheaply. In future work it will be important to model how an optimised use of heat can contribute to the overall decarbonisation process.

- Targeted use of flexibility

Currently it is very complex to represent the entire flexibility potential in existing models. In the future, new capabilities will need to be developed to model and understand the full potential contribution of the targeted use of flexibility services as these may have considerable impacts on electricity prices, the available "surplus" of electricity generated by RES, and the technical and economic potential for electrolysis applications. Moreover, flexibility options have different specific costs, each requiring different levels of full load

hours to enable profitable operation. Models, in the near future, will need to be able to deal with different options which influence the operating behaviour of flexibility assets.

- Digitalisation and how to build multi-use cases for flexibility? (Self-optimisation, power market, system services, flexibility for energy traders...)

One of the changes that digitalisation brings with it is that even the smallest transactions become feasible. It is well known from stock exchange trading that remarkable profits can be achieved by a large number of very small transactions. Therefore, it seems likely that flexibility options will be controlled by digital optimisation algorithms that aim at optimising between different markets and applications. Here, too, procedures must be developed that allow us to map this optimisation in the model and to draw conclusions on whether the potential large numbers of small transactions impact important system indicators such as social welfare.

- Representation of the distribution network level in the model

For an efficient planning of high-voltage networks, new approaches must be found to map distribution networks. Indeed, in the future, the majority of generation, flexibility resources and demand will be connected at the distribution grid level. The complete simulation of the transport and distribution network exceed the computing power available today, thus requiring some sort of simplification. Networks with similar behaviour could be mapped together and then adapted to the local conditions at the respective network node.

- Interconnector capacities

In the model run done by Öko-Institut, the interconnection capacities for the year 2040 from TYNDP 2018 were imposed as constraints. This led to a reduction of curtailment of RES plants, of necessary back-up capacities and also to a reduction of electricity prices. The importance of the expansion of cross-border capacities was thus confirmed. However, the domestic transport capacity was not taken into account. It is to be expected that there is also a need for additional expansion here.

- Geographic distribution of Power-to-X and system impact

Modelling done by Öko-Institut has shown that a large RES potential leads to a large Power-to-X potential. Power-to-X allows optimal use of RES resources and contributes to cover most of the national energy demand of different sectors. In countries where the RES potential is not sufficient to cover the entire electricity demand, back-up power plants need to run for several thousand hours per year to meet full demand. In future modelling work, it will be important to verify how different geographic distribution of RES generation, of Power-to-X plants and other flexibility options can contribute to the better use of the overall resources.

- Electrolysis limitations in modelling

Due to limited financial resources of the project, Öko-Institut could model electrolysis plants only with a must-run base. This implies that, in the model, Power-to-X capacities were partially kept running even at times when surplus RES generation was not available. The model therefore increased fossil electricity production, which is not in line with the objectives of the PAC Scenario. In future modelling work, it will be necessary to ensure that electrolysis plants only run with surplus RES-based electricity. This will provide a more

accurate understanding on the economic implications and related consideration about the potential need for additional RES capacities and/or imports.

Conclusion

The future European energy system has to be planned with multiple objectives and concerns in mind. This includes technical feasibility, affordability, nature protection, cautious use of scarce resources such as land, biofuels and rare metals, and the recognition of societal wishes and political objectives.

The PAC project has achieved far more than originally planned: a storyline was to be delivered, but instead a whole scenario has emerged. Coordinated by the Renewables Grid Initiative and building on its 10 years of experience, the project has also shown once more that a constructive exchange between energy infrastructure planners and representatives of NGOs is possible and leads to new insights.

Many questions raised during the exchange and by the PAC Scenario remain open. A changing system will present new challenges and new opportunities; both require extensive public debate and scientific investigations.

RGI will seek ways to continue the fruitful collaboration with CAN Europe and the European Environmental Bureau and their extensive networks while aiming to continuously enlarge the exchange by bringing in additional actors from the relevant sectors across Europe. We hope that this work can be continued and that the interested citizens of all European countries can be involved in and support the design of the future energy supply system.

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For more information about the PAC project, see https://www.pac-scenarios.eu.

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