

SYSTEM RESILIENCY AND FLEXIBILITY

EXECUTIVE SUMMARY



An event organized under the auspices of the
**Experts' Group on R&D Priority Setting and Evaluation
(EGRD)**

13 – 14 May 2019

Vienna, Austria

Hosted by the Austrian Ministry for Transport, Innovation and Technology

Venue Day 1: Technologiezentrum Seestadt, Seestadtstraße 27, 1220 Wien

Venue Day 2: Austrian Ministry for Transport, Innovation and Technology (BMVIT), Room EA08,
Radetzkystraße 2, 1030 Wien

Executive Summary

Introduction

On 13 and 14 May 2019 delegates to the IEA Experts' Group on R&D Priority Setting (EGRD) organized a meeting to gain further knowledge of the research and innovation needs associated to system resiliency and flexibility. International technology experts from academia, research entities and leading agencies offered a wide range of perspectives and insights. The event was hosted by the Federal Ministry for Transport, Innovation and Technology, Vienna, Austria.

Rationale and Background

In the *World Energy Outlook 2018*, primary energy consumption is expected to increase by 27% by 2040. In 2017, energy-related CO₂ emissions rose by 1.6 % for the first time in three years. These forecasts point to a further increase by 2040 (+10 % compared to 2017).

Complementarily the Intergovernmental Panel on Climate Change (IPCC) special report *Global Warming of 1.5°C* states that CO₂ emissions have to decline by about 45 % by 2030 (from 2010 levels) in order to reach net zero emissions by 2050.

This leads to one of the questions that are currently of utmost importance: How do we design energy systems, to reach climate and energy objectives globally? An intelligent linking of generation, distribution and consumption is required. Connecting different parts and sectors of the energy system will play a crucial role. Sector coupling is considered as a guiding principle. Furthermore, also energy storage and 'power-to-x' technologies will play a key role.

At present the main options for balancing supply and demand in the electricity system beside (fossil) power plants are transmission grids between countries/regions, energy storage, demand side management, power to-x technologies and curtailment of RES.

The integration of variable RES requires flexibility in order to be able to compensate for possible imbalances between supply and demand in the future energy system. The high share of renewable energy sources in electrical power and district heating grids will force the transition from a purely demand-oriented energy production to a production-oriented demand.

The use of the storage capacity in electric vehicles will depend on attractive business models for car owners. The potential for energy flexibility in buildings is determined by a number of factors such as heat storage capacity of building components, quantities and sizes of thermal storage or the type of electrical devices like heat pumps.

Issues Addressed

- What will the future energy system look like? What are the key challenges and main risks for energy systems with a high share of variable energy sources?
- New technologies and new business models: where are we heading?
- Best practice examples: Which lessons have we learned so far?
- What are the resilient transformation paths for the future?
- Which are the main factors to be considered regarding R&D policies and decision making?

Flexibility: a key to reach the worldwide goals in CO₂-reduction

Nowadays a lot of small decentralized volatile power plants are producing renewable energy. In the future the share of renewable energy is growing constantly. A 100 % renewable energy system needs flexibility to deal with the huge amount of volatile power in the system. Flexibility can be defined as the ability of the power system to respond to variability and uncertainty with an adequate production.

Measures to reach flexibility

Innovative market models and measures like sector coupling, demand side management, energy storage, investments in grid infrastructure, digital solutions and cross-border harmonisation are essential to reach flexibility.

Risk assessment the way to a resilient energy system

In the last 10 years the risk assessment of natural gas supply has greatly evolved. The focus should particularly be on extreme events because they have an immediate impact on the energy system. Also cyber attacks will increase in the future and energy system cannot be protected by the traditional methods. Therefore an integrated, holistic resilience planning is the key to reduce the impact and recover the system quickly. Tools, analysis, technical assistance and research are available and should be implemented.

Recommendations
<ul style="list-style-type: none">• Flexibility is the key to the integration of renewable energy and decarbonisation and must be considered along the energy value chain.• Building sector: Flexibility helps to stabilize the energy grid and depends on the building, the users and the conditions in the grids.• Flexibility allows the power system to manage changes.• Sector coupling: Fluctuations on the power supply side require a stronger link to other energy sectors, especially mobility and heat.• More research is needed: Living labs and large-scale demonstration projects are needed.• Lessons learned: The experiences that are currently made in other parts of the world such as Austria, Italy and the Nordic countries provide valuable insights how to gain more flexibility.• Need for common definition and understanding of resiliency. This particularly includes resiliency in the light of extreme events, being accidentally or intentionally, having an immediate impact on the energy system• An integrated, holistic resilience planning is the key. Tools, analysis, technical assistance and research are available but there is no model to implement it.• Modern energy systems are complex cyber-physical systems that are vulnerable to targeted attacks and dynamic failures and cannot be protected by the traditional methods.• We need to reaffirm that the resilience of the energy system affects not only the energy system but the whole society.

All presentations are available on the [workshop webpage](#).