Renewables Grid Initiative

ENABLING A RENEWABLES-BASED ELECTRICITY SYSTEM

Joint conclusions from RGI's "Future scenario exchange" workshops

A mixed group of transmission system operators (TSOs) and NGOs have identified the following issues which must be addressed if the electricity systems of Europe are to successfully and sustainably be based on renewables.

These issues represent the main conclusions of RGI's "Future scenario exchange" workshop series. In these workshops, a mixed group of stakeholders examined a number of future energy scenario and modelling studies for the countries of Europe. Participants assessed the studies assumptions and their conclusions, with a special focus on understanding what will be required to enable a future system which is based on renewables. From this process, a necessary direction was concluded. We hope this gives confidence and inspiration to policymakers, industry and consumers.

RGI believes in building broad coalitions by fostering dialogue. This is a working document. If your organisation wishes to support these messages, please contact RGI.

For more information on RGI's "Future scenario exchange" workshop series, including a full list of the studies examined, please visit us at:
https://renewables-grid.eu/future-scenarios

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The Renewables Grid Initiative is a unique collaboration of environmental NGOs and Transmission System Operators from across Europe. We promote transparent, environmentally sensitive grid development to enable the further steady growth of renewable energy and the energy transition.

More information:
www.renewables-grid.eu

The need for grids in a system based on renewables

New transmission lines are needed, even in a future where many of us become “prosumers”

In a future where we produce and consume more of our own electricity (becoming “prosumers”), the need for transmission grid development remains. This is because urban areas where most people live do not have enough space to produce all their electricity at all times. Therefore, different regions with different renewable resources (both urban and rural areas) need to complement each other by using the grid. Optimising the existing grid, improving energy efficiency, reducing demand at busy periods and electricity storage can all help in reducing the total need for new grids, but not eliminate it entirely.

- It is sometimes assumed that the increased localisation of generation and consumption by citizens (coupled with home batteries and electrical vehicles) will lead to significantly fewer grids being needed.
- After looking at the studies, we found that the scenarios which represent a larger uptake in prosumer behaviour do not significantly reduce the need for grids.
- This is because most large industrial areas and large cities do not have sufficient space to generate all the energy they need, and thus need to import the energy from more remote areas. Also, regions still need to be supported by their neighbours in times of little wind and sun.
- Although seen as an important tool, optimisation, reducing demand by improved energy efficiency measures, temporal reduction through demand side management and (short-term) storage will not be sufficient to correct the imbalance.

Technologies to optimise and upgrade the existing grid need to be encouraged and incentivised where appropriate

By optimising and upgrading the existing high voltage grid and operating the system in a smarter way, it is possible to use existing capacity better, whilst reducing the need for some new grids. New technologies which will make this possible are already being developed. Further research and development, as well as an open discussion on the pros and cons of these technologies, is necessary. We then need to find effective ways to properly incentivise the required investments.

- It is possible to improve the capacity of the existing grid by optimising and upgrading the infrastructure. This holds true for scenarios with conventional power mixes, with large centralised renewables (large wind farms) or with high shares of distributed renewables. This is also applicable for the medium and low voltage grids.
- Currently, several options for grid optimisation and upgrade are being considered. Examples include:
  - Innovative power line materials
  - Wider deployment of power electronics (e.g. STATCOMs[1])
  - Allowing higher thermal/noise limits
  - Automated N-1 criteria[2] compliance

1 STATCOMs (Static Synchronous Compensators) are regulating devices used to help keep AC grids stable

2 The N-1 criteria is a system security standard where enough grid capacity must remain to accommodate all the electricity if part of the network is down.

- Some of the studies envisage that these technologies can become especially important once we have reached very high shares of renewables in the system.

- Additional research and development is necessary today to develop the system-supporting, cost effective solutions for the longer term. This will assist in increasing the share of renewables without putting the security of the electricity system at risk.

- It is important that policymakers find ways to properly incentivise innovative approaches, rather than narrowly focussing on the conventional "copper and steel" infrastructure. Many techniques will also require changes to legislation (e.g. allowable noise thresholds). In such cases, an open discussion on the pros and cons of such technologies needs to be had.

Europe needs to become better connected to enable a higher share of renewables

Some regions are more suitable for particular kinds of renewable energy generation than others. Weather conditions also vary across Europe at any one time. This means that, in a future with more electricity from renewables, more transmission lines will need to be built between regions to take advantage of these variations on a large scale. More interconnection also allows those involved in the electricity market to buy renewably generated electricity from a larger area at competitive prices.

- Many of the studies showed the importance of regional and cross border flows in enabling high renewable scenarios. Most of these scenarios assume a certain amount of available capacity from neighbouring countries to support periods of low generation from renewables in the main study area.

- As wind patterns across Europe are often complementary, the need for conventional back-up capacity or storage (e.g. large batteries) can be reduced if the continent is properly connected.

- Hydropower in the north and other elements such as flexible demand can be used by systems across borders to provide more flexibility.

- More cross border interconnection capacity is therefore needed, as well as improving the efficiency of those interconnectors already built.

- In order to optimise the use of resources and to avoid conflicting reliance on the same generation source, more work needs to be done to understand the ability of countries to support each other regionally.

The expected costs of an electricity system based on renewables are similar to, or even lower than, those with slower renewables growth

Although the investment costs for an electricity system based on renewables are likely to be large, the costs involved are broadly similar to, or even lower than, those which represent a future system with slower renewables growth and with more reliance on thermal generation (e.g. gas and nuclear power). This is especially true when total costs to society are considered. The continued decrease in the prices for renewable technologies (especially offshore wind) will likely make the future costs of a renewables-based system even more favourable for society.

- Although total investment costs for a system high in renewables are large, there is a broad consensus across the studies that the costs involved are comparable to other less ambitious scenarios.
- This is partly because by building the necessary renewables enabling grid, we can avoid the substantial costs caused by inefficiencies in the electricity system later on (relying too heavily on battery storage etc.).
- The term "costs" can mean several different things and was addressed by the studies in different ways: In terms of total investment costs (both generation and transmission), future electricity prices, forecast re-dispatch costs if grid congestion persists, or consolidated in a measure of total "net welfare" to society.
- Further work should be done to understand the costs that will be incurred by different approaches to the energy transition. This should include work to properly understand the costs to society of not building the grid infrastructure that is needed.

To further enable renewables and the electrification of other sectors, joint planning and better coordination is needed between TSOs and DSOs

As citizens and businesses become more active on the system (by installing solar panels, owning an electric car or smart appliances etc.), the job of managing the local distribution grid becomes more complex. In this future, poorly aligned planning and communication between distribution system operators (DSOs) and transmission system operators (TSOs) can potentially lead to inefficiencies and missed opportunities. Through improved joint planning and co-ordinated action, TSOs and DSOs can find new ways to harness newly electrified sectors to provide the flexibility a high renewables system would need.

- In many of the high renewables scenarios looked at, the electrification of certain sectors (especially transport and heating) is assumed to gather pace.
- As these units are almost entirely connected to the distribution grid, it is important to gain a proper understanding of how these newly electrified sectors could behave, their impact on the local distribution system and how this interacts with the transmission system.
- Joint modelling and planning activities between distribution system operators (DSOs) and transmission system operators (TSOs) should be enhanced in order to better understand the potential impact and opportunities arising from a system in which the electricity, transport and heat sectors are much more interconnected than today.

We must invest in pilot projects that aim to develop affordable, sustainable, long-term energy storage

In a future with a very high share of electricity coming from renewables, it is likely that energy will need to be partly stored at large scale for longer periods of time. This "long-term" storage would store energy for weeks or months and would be especially important in long periods where there is little sun and wind. It is therefore important to invest in a range of pilot projects and encourage emerging technologies now, so that a number of potential sustainable technologies are available for large-scale use by the time this may be needed.

- Many studies showed that when you reach a very high penetration of renewables in the system and do not wish to rely on thermal power-plants as back-up capacity, long-term storage is required to secure supply. This need becomes more pressing the faster thermal units (e.g. coal and nuclear plants) are removed from the system.
- This need for long term storage was shown to vary depending on the geographical region, with some countries requiring such solutions sooner than others.
- Although this was generally considered a medium/long term issue, there is a need for proper financial and regulatory framework to incentivise the development of a range of pilots and develop sustainable technology options for a future where long-term storage capacity will be needed.

We need to be realistic, flexible and ambitious when defining future scenarios

To understand what type of grid we will need for a high renewables future, we must design ambitious forward-thinking scenarios. This being said, no future scenario is able to represent what the future will be. This means that the conclusions are uncertain and need to be understood as a broad guide based on a range of possible futures. By involving groups from differing backgrounds in the design of future scenarios, and by continually improving the models themselves, we can better understand what possible futures there are and what is required to significantly increase the share of renewables.

- As we do not know what the future will be, it is important to consider a range of scenarios within which the actual future may fall.
- Study authors should make the character of future scenarios as a "what-if analysis" more prominent.
- It is important that in this uncertain scenario context, governments and TSOs are able to derive short-term "no regret measures" to take action on now. This helps to ensure that their long-term ability to capitalise on future options and to decarbonise in line with the Paris Agreement is not inadvertently undermined.
- Additionally, the involvement of different stakeholders in the scenario design process should be enhanced. Overcoming the knowledge gap that exists between modellers and stakeholders who have expertise in different sectors (such as climate science, specific technologies etc.) is vital to increase the credibility of a study.

Renewables Grid Initiative

In order to minimise any negative impacts on people and nature, we need to take a more holistic approach to the planning of generation and transmission

To power Europe mainly by renewables, a lot more wind turbines and solar panels will be needed, along with grid development. All this new infrastructure will take up space and could have a negative impact on people and nature if not planned well. In order to minimise impacts, we need to take a more holistic approach to the planning of generation and transmission in tandem. This includes understanding what different scenarios mean for the location of renewables and the grid, and how we could minimise the impact of both upon people, sensitive habitats and species.

- If we are to sustainably power Europe mainly by renewables, the environment must be safeguarded and people must have the right to question developments and provide input at an early stage.
- The results from many of the studies showed that where renewables are sited has a major impact on which and how many new transmission lines are needed.
- Finding ways to measure and compare the potential environmental and social impacts of certain energy scenarios at an earlier "strategic" stage should be enhanced. This could include: improving mapping tools and ecological data sets, creation of new performance indicators for projects and generally improving our understanding of the societal and personal motivations for opposing projects.
- With such tools, our ability to understand the potential social and environmental impacts of certain scenarios and to holistically plan our energy system to mitigate such impacts would be enhanced.

To limit climate change, we must take immediate action to prepare the grid for an electricity system based on renewables

The majority of society wishes to avoid damaging climate change. Meeting our CO2 reduction targets will depend largely on how quickly we decarbonise the energy system. This means not just the electricity we use now in our homes, but our transport and heating sectors also. Understanding what grid we need is an important outcome of the scenario building and modelling process. We therefore call on governments, industry, and citizens to be proactive in helping to define what the future electricity system could look like, to find compromises, and to take the immediate action that is necessary.

- The results from many of the studies show that the window for action is short. Renewables are becoming cheaper, deployment of variable generation is growing, coal and nuclear phase out deadlines are approaching. The grid must cope with these significant changes.
- The specific actions which are needed to enable high renewable scenarios vary by study and the national and regional contexts. But the need for grids, the need for appropriate incentives and the need to have an inclusive discussion on what system we as a society desire were common themes.
- Proactive involvement by all stakeholders in the strategic planning that is undertaken by TSOs and the involvement of non-traditional civil society groups in the grid planning process is vital for increasing ambition and improving legitimacy.
- The involvement of experts from different sectors will also be important to fully understand certain new technologies (e.g. with regards to the electrification of heating and transport)
- Joint positions must then be communicated effectively to policy makers and regulators, who are instrumental in providing the correct incentives.

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