Energy [R]evolution: a Sustainable Belarus Energy Outlook

Extended summary of preliminary results

This document summarises preliminary results of the draft version of report "Energy [R]evolution: a Sustainable Belarus Energy Outlook" as of 9.11.2017. Final version of the report will be published in early 2018.

Modelling of the Reference and Energy [R]evolution scenarios for Belarus was carried by the German Aerospace Center (DLR), Department of Systems Analysis and Technology Assessment at the Institute of Engineering Thermodynamics with the support of the Heinrich Boell Foundation.

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Scenario approach

Scenarios are a necessary tool to describe possible development paths, to give decision-makers a broad overview and indicate how far they can shape the future energy system. In order to evaluate the boundaries of the future energy system, two scenarios were developed to show a wide range of possible pathways for a future energy supply system:

- a **Reference scenario**, reflecting a continuation of current trends and policies and
- the **Energy [R]evolution** scenario, designed to achieve a set of environmental policy targets resulting in an optimistic but still feasible pathway towards a widely decarbonized energy system until 2050 in close relation to basic framework assumptions of the Reference scenario.

In general, the Energy [R]evolution scenario by no means claims to predict the future; **it simply describes and compares potential development pathways out of the broad range of possible 'futures**'. The concept of all Energy [R]evolution scenarios is designed to indicate the efforts and actions required to achieve their ambitious objectives and to illustrate the options we have at hand to change our energy supply system into one that is more sustainable. The scenarios may serve as a consistent basis for further analyses of possible ways and concepts to implement pathways to an energy transition.

Methodology of modelling follows the approach outlined in the Global Energy [R]evolution scenario[1]. Input data and preliminary results were extensively discussed with local experts and civil society organizations in Belarus.

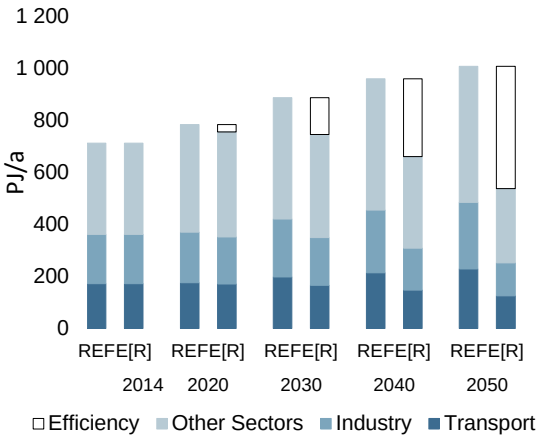
[1] Teske, S., S. Sawyer, O. Schäfer, T. Pregger, S. Simon, et al. (2015). Energy [R]evolution - A sustainable world energy outlook 2015. S. Teske, S. Sawyer and O. Schäfer, Greenpeace International.

Key results

Final energy demand by sector

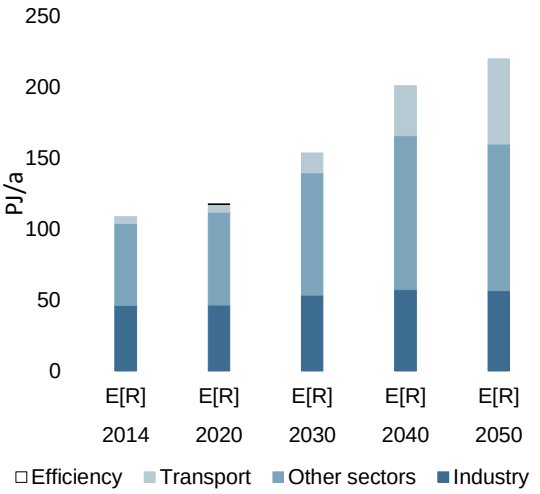
Combining the projections on population development, GDP growth, and energy intensity results in future development pathways for Belarus's final energy demand. These are shown in Figure for the Reference and Energy [R]evolution scenario. Under the Reference scenario, total final energy demand increases by 42% from the current 710 PJ/a to 1010 PJ/a in 2050. **In the Energy [R]evolution scenario, final energy demand decreases by 24% compared to current consumption and is expected to reach 540 PJ/a by 2050.**

Figure 1. Projection of total final energy demand by sector – scenarios REF and E[R] (without non-energy use and heat from CHP autoproducers)



Under the Energy [R]evolution scenario, due to economic growth, increasing living standards and electrification of the transport and heat sectors, overall electricity demand is expected to increase despite efficiency gains in all sectors (see Figure 2). Total electricity demand will rise from about 30 TWh/a to 61 TWh/a by 2050 in the Energy [R]evolution scenario. **Compared to the Reference scenario, efficiency measures in the industry, residential and service sectors avoid the generation of about 20 TWh/a.**

Figure 2. Development of electricity demand by sector in the E[R] scenario



This reduction can be achieved in particular by introducing highly efficient electronic devices using the best available technology in all demand sectors. Electricity will become the major renewable 'primary' energy, not only for direct use for various purposes but also for the generation of synthetic fuels for fossil fuels substitution. Around 20 TWh are used in 2050 for electric vehicles and rail transport in 2050 in the E[R] scenario.

Efficiency gains in the heating sector are even larger than in the electricity sector. Under the Energy [R]evolution scenario, consumption equivalent to about 300 PJ/a is avoided through efficiency gains by 2050 compared to the Reference scenario. As a result of energy-related renovation of the existing stock of residential buildings, the introduction of low energy standards and 'passive climatisation' for new buildings, as well as highly efficient air conditioning systems, enjoyment of the same comfort and energy services will be accompanied by much lower future energy demand.

Figure 3. Development of heat demand by sector in the E[R] scenario

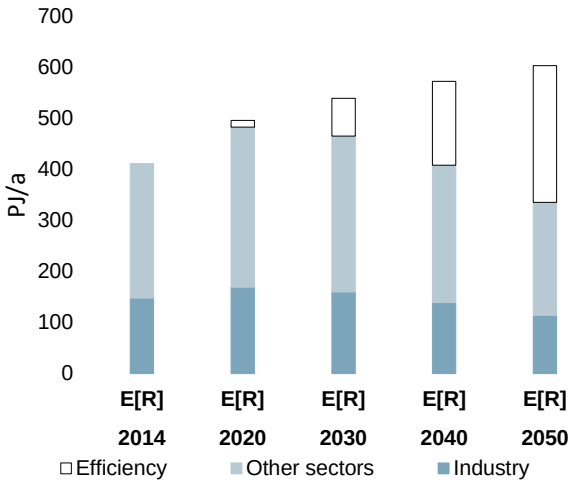
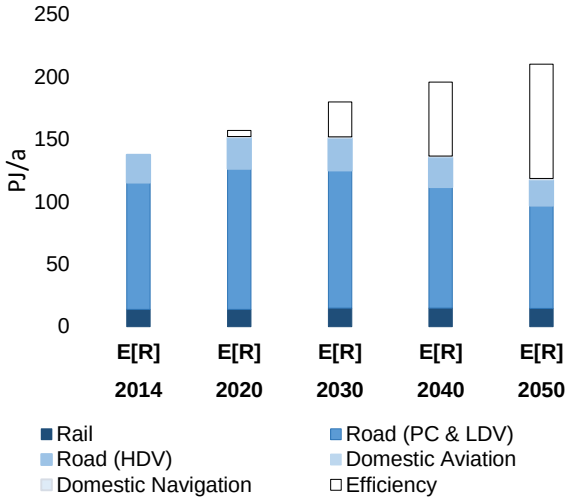


Figure 4. Development of the final energy demand for transport by sector in the E[R] scenario

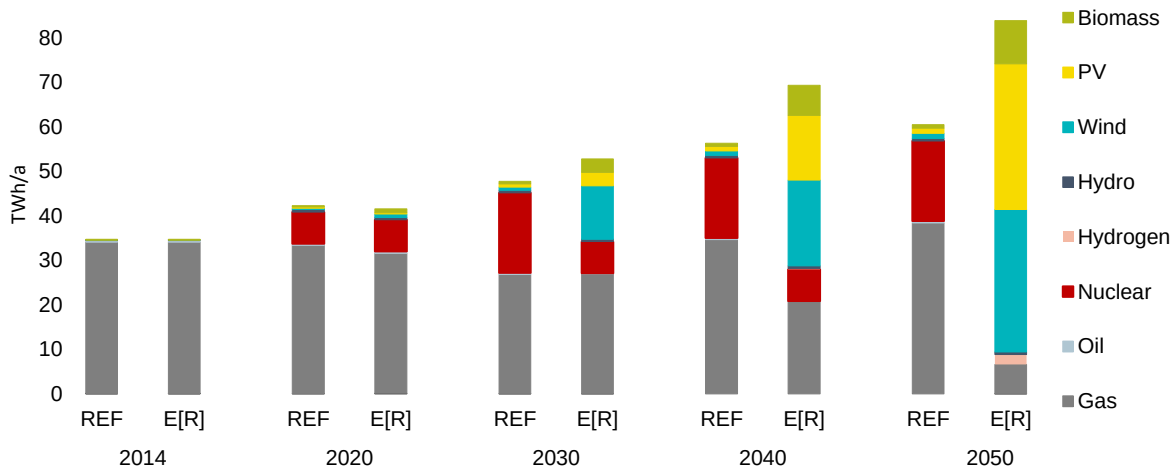


Electricity generation

The development of the electricity supply sector is characterised by a dynamically growing wind and PV market and a strongly increasing share of renewable electricity. This trend will more than compensate for the limited development out of nuclear power in the Energy [R]evolution scenario. Additionally, the number of fossil fuel-fired power plants will continuously decrease as well. **By 2050, 92% of the electricity produced in Belarus will come from renewable energy sources in the Energy [R]evolution scenario**. Already by 2030, the share of renewable electricity production will be 35%. The installed capacity of renewables will reach about 10 GW in 2030 and 50 GW by 2050 (see Figure 5).

Up to 2020 wind and PV will become the main contributors to the growing market share, backed up by increasing installations of biomass from 2030 on. The Energy [R]evolution scenarios will lead to a high share of fluctuating power generation sources (PV & wind) of already 29% by 2030 and 77% of total generation by 2050. Therefore, smart grids, demand side management (DSM), energy storage capacities and other options need to be expanded in order to increase the flexibility of the power system for grid integration, load balancing and a secure supply of electricity.

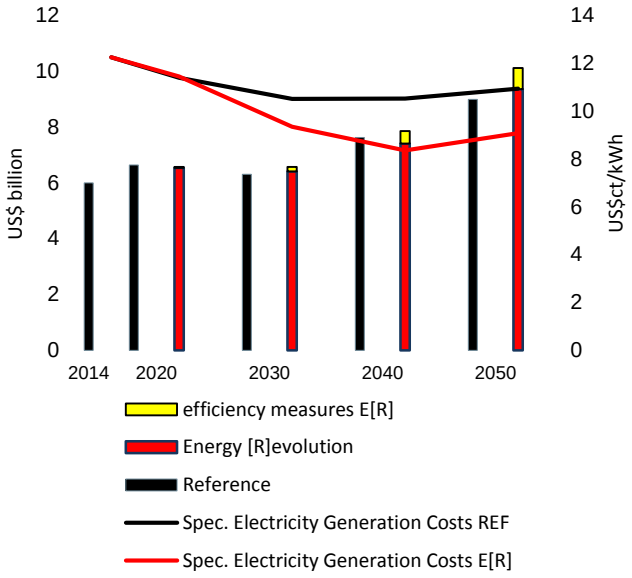
Figure 5. Development of the final energy demand for transport by sector in the E[R] scenario



Future costs of electricity generation

Figure 6 shows that the introduction of renewable technologies under the Energy [R]evolution scenario increases the future costs of electricity generation compared to the Reference scenario slightly in the beginning. This difference in full cost of generation will be around 0.1 US$ct/kWh, without taking into account integration costs for storage or other load-balancing measures. Because of increasing prices for conventional fuels and cost reduction in fluctuating renewables, electricity generation costs will become economically favourable just after 2020 under the Energy [R]evolution scenario. By 2050, the cost will be 1.9 US$ct/kWh below those in the Reference case.

Figure 6. Development of total electricity supply costs & of specific electricity generation costs in the scenarios



Under the Reference scenario, on the other hand, growth in demand and increasing fossil fuel prices result in total electricity supply costs rising from today's US$ 6 billion per year to more than US$ 9 billion in 2050. Increasing energy efficiency and shifting energy supply to renewables lead to long term costs for electricity supply that are only 4% higher in the Energy [R]evolution scenario than in the Reference scenario despite a 39% increase in electricity production.

Around US$ 80 billion is required in investment for the Energy [R]evolution scenario to become a reality (including investments for replacement after the economic lifetime of the plants) - approximately US$ 2 billion per year, US$ 50 billion more than in the Reference scenario (US$ 30 billion).

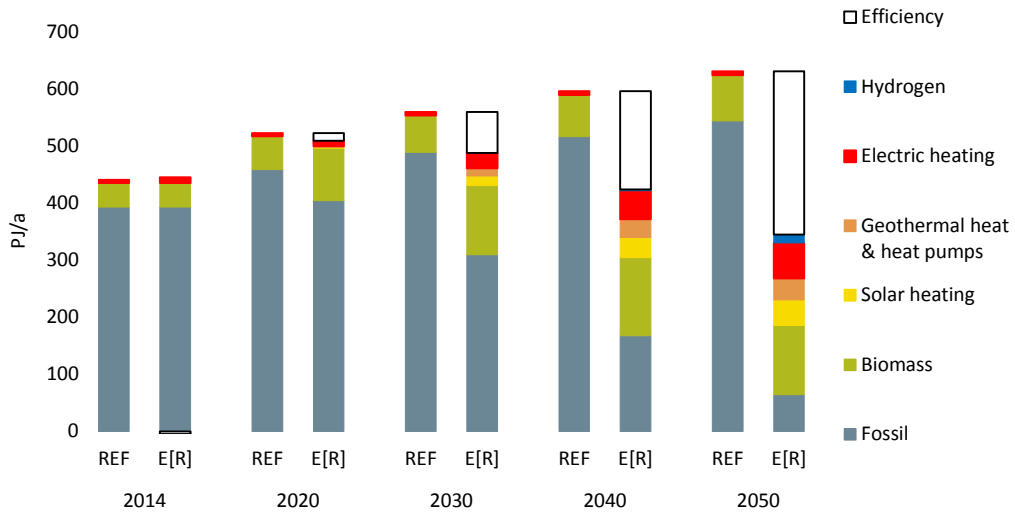
Under the Reference scenario, the levels of investment in conventional power plants add up to almost 58% while approximately 42% would be invested in renewable energies and cogeneration until 2050. Under the Energy [R]evolution scenario, however, Belarus would shift almost 95% of the entire investment towards renewables and cogeneration, respectively.

Because renewable energy has no fuel costs, the fuel cost savings in the Energy [R]evolution scenario reach a total of US$ 60 billion up to 2050, US$ 1540 million per year. The total fuel cost savings, therefore, would cover 120% of the total additional investments compared to the Reference scenario.

Energy supply for heating

Today, renewables meet around 10% of Belarus's energy demand for heating, the main contribution coming from the use of biomass. Dedicated support instruments are required to ensure a dynamic development in particular for renewable technologies for buildings and renewable process heat production. For Belarus, this especially includes support to integrate solar and geothermal heat into district heat grids. In the Energy [R]evolution scenario, renewables already provide 33% of Belarus's total heat demand in 2030 and 80% in 2050. **Energy efficiency measures help to reduce the currently growing energy demand for heating by 45 % in 2050** (relative to the Reference scenario), in spite of improving living standards and economic growth.

Figure 7. Projection of heat supply by energy carrier (REF, E[R])



Up to 2030 biomass remains the main contributor of the growing market share. After 2030, the continuing growth of solar collectors and a growing share of (shallow) geothermal and environmental heat, as well as heat from renewable hydrogen, will further reduce the dependence on fossil fuels.

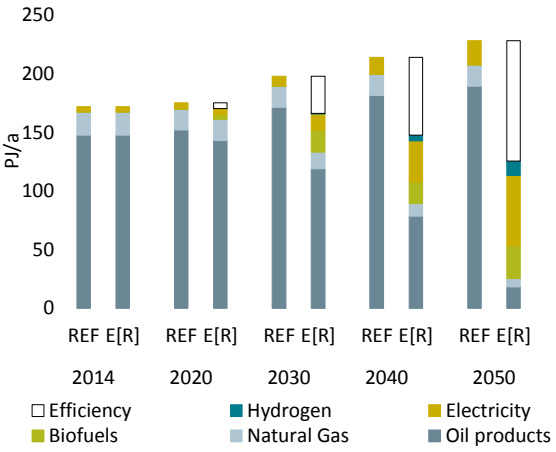
Also in the heating sector, the Energy [R]evolution scenario would require a major revision of current investment strategies in heating technologies. In particular, solar thermal, geothermal and heat pump technologies need an enormous increase in installations if these potentials are to be tapped for the heating sector.

Renewable heating technologies are extremely variable, from low-tech biomass stoves and unglazed solar collectors to very sophisticated enhanced geothermal and solar systems. Thus, it can only be roughly estimated that the Energy [R]evolution scenario in total requires around US$ 30 billion to be invested in renewable heating technologies up to 2050 (including investments for replacement after the economic lifetime of the plants) - approximately US$ 1 billion per year.

Transport

A key target in Belarus is to introduce incentives for people to drive smaller cars and buy new, more efficient vehicle concepts. In addition, it is vital to shift transport use to efficient modes like rail, light rail, and buses, especially in the expanding metropolitan areas. Along with rising prices for fossil fuels, these changes reduce the further growth in car sales projected under the Reference scenario. Due to population increase, GDP growth and higher living standards, energy demand from the transport sector is expected to only slightly increase in the Reference scenario by around 33% to 230 PJ/a in 2050. **In the Energy [R]evolution scenario, efficiency measures and modal shifts will save 45% (100 PJ/a) in 2050 compared to the Reference scenario**.

Figure 8. Final energy consumption in transport under the scenarios REF and E[R]

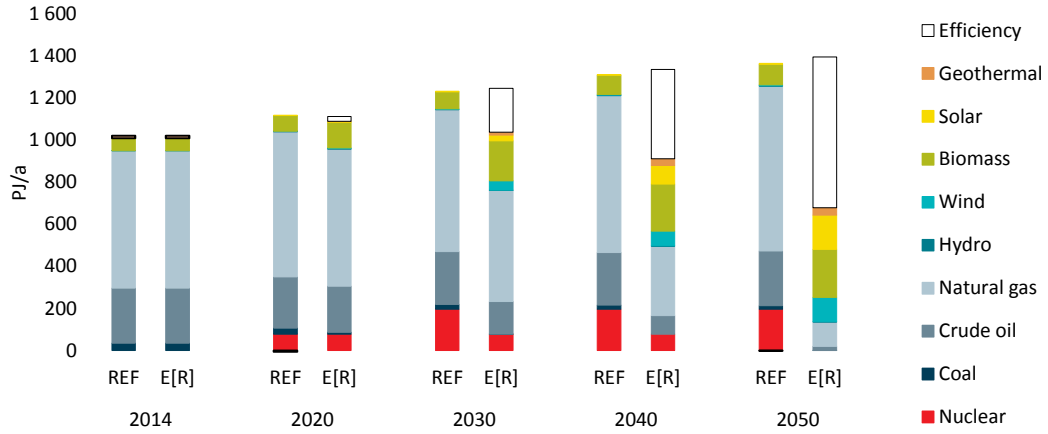


By 2030, electricity will provide 8% of the transport sector's total energy demand in the Energy [R]evolution, while in 2050 the share will be 48%. Biofuels will additionally help to reduce GHG emissions, if produced under sustainability criteria, e.g. as regulated in the EU. Hydrogen generated from renewable electricity is a complementary option to further increase the renewable share in the transport sector after very high shares of renewable power are available.

Primary energy consumption

Taking into account the assumptions discussed above, the resulting primary energy consumption under the Energy [R]evolution scenarios is shown in Figure 9. Under the E[R] scenario, primary energy demand will decrease by 33% from today's 1010 PJ/a to around 680 PJ/a. Compared to the Reference scenario, overall primary energy demand will be reduced by 50% in 2050 under the E[R] scenario (REF: around 1360 PJ in 2050). An overall renewable primary energy share is of 27% in 2030 and 80% in 2050 in the E[R] (incl. non-energy consumption). The share of renewables in the final energy demand is increasing from 6.8% in 2014 to 80.5% in 2050.

Figure 9. Projection of total primary energy demand (PED) by energy carrier
(REF, E[R], incl. electricity import balance)



Development of CO_2 emissions

Whilst Belarus`s emissions of CO_2 will increase by 13% between 2014 and 2050 under the Reference scenario, under the Energy [R]evolution scenario they will decrease from 55 million tonnes in 2014 to 8 million tonnes in 2050. Annual per capita emissions will drop from 5.8 t to 0.9 t. In spite of limiting nuclear power production and increasing power demand, CO_2 emissions will decrease in the electricity sector. In the long run efficiency gains and the increased use of renewable electricity in vehicles strongly reduce emissions in the transport sector as well.

With a 55% share of CO_2, the Power generation sector will remain the largest source of emissions in 2050 in the E[R] scenario. By 2050, Belarus´s CO_2 emissions are 93% below 1990 levels in the Energy [R]evolution scenario.

Figure 10. Development of CO_2 emissions by sector under the Energy [R]evolution scenario

(REF, E[R], incl. electricity import balance)