NATIONAL ENERGY STRATEGY

2030

MINISTRY OF
NATIONAL DEVELOPMENT

IMPRESSZUM

Date of Publication: 2012
Publisher: Ministry of National Development
Printed in 200 copies
Graphic Design: Lounge Design
Print House: Prospektus Nyomda
Supported by MVM Zrt

ISBN 978-963-89328-3-9
National Energy Strategy 2030
Ministry of National Development
Pictures are from the MVM Zrt

NATIONAL ENERGY STRATEGY 2030

MINISTRY OF NATIONAL DEVELOPMENT

„Competitiveness is how a nation manages the totality of its resources and competencies to increase the prosperity of its people."

(2008, Professor Stéphane Garelli, IMD World Competitiveness Yearbook)

„Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

(1987, Brundtland Commission of the United Nations)

„A nation-state is energy secure to the degree that fuel and energy services are available to ensure: a) survival of the nation, b) protection of national welfare, and c) minimization of risks associated with supply and use of fuel and energy services.
The five dimensions of energy security include energy supply, economic, technological, environmental, social and cultural, and military/security dimensions."

(2004, David von Hippel, Energy Security Analysis, A New Framework in reCOMMEND)
(2006, Department of Economic and Social Affairs of the United Nations)

TABLE OF CONTENTS

DEAR READERS,

While the final version of the National Energy Strategy has been the result of mutual efforts of one and a half year, its impacts will last for several decades. During its preparation, extensive professional and social consultations were therefore conducted in order to secure the support of as many of the stakeholders as possible when we set about to putting the concept into practice.

An economic feasibility study and a strategic environmental assessment were drawn up prior to the public debate, shedding light on the background of the strategy and marking out the framework, both in terms of sustainability and financing, into which the action plans, currently in progress, can be integrated.

The National Energy Strategy, based on new foundations, will ensure the long-term sustainability, security and economic competitiveness of energy supply in Hungary. Serving primary national interests, guaranteeing the security of supply, taking into account the least cost principle and asserting environmental considerations, it enables Hungary to contribute to resolving global issues to an extent proportionate to its international weight and as far as its resources allow.

In order to achieve our goals, the document lays downs five crucial efforts: increasing energy savings and energy efficiency, increasing the share of renewable energies, integrating the Central European grid network and constructing the required cross-border capacities, maintaining the existing nuclear capacities and utilising the domestic coal and lignite resources in an eco-friendly manner for power generation.

Thinking responsibly, the Government considers it to be of critical importance in terms of energy policy to rebuild those Government positions that were given up in previous years due to short-term fiscal considerations or even less transparent or meaningful reasons. The only way to achieve the objectives of the strategy, including in particular the ensuring of affordable energy supply to consumers, is by increasing the involvement of the government.

Finally, let us thank our colleagues who have made every effort in order to enable the completion of the National Energy Strategy and who are now working in order to achieve that the action plans are completed, the legal framework is adjusted to the aims and the new support schemes are created along the path determined by the strategy, that being the only way of developing a uniform set of strategic objectives.

Bencsik János

Kovács Pál

1 FOREWORD

Assuring the supply of healthy food, clean drinking water and sustainable energy constitute the most important strategic challenges of the 21st century. In energy policy, the forthcoming period will be a period of structural changes and a paradigm shift for both demand and supply. Even today, humanity lives under the delusion of cheap energy sources, available in infinite quantities. In the future, however, the current consumption patterns will no longer be sustainable. In order to ensure our future and the needs of future generations as well as to preserve a liveable environment, an urgent shift in attitudes is called for in energy policy.

Since economic productivity and the wellbeing of the society depend on the safe accessibility and affordability of energy, answering energy-related questions remains one of the greatest challenges of our country's future. Since the development of sustainable energy systems takes decades, the decisions on future improvements must be made as soon as possible.

Through the development of the National Energy Strategy 2030 document (hereinafter referred to as the 'Energy Strategy'), the objective of the Government is to reconcile its energy and climate policies while keeping economic development and environmental sustainability in mind, to determine an acceptable level of energy demand and the future directions of energy improvements and to frame, in collaboration with energy market stakeholders, a vision of the future for Hungarian energy policy. The Energy Strategy contains detailed proposals for the Hungarian energy sector and the decision-makers for a time horizon until 2030, including a roadmap until 2050, which puts the measures proposed for the period until 2030 into a more comprehensive and longer-term perspective. Detailed impact studies will be required prior to each specific point of decision, providing the widest possible range of the latest data and information for the preparation of decisions.

The Energy Strategy focuses on energy savings, the guaranteeing of the security of supply for Hungary and the sustainable improvement of the competitiveness of the economy. These will warrant that the services of the energy sector should remain accessible to economic players and the general population at competitive prices in the face of an increasingly tight environmental regulation and the longer-term depletion of hydrocarbon reserves.

The opinion of nearly 110 important stakeholders (including economic, academic, trade and social organisations) has been incorporated into the process of the development of the strategy. The recommendations of the consultative committees attached to the Ministry and of the International Energy Agency and the energy policy concepts of the European Union have also been taken into consideration. The reason why we have opted for this path, both more time-consuming and involving more efforts and consultations, is because we are convinced that no energy strategy can be suitable to increase the confidence of the society and of investors and thus ultimately to succeed, unless it is based on the cooperation of all industry stakeholders and ensures long-term planning.

2 EXECUTIVE SUMMARY

The energy policy of the future should be developed on the basis of the answers to the most important domestic and global challenges and the energy policy efforts of the EU, also taking into consideration our specific geopolitical features. It should focus on achieving both a rationalised energy demand and an energy supply (infrastructure and service) encouraging the growth of the Hungarian economy, ensuring the accessibility of the services and prices affordable to a large group of consumers.

The challenges related to the imminent change of the energy structure may be turned to the advantage of our country. In order to do so, however, we should be able to make the most of the opportunities, conducive to employment and economic growth, offered by energy improvements. The change of the energy structure should include:

- (I) energy efficiency measures spanning the entire supply and consumption chain;
- (II) increasing the share of low CO_2-intensive electricity generation based primarily on renewable sources of energy;
- (III)promoting renewable and alternative methods of heat generation;
- (IV) increasing the share of low CO_2-emission modes of transport.

By achieving the above four objectives, we could take a significant step toward the establishment of sustainable and safe energy systems, which would in turn substantially increase economic competitiveness. The 'Economic Impact Analysis of the National Energy Strategy 2030' and the Annex to the National Energy Strategy 2030', including the most important findings of the economic impact analysis, constitute organic parts of the 'National Energy Strategy 2030' technical document. The above three documents are geared primarily toward experts, policy decision-makers and energy market stakeholders. However, the need to communicate information to the public as extensively as possible has required the addition of another version, including all the essential elements of the former and yet being accessible to a wide public.

Summarising the key message of the Energy Strategy in a single sentence, our purpose is to seek ways out of our energy dependency. The five means to achieve the above goal include energy savings, increasing the share of renewable energy sources to the greatest possible level, safe nuclear energy and the electrification of transport on the basis of the former, creating a bipolar agriculture and integration to the European energy infrastructures. The latter guarantees the market purchase price of natural gas, enabling the maintenance of the critical role of natural gas by employing carbon capture and storage (CCS) technologies, while the existing Hungarian coal and lignite resources (of 10.5 billion tons) will constitute the strategic reserve of the Hungarian energy industry at the current exploitation capacity and infrastructure. For the time being, we cannot afford giving up fossil fuels.

As an open, export-oriented economy with low stocks of economically exploitable fossil fuels, Hungary obviously cannot be entirely independent in terms of energy supply. Thinking responsibly, however, it should still strive for energy independence in an effort to stay away from the looming international conflicts arising due to conflict of diminishing worldwide stocks of fossil fuels and an ever-increasing consumption demand. As pointed out above, the cornerstones of Hungary's energy independence are energy savings, domestic renewable energy used in a decentralised manner, integration into the European energy infrastructures and nuclear energy, the potential basis for the electrification of road and railway transport. The fifth cornerstone is the establishment of bipolar agriculture, possessing the required market-oriented flexibility enabling it to shift between food production and energy-geared biomass production, encouraging, by the cultivation of energy crops, the gradual conversion to arable land of areas unsuitable for food production at the required efficiency, which are therefore currently left uncultivated. This is also a prerequisite of job-creation in rural areas and the increase of green-collar employment, in other words, the rehabilitation of 'agricultural rust belts'.

Rather than the achievement of a desirable energy mix, the objective of the Energy Strategy is to guarantee the safe energy supply of Hungary at all times, taking into account the country's economic competitiveness, environmental sustainability and the load-bearing capacity of consumers, while enabling a shift toward a change of the energy structure under the conditions imposed by the available margin of the actual budget. The outlines of a number of alternative energy technologies are currently taking shape, which may give rise to great expectations. Most of these, however, are not yet ripe for the market, even considering the continuous increase of the prices of fossil fuels, and would not be viable without substantial state subsidies. It is yet difficult to predict the exact point in time of the market-price inversion of traditional and alternative energy sources. The impossibility of predicting the future changes of the price of natural gas only adds to the complexity of the situation, as the energy supply of any country should essentially be based on an energy source or energy source mix available in a safe and predictable manner, at an affordable price. On the basis of the above, the 'Joint Effort' vision, considered to be the most realistic objective and therefore an objective to be implemented, is represented by the 'Nuclear-Coal-Green' scenario of the Energy Strategy in terms of electricity generation. Its most important elements are as follows:

- the long-term preservation of nuclear energy in the energy mix;
- the maintenance of the current level of coal-based energy generation, for two reasons: (i) in energy crisis situations (e.g. the price explosion of natural gas, nuclear breakdown) it is the single readily available internal reserve, (ii) preventing the final loss of a valuable trade culture due to the above and with a view to maintaining the possibility of an increased share in future utilisation. The latter depends on full compliance with the committed sustainability and GHG emission criteria (full use of carbon capture and clean coal technologies);
- in terms of renewable energy sources, the linear extension of Hungary's National Renewable Energy Action Plan (NREAP) after 2020, provided that efforts should be made in order to increase the set objective, depending on the capacity of the economy, system controllability and technological development.

The implementation of the Nuclear-Coal-Green scenario would enable the redemption of imported electricity, currently accounting for 13 percent of the total domestic consumption, arising particularly during the summer months. Indeed, by 2030 we may be exporting 14 percent of the total amount of electric power of domestic generation, a target appearing viable in the light of the envisaged phase-out of German and Swiss nuclear capacities.

However, the preference of the Nuclear-Coal-Green scenario does not mean that the other scenarios are based unrealistic elements. If certain external and internal economic policy conditions are met, the government may change its energy preferences, as a different scenario might deliver a more reliable guarantee for the safety of energy supply under the changed conditions. The biennial review of the Energy Strategy is therefore an important element.

The most important propositions of the Energy Strategy in order to achieve a competitive, sustainable and secure supply are as follows:

Energy savings

The reduction of consumption through energy savings and improving energy efficiency is the most efficient and effective method of increasing the safety of supply, offering a viable method in the short term. Substantial energy saving measures, spanning the entire utilisation and consumption value chain and affecting both producers and consumers, are required in order to maintain the use of primary energy at the target level.

The aim is preferably to reduce the 2010 level of domestic primary energy use of 1085 PJ or, at worst, that it should not exceed 1150 PJ, the level typical of the years prior to the economic crisis, by 2030. This must be achieved while meeting the competitiveness, sustainability and safety of supply requirements and reducing the use of fossil fuels and CO_2 emissions.

From 1150 PJ, a relatively high value in European comparison, the energy intensity of the economy will be substantially reduced as the result of the decreasing primary energy demand, as the growth of the GNP is achieved at a declining or nearly stable level of energy consumption. This may lessen Hungary's vulnerability and dependency on the import of fossil fuels as well as decrease the volatility of domestic energy prices.

Energy-efficiency projects in the building sector are a key component of the improvement of energy efficiency. Today, 40 percent of all energy consumed in Hungary is consumed in our buildings, two-thirds of which goes to heating and cooling. 70 percent of the approximately 4.3 million Hungarian homes fail to meet modern functional technical and thermal engineering requirements, with a similar ratio for public buildings. Despite an improving trend as the result of the communal energy efficiency programs implemented in recent years, the heating energy consumption of a flat in Budapest is still twice that of a similar sized flat in Vienna.

The renovation of existing buildings, with particular regard to public buildings, is therefore a priority. As far as the built cultural heritage is concerned, the possibilities of the feasibility of environment-energy objectives should be considered and determined on a case-by-case basis in order that the implementation should not endanger irreplaceable items of the heritage or hinder the unfolding of their inherent values. Special consideration must be given to preserving the assets of World Heritage sites. It is the purpose of the Energy Strategy to reduce, by 2030, the heating energy requirements of buildings by 30 percent through energy-efficiency programs in the building sector in accordance with European Union targets. This will enable an over 10-percent reduction of the overall primary energy demand in Hungary.

The renewal of obsolete, low-efficiency power plants and the reduction of grid losses will, between them, represent an additional primary energy saving of 6 to 9 percent. In addition to the above, the reduction of the energy needs of industrial workflows and transport is another important constituent of the energy saving program.

Awareness-raising also plays an important role in the propagation of energy conservation and the reduction of the environmental load of ecosystems: the widest possible groups of society must be converted into environmentally conscious consumers, from schools to adult education

Increasing the use of renewable energy and energy with low carbon dioxide emissions

With a view to sustainable energy supply, it is expected that the share of renewable energy in primary energy use will rise from the current 7 percent to the vicinity of 20 percent by 2030. The estimates for growth until 2020 (the target set being a share of 14.65 percent in terms of gross final energy consumption) are described in detail in Hungary's NREAP. In terms of renewable energy sources, combined heat and power biogas and biomass power plants and geothermal energy utilisation, serving primarily, but not exclusively, heat generation purposes, will be treated as priorities. In addition to the above, solar energy-based heat and electric power generation and wind-generated electric power generation are also expected to increase. A more substantial utilisation of the Hungarian solar energy potential for direct electric power generation may become possible after 2020, due to the decreasing price of photovoltaic technology.

As far as the utilisation of bioenergy is concerned, decentralised energy-producing units (e.g. biogas plants) processing feedstock originating from energy plantations and agricultural and industrial (e.g. food industry) by-products will be given priority. Another important question is the energy utilisation of communal and industrial wastes non-utilisable in their materials and of waste waters.

In addition to the increasing share of renewable energy sources, the scenarios envisaging the extension of the nuclear power plant with a new unit or units (see the Annex to the Energy Strategy) reckon with an increase of the currently 16-percent share of nuclear energy in primary energy use by 2030. That will enable a substantial reduction of the share of fossil fuels and the reduction of energy-related GHG-emissions. .

Power plant modernisation

In order to ensure the reliable supply of electric power demand, a detailed set of criteria will be drawn up for the replacement of closed-down power plants. Electricity generation-related CO_2-intensity should be reduced from the current level of 370g CO_2/kWh to about 200g CO_2/kWh. Scenario analyses have shown that, taking safety of supply and emission-reduction aspects into consideration, it can be achieved by substantially increasing the share of renewable energy sources and adding new unit(s) to the Paks Nuclear Power Plant while extending the lifecycle of the existing four units. The new nuclear unit(s) to be built by 2030 will undoubtedly have a positive effect in terms of CO_2-emissions. Since a scarcity of the CO_2-quota is clearly predicted for the period following the start-up of the new unit(s), the CO_2-quotas unsold or available for sale as a result of the addition of the new unit(s) will yield a substantial, clearly quantifiable economic benefit on the level of the national economy.

Importantly, the period between 2032 and 2037 should also be analysed. As a result of the decommissioning of the four currently operating units of the Paks Nuclear Plant and their replacement with non-nuclear capacities, the level of CO_2-emissions may repeatedly increase unless carbon capture and storage (CCS) technologies are sufficiently advanced for the market, which means that we may lose our advantage in terms of CO_2 emissions. Through the use of CCS technologies, modern gas turbines and coal-fired units of increased efficiency may also represent a potential alternative provided that the required cost-efficiency, environmental, health and safety of storage conditions are met. Regardless of the above, the strictest and regularly reviewed safety standards must be applied for both the four existing Paks units and the potentially added new nuclear unit(s).

Modernisation of community district heating and private heat generation

The competitiveness of the district heating service must be ensured. This essentially requires the development of an autonomous district heating development action plan, the development of the technical level of the service (decentralised district heating islands, suitable for gradual integration, conversion to low-temperature district heating, the investigation of the potential of district cooling systems, setting up a service quality control system and a set of efficiency criteria, individual controllability and measurement and the development of rural district heating plants), the use of renewable energy sources and the integration of strictly regulated waste incineration with distant heat generation. This may even result in an increase of the share of the district heating service from the current level of 15 percent of Hungarian homes. Based on the investigated scenario, the share of the generation of renewable heat energy within the total heat energy consumption will increase to 25 percent from the current 10 percent by 2030, including the individual heat energy-generating capacities (biomass, solar and geothermal energy).

Increasing the energy efficiency and reducing the CO_2 intensity of transport

Increasing the share of electric (road and railway transport) and hydrogen-based (road transport) transport to 9 percent and that of the share of biofuels to 14 percent by 2030 serves the purpose of reducing the oil dependency of transport. In order to achieve that goal, it is essential to roll out the required infrastructure, primarily in the major cities, which may put Hungary on the European map of electric and hydrogen-powered transport. The electrification of transport may primarily be based on nuclear-generated power.

The energy efficiency of transport is increased by strengthening the role of railway passenger and goods transport and the employing of modern traction technologies. The transition of community transport to locally generated fuels, meeting the sustainability criteria (second-generation technologies, biogas, hydrogen and electricity) will also contribute to the achievement of the Energy Strategy objectives.

Green industry, renewing agriculture

The increasing of energy efficiency and the reduction of GHG emissions are critical cost-efficiency issues in industry and agriculture. Rather than end-of-pipe solutions focusing on pollution management, the goal is to support the development and catching on of preventive technologies of low carbon intensity throughout the entire lifecycle. As well as sources of energy, biomass and wastes are also potential industrial base materials, available for use in a number of areas of a fast developing biotechnology-based economy. It enables the production of pharmaceutical and fine chemical products by biotechnological processes considerably reducing the GHG emissions of industrial manufacturing processes and products.

Traditional agrotechnological practice is responsible for 13 to 15 percent of total GHG emissions. Since appropriate agricultural technologies and organic farming can help reduce the level of GHG emissions, including, among others, the minimisation of the use of agrochemicals and preference given to labour-intensive practices, their promotion is a priority in terms of both the improvement of energy efficiency and the reduction of GHG emissions.

The energy efficiency in agriculture may also be improved by supporting greenhouse cultivation based on the utilisation of sustainable geothermal energy. The sector is currently dominated by fossil energy-based heat generation. The local utilisation of agricultural by-products, according to local needs, is conducive to the shaping of the vision of a renewing economy.

Waste-to-energy

Since municipal organic waste qualifies as biomass, its energy utilisation is added to the share of renewable energy sources. Similarly to many other countries, where it accounts for up to 15 to 20 percent of biomass-to-energy utilisation, it could increase the share of renewables also in Hungary. In highly industrialised countries worldwide, the energy utilisation, in incineration plants, of burnable municipal wastes, in strict adherence to technological discipline and the strict environmental standards, is considered a resolved issue. The utilisation of up to 60 percent of such wastes would be feasible in that manner even at the current technical level. Hungary must also move into this direction, as deposition without recycling is not sustainable, occupies an increasing area of valuable arable land and endangers drinking water supplies and natural biodiversity.

Strengthening the role of the state

The presence of the government is currently rather moderate on a market-oriented, liberalised and highly privatised energy economy. The government is primarily able to assert its priorities through regulatory instruments, in accordance with the rules of the European Union. In itself, the ensuring of the coherence of legal and economic conditions is insufficient in order to efficiently vindicate public good and national interests. While in the electric power sector, the government continues to have a substantial direct potential to influence the market through the state-owned MVM Zrt. (Hungarian Power Companies Ltd.) and the Paksi Atomerőmű Zrt. (Paks Nuclear Power Plant Ltd.), a similar potential should be established in the natural gas and oil sectors, with particular regard to the expiry in 2015 of the long-term natural gas contract between Hungary and Russia. This may include the granting of new authorisations to the MVM Zrt., creating a new state-owned natural gas trading company or acquiring a controlling interest in a company with a high market share.

Since the renewal of the Hungarian energy infrastructure (power plants, grids, smart meters) is investment-intensive, the predictability of the investor environment and a system of institutions ensuring rapid administration must be established. The failure of the above may prevent the projects indispensable for a long-term security of supply.

In order to diversify the import sources of natural gas, increase the electric grid regulatory capacity and promote the emergence of competition, the North-South High-Level Group was set up in February 2011 with the participation of East and Central European countries and the experts of the European Commission.
With regard to the shortage of energy experts and with a view to achieving the objectives of the Energy Strategy, high-quality vocational education in energy needs to be revived as soon as possible, with particular regard to the launching of the multi-level training of experts skilled in the mapping of energy saving options and the utilisation of renewable energy sources, including, among others, renewable energy engineers, energy consultants, solar collector and heat pump mechanics, etc. The human resource requirements of the creation of the new nuclear units also require the implementation of a substantial educational and training program.

The major actions listed in the Parliamentary Decision with regard to the objectives of the Energy Strategy are as follows:

1. Framing the Act on sustainable energy management

2. Improving energy efficiency

- **a.** National Energy Efficiency Action Plan
- **b.** Energy Strategy for the Building Sector
- **c.** Power Plant Development Action Plan

3. Increasing the utilisation of renewable energies:

- **a.** Hungary's Renewable Energy Action Plan
- **b.** Regional mapping of the renewable energy potential

4. Transport development:

- **a.** Transport Concept

5. Utilisation of domestic fuel resources:

- **a.** Reserve management and utilisation action plan

6. Environment awareness-raising:

- **a.** Awareness-Raising Action Plan
- **b.** Establishment of a network of energy engineers

7. Achieving industry development objectives:

- **a.** Energy industry development and R&D&I Action Plan

8. Ensuring the competitiveness of the district heating service:

- **a.** District Heating Development Action Plan

3 STATE OF AFFAIRS

„Our Earth is a fragile planet that we must work hard to protect for many future generations to enjoy. We can protect our planet only if we work together."

(Dr. Julian M. Earls, NASA)

„The planet has a fever. If your baby has a fever you go to the doctor. If the doctor says you need to intervene here, you don't say, ‚Well, I read a science fiction novel that told me it's not a problem.' If the crib's on fire, you don't speculate that the baby is flame retardant. You take action."

(2007, Al Gore)

3.1 GLOBAL TRENDS

Growing demands and increasing competition for diminishing resources.

According to the data published by the International Energy Agency (IEA), in 1980 the global energy demand amounted to 7,229 million tons of oil equivalent (Mtoe), which increased by nearly 70 percent, to 12,271 Mtoe by 2008. Fossil energy sources account for more than 80 percent of the global primary energy demand, next to which the share of nuclear energy and renewable energy sources seems insignificant (Figure 1). Since the increase of consumption will not stop, according to authoritative forecasts, the high share of fossil fuels is no longer securely sustainable on the long run.

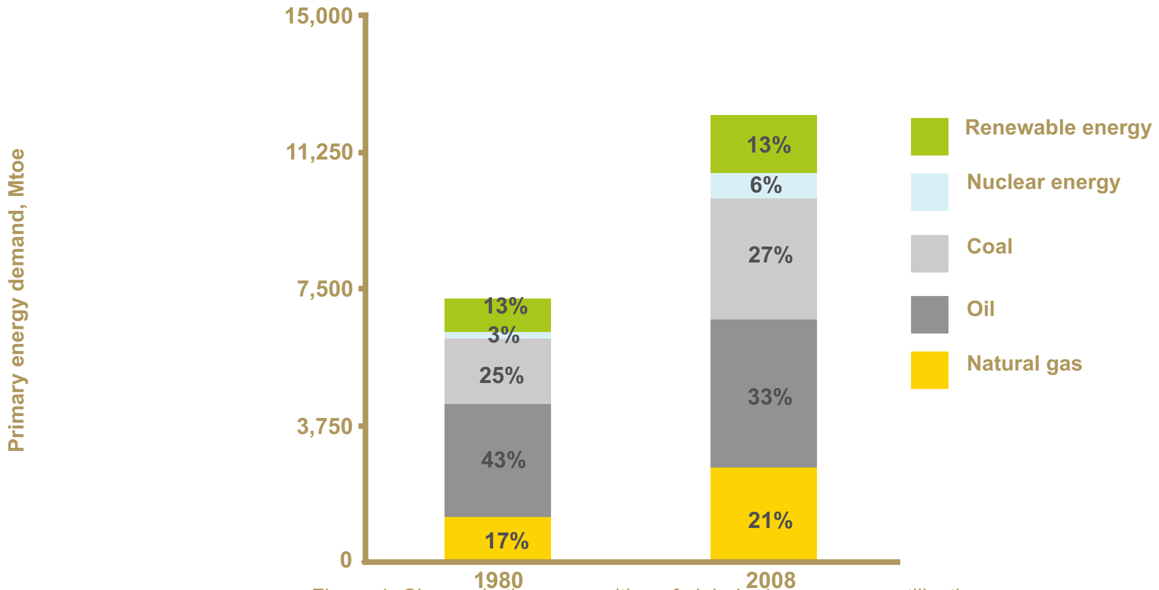

Figure 1: Change in the composition of global primary energy utilisation
Source: World Energy Outlook 2010, IEA

Of the fossil fuels exploitable on Earth, crude oil is the first where peak production rates per year will either soon be reached or we may even have passed the peak of the production curve. In practice, it means that we have extracted half of the total known available quantities of oil. Prices will increase and difficulties of supply will arise due to the fact that the remaining half of the available oil supplies are more difficult and more expensive to extract. The complexity of situation is aggravated by the fact that 70 to 80 percent of prospective oil fields are situated in autocratic states, in a politically unstable environment. Peak oil may be followed, in 100-120 years and 150 years respectively, by the peaking of the extraction of natural gas, by the exploitation of unconventional natural gas resources, and coal. Rather than the size of the resources, the times of the peaks depend primarily on the rate of the exploitation of the resources, i.e. the rate of the increase of demand, which results in a demand-supply imbalance. The time of reaching the production peaks therefore rather depends on the energy policy trends set by the world's governments than on the size of the available reserves, the viability of the exploitation of the latter being doubtful. The exploitation of unconventional resources (shale gas, gas shale, tight gas) is currently becoming economical. The price-reducing effect of the emergence of unconventional natural gas can already be felt on the markets despite the fact that it is still unable to make a substantial contribution to the satisfaction of global demand due to quantitative limitations. The technology has, however, gained wide currency in the US, enabling the maintenance of the level of domestic production in the face of the depleting of traditional reserves. Non-conventional oil does not have a price-reducing effect and is unable to make a significant contribution to the satisfaction of the demand even despite the increasing prices. Deep sea oil extraction, currently in the experimental phase, the utilisation of methane hydrates, continental deep extraction and the exploration of East Siberian and polar reserves may result in the availability of additional resources. At the same time, we have to consider that these new technologies will have an unprecedented effect on the human environment. The danger of irreversible environmental damage calls for continuous, proportionately strict and efficient global surveillance.

In 1980, the anthropogenic CO_2-emissions, responsible for the global climate change, of the energy sector, amounted to 18.7 billion tons, increasing by 57 percent to 29.4 billion tons by 2008. As a result of the increase of atmospheric CO_2-concentration, global warming may lead to unprecedented climatic catastrophes, which may result in millions of people becoming homeless. One of the conclusions of the Copenhagen Climate Summit was that the rate of the increase of average global temperature must be kept within a range of 2°C compared to the pre-industrial level in order to achieve a sustainable economy. The only way this can be achieved is by radically, i.e. by at least 50 percent before 2050, reducing global emissions. Although the 16th Climate Summit in Cancún, following the Copenhagen Summit, proposed the consideration of a target within the 1.5°C range, the level of CO_2-emissions has continued to increase during the past decade, in spite of a number of international agreements with a view to the reduction. It seems that the current energy and climate policy tendencies have failed to enable even the slowing down of the rate of the increase of CO_2 emissions. Reversing such trends would require a more powerful political will and increased resources.

Despite these uncertainties, governments worldwide are striving to satisfy the growing energy demand. 44 percent of global primary energy resources are consumed by highly industrialised countries (OECD members), while their share in the world's population amounts to a mere 18 percent. According to the forecast of the International Energy Agency until 2035[1], non-OECD members account for 93 percent of the increase of primary energy use. As a result of economic development, energy demand is expected to increase considerably in Brazil (3% of population, 2% of energy consumption), Russia (2% of population, 6% of energy consumption), India (17% of population, 5% of energy consumption) and China (20% percent of population, 17% of energy consumption), i.e. in the so-called BRIC countries. This trend involves the risk of draining away resources from the markets affecting Hungary. The increasing demand for fossil fuels leads to imbalances between supply and demand, including price increases. In order to control these adverse effects, we need programs enabling adaptation to the new resources structure and climatic conditions.

A number of countries (Italy, India, Malaysia and China) have planned to rely more heavily on nuclear energy in order to meet the growing demand and with a view to energy independence and decarbonisation. Of these countries, the three Asian countries have declared that the nuclear accident at the Japanese Fukushima Daiichi power plant will not essentially affect their respective nuclear programs. The UK government has also opted for the long-term maintenance of nuclear energy production, whereas Germany and Switzerland have opted for the phasing out of nuclear energy. At the end of May 2011, the Italian government announced the suspension of the program of the preparation of new nuclear plants for a period of one year. However, regardless of the scenario to be actually implemented in the future regarding nuclear capacities, the availability and the size of uranium reserves will remain an important piece of information for decision-makers. Unlike hydrocarbons, uranium supplies are not limited to a specific region, they are also available in politically stable democracies worldwide. The countries possessing a substantial uranium supply include Australia, Canada, Kazakhstan, Russia and certain African countries. At the current rate of utilisation, uranium reserves will

[1] World Energy Outlook 2010, New Policies scenario

run out in 100-120 years. The economically recoverable volume of uranium is determined by its actual market price. Current nuclear technologies utilise the uranium-235 isotope, which accounts for a mere 0.7 percent of the total amount of uranium, i.e. the size of the supply may increase with the development of technology. The so-called generation IV breeder reactors are expected to be in operation in 20 to 30 years. They will be capable of utilising the total quantity of uranium (both ^{235}U and ^{238}U), including spent fuel, extending the amount of continental fissionable material available by thousands of years (the peak of the extraction of ^{238}U is estimated between 10,000 and 60,000 years). Further options may be the extraction of uranium from seawater and the utilisation of thorium. On the basis of the above, it seems clear that the future of nuclear energy production is not threatened by a shortage of supply.

While developing countries have a legitimate claim for the increasing of their standard of living, it will not become viable on the long term, due to the shortage of resources as a result of the current energy structure and consumption patterns. A change reflecting the sustainability approach will be inevitable in order to avoid international conflicts, failing which growth will come up against insurmountable energy and environmental limitations. In the event a pessimistic scenario is realised, we should be prepared for the possibility of a radical economic change, which may result in a situation where the goal will be to ensure reasonable living conditions for humanity rather than its wellbeing.

The current practice	
is NOT competitive because	• the price and the availability of today's key fuels will become uncertain in the future, leading to the emergence of a seller's market. • the infinite economic growth model is no longer viable. • the desired locality is not fulfilled.
is NOT sustainable because	• supplies are being consumed at a higher rate than they are being replaced.
is NOT secure because	• the rate of extraction of the remaining supplies is unable to meet the increase of demand. • conditions are set by the countries disposing over the supplies, putting importers into a vulnerable situation.
The solution	• changing the attitudes of the society and introducing new and more efficient technologies.

3.2 EUROPEAN UNION

High energy import dependency, changing regulation and high ambitions for the future, whose fulfilment, however, remains doubtful

The need for a uniform, long-term energy policy emerged within the European Union for the first time in 2005, due to the increase of the oil price and the challenges brought about by climatic change. These prompted the Commission to publish, in 2006, a Green Book entitled 'A European Strategy for Sustainable, Competitive and Secure Energy'. It was followed by the publication of the documents that have defined energy policy to this day, including the Energy Efficiency Action Plan (2006), targeting a 20-percent improvement of energy efficiency and the first EU Energy Action Plan (2007).

The third internal energy market package was adopted in 2009 with a view to facilitating the integration of European gas and electric power markets. A uniform market, ensuring the freedom of the choice of service providers enables the customers the choice of most suitable service in terms of their consumption patterns, financial and risk management strategies, as well as guarantees stable market prices. In addition to increasing the security of supply, it also enables the market entry of smaller investors, specialising primarily in renewable energy generation. In accordance with establishing the uniform internal energy markets, the appropriate operation of the system of the trading of CO_2 emission quotas is also indispensable. Its prerequisites include the careful examination of the energy infrastructure, the supply of isolated regions and the widening of the diversification of resources.

The energy policy principles of the European Union are set out in the Energy 2020 Strategy[2], which sets as its objective the achievement of a resource and energy-efficient, low carbon-intensive (i.e. low CO_2-emission) economy. It requires the establishment of an integrated system of conditions for economic growth at decreasing energy consumption, the reduction of CO_2 emissions and improving competitiveness, which will in turn increase the security of supply. The quickest and most cost-efficient way to achieve the energy and climate policy objectives, particularly in heat utilisation, is the improvement of energy efficiency and saving, which are also conducive to job creation, the reduction of consumer costs and the creation of better living conditions for consumers.

Between 2000 and 2004, the energy consumption of the European Union grew by 5.9 percent before stabilising at 1,825 Mtoe between 2004 and 2006. That value decreased slightly in 2007 and 2008, then plummeted in 2009 to around 1,700 Mtoe, back to the 2000 level. While the economic crisis undoubtedly played a part in the decline, the stabilisation is a clear sign of the divergence of the previously proportionate relationship between economic growth and energy consumption (Figure 2). At the same time, the energy intensity (the ratio of gross final energy consumption and the GDP) of the European Union also improved, i.e. from 187.3 kg oil equivalent/1,000 EUR in 2003, the indicator dropped below the 160 limit.

Despite the above, achieving the 20-percent rate of efficiency improvement still presents a major challenge for EU members.

Forecasts have demonstrated that the current measures of the member states may result in a reduction of primary energy use of around 9 percent by 2020. A number of elements (eco-labelling, energy efficiency requirements of buildings, long-term energy-efficiency improvement agreements with businesses) potentially enabling a higher rate of reduction are currently

[2] Communication from the Commission: Energy 2020: A strategy for competitive, sustainable and secure energy – COM (2010) 0639 final

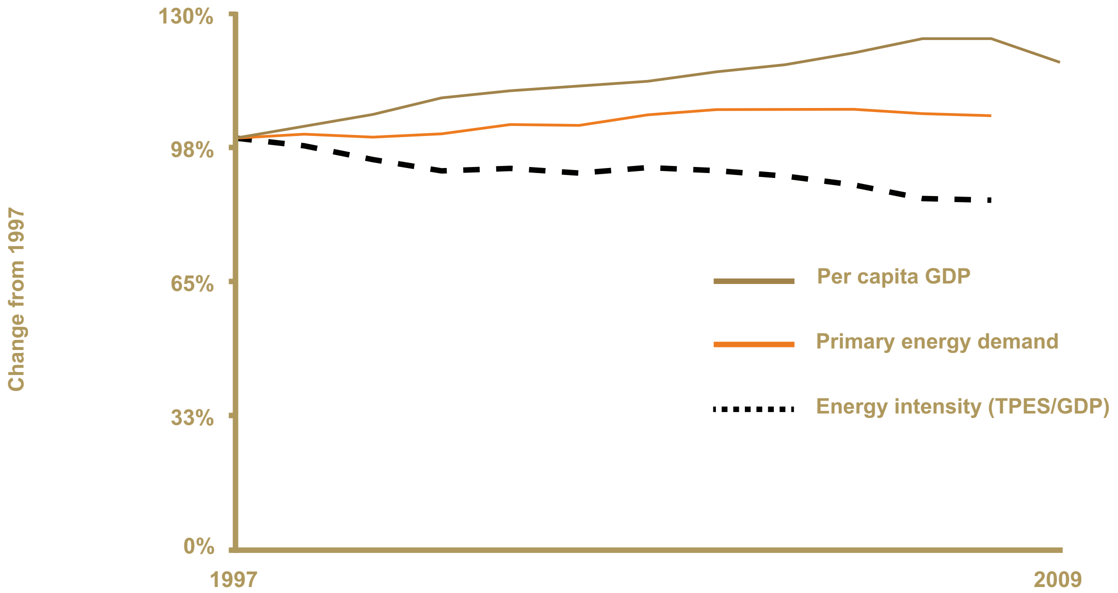

Figure 2: Change of the primary energy demand and per capita GDP in the EU-27
Source: Eurostat

being established or reviewed. In addition to setting back energy consumption, the economic crisis has, however, also had a negative impact on energy efficiency projects. The EU therefore lays great emphasis to the review of financing and the development of new, innovative financing mechanisms. With a view to achieving the targets, the EU intends to develop a system that gives priority to the specification of requirements concerning the energy consumption of devices, buildings, manufacturing processes and services, the improvement of the efficiency of transport and public utilities and the changing of consumer behaviour.

The import dependency of the EU-27 in primary energy supply is considerable, having reached 1,015 Mtoe in 2008 (55 percent), which represents approximately 10 percent increase over the previous 10 years (Figure 3). This necessitates the maintenance of stable economic and political relations with the transit and source countries. The three most important technological tools with a view to the increased future security of European energy production are the exploitation of renewable energy sources, increasing reliance on nuclear energy and development and promotion of the still immature clean coal (CC) and carbon capture and storage (CCS) technologies.

Natural gas import, showing a marked increase over the past 15 years, represents the most significant item of the EU's energy resource imports. Reaching its peak in 1996, internal extraction then stagnated for nearly a decade and has been declining since 2004. As a consequence of the above, the increasing demand can only be satisfied by an increasing volume of import. In 2009, 42, 24 and 18 percent of the total natural gas import of the European Union was imported respectively from Russia, Norway and Algeria.

The use of renewable energy plays a substantial role in local energy supply and the diversification of supply. Besides, it may help create hundreds of thousands of new jobs (manufacturers, contractors, operators, engineers) throughout Europe. There are currently over 1.5 million jobs related to renewable energy, a number which may rise, according to the optimistic forecast of a study ordered by the European Commission, to approximate 3 million by 2020[3]. During the past ten years, the share of renewable energy sources has grown at a high rate particularly in those member states which have implemented predictable, encouraging policies, created the required conditions of system management and employed technologies capable of turning to good account the economic, natural and human conditions of their countries, thus securing a steady flow of orders for the local industry. Between 1997 and 2007, the renewable energy and waste-to-energy capacities of the EU grew by 80 GW, as opposed to a growth of a mere 15 GW between 1990 and

[3]EmployRES - The impact of renewable energy policy on economic growth and employment in the European Union.

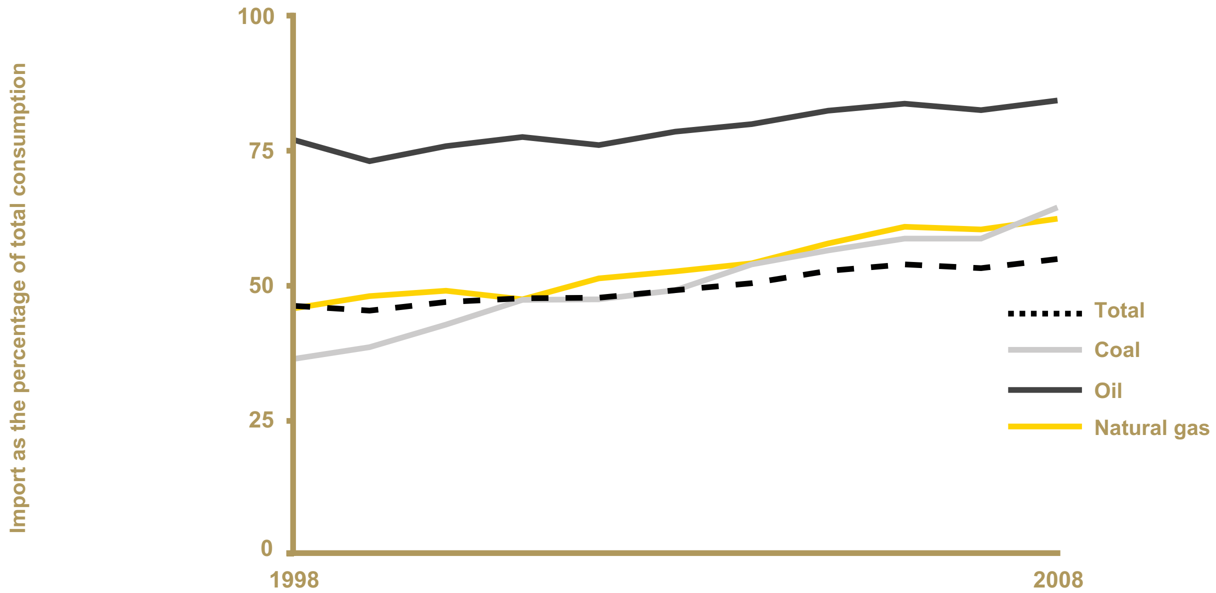

Figure 3: The import dependency of the EU-27 over time
Source: Eurostat

1997. As far as the technological basis of renewable energy production is concerned, the utilisation of major hydroelectric power plants, off-shore and continental wind power, solar thermal, geothermal systems, biomass and first-generation biofuels has been resolved. Taking collateral benefits into account, the renewable energy potential can best be exploited in Hungary through the philosophy of decentralised small-region renewable energy generation. However, ambitious, large-scale renewable energy strategies, representing the other end of the spectrum, have also emerged within the EU. Concentrated off-shore North Sea wind farms, tidal power plants or the envisaged import of solar energy from the Mediterranean and North Africa[4] may bring about new kinds of energy dependencies and preserve centralised energy production. The use of renewable energy sources may, however, become simpler and cheaper after 2020 as a result of mass industrial production, technological innovations and increased consumer awareness. Development may be driven by 'greennovation', which may help new technologies reach market maturity, including electric power generation by photovoltaic panels, high-performance solar power plants, electric and hydrogen-based transport, second-generation biofuels and advanced biomass utilisation technologies. For Europe, however, the biggest challenge will remain staying at the vanguard of the global industry.

By 2010, directives envisaged a 21-percent share of electricity production (2001/77/EC[5]) and a 5.75-percent share of renewable energy in transport (2003/30/EC[6]) in the EU. Despite the high rate of growth (16.6 percent for green electric power and 3.5 percent for renewable fuels, according to 2008 statistical data), these targets have not been met. Directive 2009/28/EC[7] of the European Union specified mandatory targets for the member states for all types of renewable energy consumption. The target for the average of the EU is to achieve, by 2020, a share of the use of energy from renewable sources of 20 percent in terms of the gross final consumption, including 10 percent in transport. While the transport target is 10 percent across the board for each member state, the 20 percent target for the overall share of renewable energy is an EU average, the Directive specifying the minimum share to be achieved by each member state.

Nuclear energy production contributes to the struggle against climate change and reinforces the security of supply by replacing natural gas and oil-based energy

[4]Desertec Foundation http://www.desertec.org

[5]Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market

[6]Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport

[7]Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (text with EEA relevance)

generation. Since nuclear energy is currently one of the cheapest low CO_2-intensity technologies, it also increases the competitiveness of the European economy. While nuclear energy production accounted for almost 30 percent of the total electric power production of the EU in 2008 (Figure 4), that share has probably declined due to the shutdown of German nuclear plants in 2011. While the interest for the use of nuclear energy has increased during recent years, there are differences in the attitude of member states toward nuclear energy. The issue of nuclear safety is a priority in the EU and its importance will certainly increase in the wake of the 2011 nuclear accident at the Fukushima Daiichi nuclear power plant. The Annex to the Energy Strategy also includes an analysis of scenarios that do not envisage the increase of the current share of nuclear energy or even calculate without nuclear energy in the country's energy supply.

The carbon capture and storage (CCS) technology, still in the experimental phase, may therefore play an important role in the reduction of CO_2 emissions caused by fossil fuels. For 2050, the European Commission set the objective of the decarbonisation of the electric power sector[8], which can probably only be achieved through maximising the utilisation of renewable energy sources and the widespread use of CCS technology, while maintaining the share of nuclear energy. The EU therefore assigns an important role to CCS on the path toward decarbonisation, in particular as far as carbon-based energy production and various industries (e.g. bioethanol production, chemical industry, cement industry) are concerned. The EU, however, leaves member states the option of restricting the use of CCS with regard to its environmental risks. The technology is based on capturing and removing the CO_2 released during incineration and thus preventing its entry into the atmosphere, injecting it permanently into suitable porous underground geological formations, e.g. deep saline aquifers or depleted natural gas reservoirs. Since the goal is to achieve the marketability of the technology, the Commission has established the basis of the financing of the European-level demonstration of the technology[9]. From 2013, the amendment of Directive 2003/87/EC[10] will include CCS technology in the emissions trading mechanism of the EU. Similarly, the application of the technology has been included among the potential technologies of the Clean Development Mechanism – CDM, one of the flexible Kyoto mechanisms. One of the most important conditions of the marketability of CCS is the right price of carbon dioxide which, according to a study[11], will occur at €30-50/t of CO_2, assuming the considerable improvement of the technology. For several years, however, the price of CO_2 has not reached the €20/t threshold. Directive 2009/31/EC of the EU on the geological storage of carbon dioxide[12] targets the Community harmonisation of the conditions of storage, which member states are required to adapt into their national legislations by June 2011.

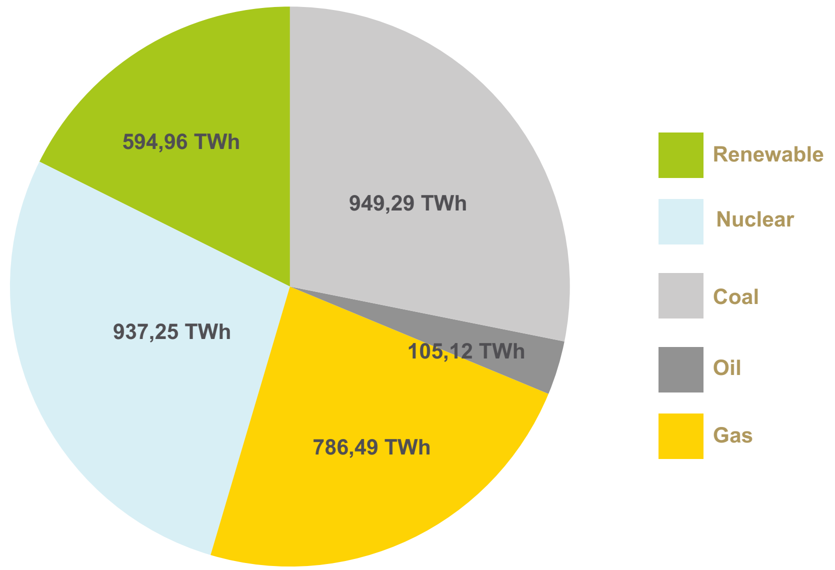

Figure 4: Composition of the sources of the electric power production of the EU-27, 2008
Source: Electricity Information, IEA, 2010.

Our interests and potentials must be kept in mind when determining the burdens to be undertaken by Hungary concerning the targets for the whole of the European Union. When quantifying our commitments, we need to seek a compromise between the benefits of meeting the target and the related economic and social cost and expenses. As far as the target to be committed to is concerned, the smallest cost principle should be borne in mind, while also taking into account the potential costs due to the failure to commit to a target or to if the target is too low (e.g. the costs of maintaining the situation and externalities). One also has to take into consideration that short-term decisions may potentially preserve the structure of energy production and utilisation for a long time (lock-in), and therefore the impacts of the decisions should be examined on a longer perspective, even up to 2050.

As far as energy efficiency is concerned, Hungary makes the biggest contribution to the current objectives of the common energy policy through reducing energy intensity and energy consumption.

Priorities of the Energy 2020 Communication (COM(2010) 639 final) A strategy for competitive, sustainable and secure energy	
Energy efficiency	• The initiatives of the EU should focus on the biggest energy-saving potential — buildings and transport. Until mid-2011, the Commission will develop innovative financial instruments to encourage investments with a view to supporting property owners and local bodies in financing the renewal of property and energy-saving measures.
Integrated electric power and the required infrastructure	• The Commission set 2014 as the target date for accomplishing the internal energy market. After that, no member state should be isolated from the European internal market.
Leading role in technology and innovation	• The Communication envisages the launch of four new large-scale projects, of key importance in terms of the competitiveness of Europe. These projects will focus on smart grids, the new technologies of electricity storage, the researching of second-generation biofuels and the partnership of 'Smart Cities' intending to increase the economy of energy consumption in urban areas.
Secure and affordable energy, active consumers	• The Commission has proposed new measures in the fields of price comparability, the change between service providers and clear and transparent billing.
Global action in energy issues	• according to the proposal, the EU should coordinate its relations with third countries. In order to achieve the further integration of countries interested in participating in the energy market of the EU and accepting its system of conditions, it has been proposed that the Treaty establishing the Energy Community should be extended.

[8] A roadmap for moving to a competitive low carbon economy in 2050 (COM(2011) 112 final)

[9] The NER300 program and Regulation (EC) No 663/2009 of the European Parliament and of the Council of 13 July 2009 establishing a programme to aid economic recovery by granting Community financial assistance to projects in the field of energy

[10] Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC (Text with EEA relevance).

[11] McKinsey & Company: Carbon Capture & Storage: Assessing the Economics, 2008

[12] Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006 (Text with EEA relevance)

3.3 REGIONAL OUTLOOK

Regional cooperation and the diversification of supply routes are the only means to reduce Hungary's natural gas vulnerability.

The major part of Hungary's energy supply is imported, and it will remain so for a long time. Since Hungary is unable to guarantee its energy security on its own, co-operation with the neighbouring countries is essential with a view to the integration of infrastructures. On the other hand, the interests of the individual countries can be enforced more efficiently vis-à-vis energy exporter countries on a regional level. International energy relations constitute a critical component of the security of supply and the success of the assertion of interests depends on the performance of the whole economy and its leverage to negotiate. In that context, the Energy Strategy articulates three priorities: participation in the shaping of the common European energy policy, the management of acute energy crisis situations on the basis of solidarity on an EU-level and the management of regional/bilateral relations.

- The establishment of the Central European regional energy market represents the basis of bilateral energy relations. While the regional market results in a significant increase of efficiency and market stabilisation compared to the independent national markets, its establishment requires a close political cooperation. The Central European region plays an important role in three plans within the long-term infrastructure development strategy of the European Union (Figure 5)[13]. In the context of the supply of Hungary, these, as the safeguards of the diversification of sources will enable the supply of natural gas into the region from sources other than the Brotherhood pipeline:
- (I) increasing the capacity of the Austro-Hungarian interconnector (Baumgarten/Moson) and the construction of the planned Slovakian-Hungarian interconnector, whose collective capacity will almost equal the entire Hungarian natural gas import and represent a link to the Western European gas market;
- (II) the construction of the North-South Interconnections, with Slovakian-Hungarian and Croatian-Hungarian gas connections, enabling access to the envisaged Polish, Croatian, Slovenian and North Italian LNG terminals and, over time, the Polish shale gas sources once the related climate protection risks (e.g. the significant leakage of methane accompanying the extraction) have been resolved and extraction has begun;
- (III) the Southern Gas Corridor projects would give access to the Caspian and Middle Eastern natural gas deposits (Nabucco and AGRI), while the South Stream would provide an alternative supply route for Russian natural gas.

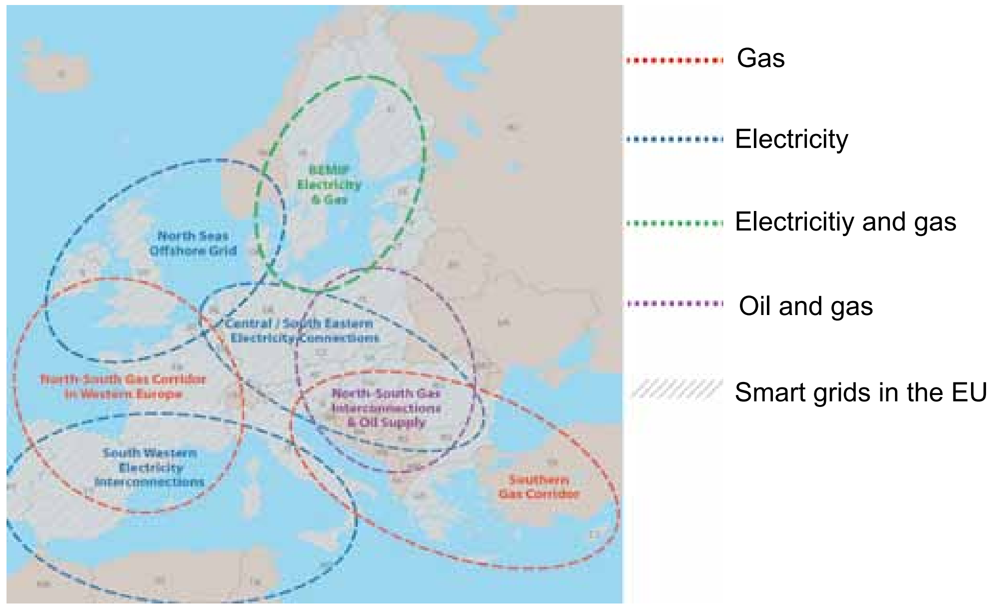

Figure 5: Main areas of EU infrastructure development
Source: European Commission, DG ENER

[13] Energy infrastructure priorities for 2020 and beyond — A blueprint for an integrated European energy network (COM(2010) 677 final)

The European infrastructure development projects affecting Hungary also include the Central-South-Eastern Electricity Connections, establishing links with the Western European markets.

Russia is Hungary's most important energy partner. Since Russia will remain the most important source of import on the long term, a balanced partnership between Russia and Hungary is in indispensable element of the security of supply. During recent years, the Russian-Ukrainian gas debate has repeatedly given trouble in the gas supply of Hungary and the EU, shedding light on the high risks of unilateral dependency on energy import. Since the crisis, however, energy security has become a priority issue within the EU.

Hungary should also strive for close energy relations with Ukraine and Austria, also important as transit countries, and the potential transit countries Romania, Italy, Slovenia, Slovakia, Poland and Croatia. Hungary may strengthen its strategic position through collaboration with the V4 countries and close cooperation with Balkan countries, primarily the ex-Yugoslavian republics, with regard to the fact that the gas supply of these countries (Serbia, Bosnia and Herzegovina) is currently fully viable only through Hungary. The Hungarian natural gas storage capacities and their development contribute to the security of supply of the entire region. In the Southeast European region, Croatia may be Hungary's most important partner in terms of energy cooperation. A Croatian-Hungarian agreement was entered into earlier on the interconnection of gas pipelines, enabling Croatia to satisfy its gas import demand from cheaper sources and, potentially, a significant transit volume toward Slovenia/Italy.

Due to the deficiencies of interest reconciliation and certain conflicts of interest, the V4 have so far failed to make the most of the economic potential from their similar geopolitical situation and joint action. The lack of a common energy policy and the existence of regional energy market have resulted in quantifiable economic losses in the form of lost profit. From an energy policy point of view, the Central European region constitutes a buffer zone and an unavoidable transit route between the main import sources and the importer regions of the European Union.

3.4 THE HUNGARIAN SITUATION

3.4.1 PRIMARY ENERGY

Our natural gas vulnerability is partly mitigated by the valuable Hungarian natural gas infrastructure, including the availability of commercial and strategic storage capacities.

In the 20 years since the fall of Communism, the Hungarian economy has undergone a fundamental structural change, resulting in a rapid decline of energy-intensive industries and the setback of material and energy utilisation to the level of the 1970's. The change of the structure of the economy during the past two decades has also resulted in a dramatic increase of unemployment and the widening of gaps both within the country and compared to highly industrialised EU regions. Ensuring the desired rate of catching-up and the harmony of the Energy Strategy is a key issue of social, economic and energy policies. As the service sector has gained importance and the GDP continued to increase, primary energy use decreased by 17 percent between 1990 and 1992, which was followed by an average annual growth of 0.5 percent from 1992 to 2007. In 2009, primary energy use declined by 7.6 percent from the previous year's level as a result of the economic crisis, dropping to 1,056 PJ (1,085 PJ in 2010).

In Hungary, primary energy intensity, i.e. the primary energy demand of the total domestic output (the nominal GDP) was approximately 2.4 times the average of the European Union in 2007. Converting it to purchasing power parity, however, the ratio is only 1.22. Electricity intensity, again converted to purchasing power parity, is even lower in Hungary (97 percent) than the EU average. It means that Hungary is simultaneously characterised by very low specific (per capita) energy consumption and a relatively high energy intensity.

As far as primary energy sources are concerned, with the degradation of the Hungarian deep coal mining, the fuel structure shifted toward increasing reliance on natural gas. As a result of the powerful increase of the volume of imported gas, the net import of fossil fuels increased at a considerable rate between 1990 and 2005, despite the fact that the level of energy consumption hardly changed during the period (Figure 6). The share of fossil fuels in the use of primary energy sources was 80 percent in 1990 (958 PJ), as opposed to 75 percent in 2009 (789 PJ) (Figure 7). 80 percent of the imported gas comes from Russia, essentially through a single transport route (the Brotherhood pipeline), which results in a vulnerable situation for Hungary in terms of the security of supply.

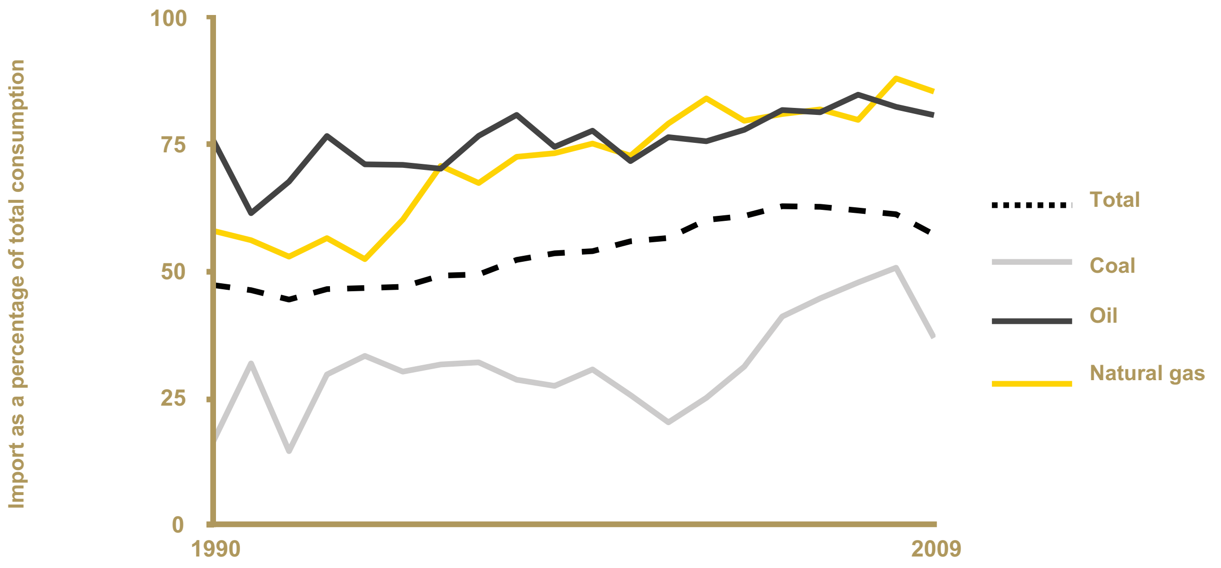

Figure 6: The energy import dependency of Hungary
Source: Energy Centre Hungary

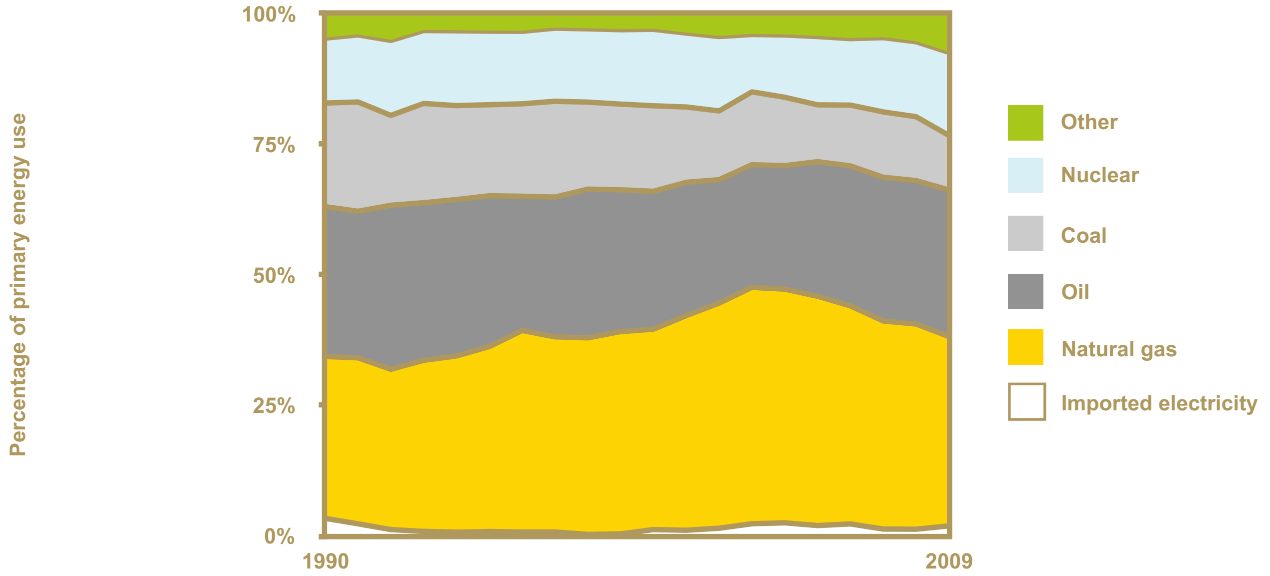

Figure 7: Hungary's primary energy use
Source: Energy Centre Hungary.

While the HAG pipeline provides a link to the Austrian transit hub, its transport capacity is limited for the time being. Plans, however, have been drawn up for the doubling of its current capacity.

The security of natural gas supply is also guaranteed by building of commercial and strategic stocks, i.e. the existence of appropriate storage capacities. Uniquely for Europe, the current Hungarian gas storage capacities exceed 50 percent of the annual natural gas consumption (approximately 5.8 billion m^3). According to the provisions of Act XXVI of 2006 on the accumulation of security reserves of natural gas, the volume of the security stocks should be between 600 million m^3 and 1,200 million m^3 of mobile natural gas stocks, provided that the natural gas security stock should be stored in containers of a daily withdrawal capacity of 20 million m^3. According to the requirements of the IEA and the EU, crude oil and oil products are stored at a quantity equivalent to at least 90 days of consumption.

The share of renewable energy in final energy consumption was 6.6 percent in 2008 (7.4 percent in 2010 is foreseen by the NREAP), i.e. Hungary ranks in the lowest third among EU member states (2008 EU-27 average: 10.3 percent) lagging behind even the countries of a similar level of economic development (Bulgaria 9.4 percent, Czech Republic 7.2 percent, Poland 7.9 percent, Romania 20.4 percent and Slovakia 8.4 percent). The difference is partly due to the more favourable and better exploited hydro energy potential and forestation indicators of the neighbouring countries as well as their more efficient regulatory systems. On the basis of Directive 2009/28/EC[14], this indicator should reach 13 percent in Hungary by 2020. That Directive sets out an indicative trajectory, whose first stage will probably be met, as it provides that the share of renewable energy use should reach 6.04 percent on average during the two-year period between 2011 and 2012. The targets set in Hungary's NREAP, adopted in December 2010, are more ambitious than those set out in the Directive: 7.4 percent for 2012 and 14.65 percent for 2020. Considering Hungary's geographical conditions, of the renewable energy sources, energy generation from biogenic sources (forestry and agricultural biomass, biogas and biofuels), geothermal energy and, on a long term, solar energy, are the most important. In terms of the utilisation of renewable energy sources, Hungary has so far failed to make full use of the available domestic potential. According to the findings of a survey conducted in 2005 and 2006 by the Renewable Energy Subcommittee of the Hungarian Academy of Sciences, the theoretical annual renewable energy potential is 2,600-2,700 PJ, the full exploitation of which can never be achieved. The actually available level is characterised by the technically and economically feasible potentials. For the latter, however, no unequivocal estimates exist and this potential keeps growing with the

[14] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

development and gaining ground of new technologies. In their natural condition, the country's mineral raw materials are in the public ownership. These assets, registered by the National Office of Mining and Geology, constitute part of the country's natural resources and national wealth (Table 1).

In the Hungarian energy supply, coal mining was of decisive importance up to the 1960's. Since that time, however, the volume of coal extracted has been declining. Increasing reliance on Hungarian coal is both necessary and can be supported, provided that environmental requirements are fulfilled.

Energy carrier	Geological resources (2010)	Extractable reserves (2010)	Production (2008)	Production (2009)
	(million tons)			
Crude oil	209,4	18,4	0,81	0,80
Black coal	1625,1	1915,5	-	-
Brown coal	3198,0	2243,8	1,39	0,95
Lignite	5761,0	4356,3	8,04	8,03
Uranium	26,8	26,8	-	-
	billion m^3			
Natural gas	3563,0	2392,9	2,88	3,12

Table 1 – Hungary's fossil energy resources
Source: National Office of Mining and Geology

The size of the geological natural gas resource, including the Makó site, is 3,563 billion m^3. As far as the latter place of occurrence is concerned, however, no technological solution currently exists for the extraction. Taking only the operating mines into account, the size of the recoverable natural gas resource is, as at 1 January 2008, only 56.6 billion m^3, ensuring (divided by annual production) supply for 21 years. While the greatest volume of natural gas is extracted in Algyő, the greatest resource can be found at the Makó Trough. The exploration of the Makó unconventional deep (3 to 6 km) natural gas deposit was begun by the Canadian Falcon Oil and Gas Ltd., joined later by the Mol Nyrt. and ExxonMobil's subsidiary, the ExxonMobil Kutatás és Termelés Magyarország Kft. Only Falcon Oil has been left of the former consortium. According to former surveys and high-precision estimates, in the Makó Basin, of an area of 1,567 square km, total recoverable industrial gas amounts to 2 billion barrel equivalent, i.e. in excess of 340 billion m^3. On the basis of our current technological knowledge, calculating with the drilling of fifty wells a year, app. 30 percent of that industrial asset can be extracted over the forthcoming 30 years. That would cover over one-third (34.2 percent) of domestic demand on the long term. The technological conditions of the recovery of the Makó gas deposit, however, are currently not available and no estimates exist as to when exactly that may become feasible. In addition to the above the Mecsek coal deposits contain high quantities of coalbed methane.

In Hungary, uranium used to be mined near the village of Kővágószőlős, from which uranium oxide was produced locally, processed into fuel in the former Soviet Union. The mine was closed down for economic reasons in 1997, which put an end to Hungarian uranium mining and processing. Since 2006, however, the increase of market demand has spurred intensive search for uranium in Southwest Hungary (Mecsek, Bátaszék, Dinnyeberki and Máriakéménd). While according to international ratings, the Mecsek uranium deposit belongs to the major ones, the metal content of the ore is only about 1.2kg/t. During recent years, the price per ton of uranium oxide has ranged between $88-110. According to current estimates, the recovery and enrichment of the ore would become profitable over $154.

3.4.2 ELECTRIC POWER

At a decisive share of nuclear energy, demand is supplied mainly by obsolete and low-efficiency power plant units.

There is a contradictory situation in Hungary as far as the sources of electric power supply are concerned. Since the Hungarian electricity system is based mostly on base load units, it is increasingly difficult to control the system through technical means, with particular regard to off-peak load balancing. Non purpose-built, uneconomical and obsolete power plant units running on fossil fuels are currently used for load balancing. These 200 MW capacity units are used to provide secondary reserves within the electricity system.

In a few years' time, a situation may arise when the capacity losses can no longer be managed due to the lack of supplemental reserves. By providing the required cross-border capacities and the integration of day and intra-day markets, the integrated European electricity market, currently under development, may help prevent the disturbances of supply in Hungary. As at 31 December 2010, the built-in capacity of the Hungarian power plants generating interoperable electricity in the electricity system was 9,317 MW. The available capacity was 8,412.7 MW, including 3,061.9 MW and 5,350.8 MW controllable and non-controllable capacities respectively. Of the 9,317 MW capacity, 7,895.9 MW was provided by 20 large power plants, whereas the remaining 1,421.1 MW was provided by small power plants of a capacity below 50 MW, powered mostly by gas or, to a smaller extent, by renewable energy sources.

During the two decades before the crisis, gross electricity consumption increased by 21 percent, which was followed by a decline of approximately 6 percent compared to previous years due to the economic crisis in 2008 and 2009. However, consumption increased again in 2010, by 2-3 percent. Since the domestic situation, i.e. the lack of competition on the wholesale market does not force operators to carry out continuous technological development, most Hungarian power plants have become obsolete, i.e. their fuel consumption, level of pollution and labour intensity is higher than the European average. While the existing coal-fired power plants still play a sig-

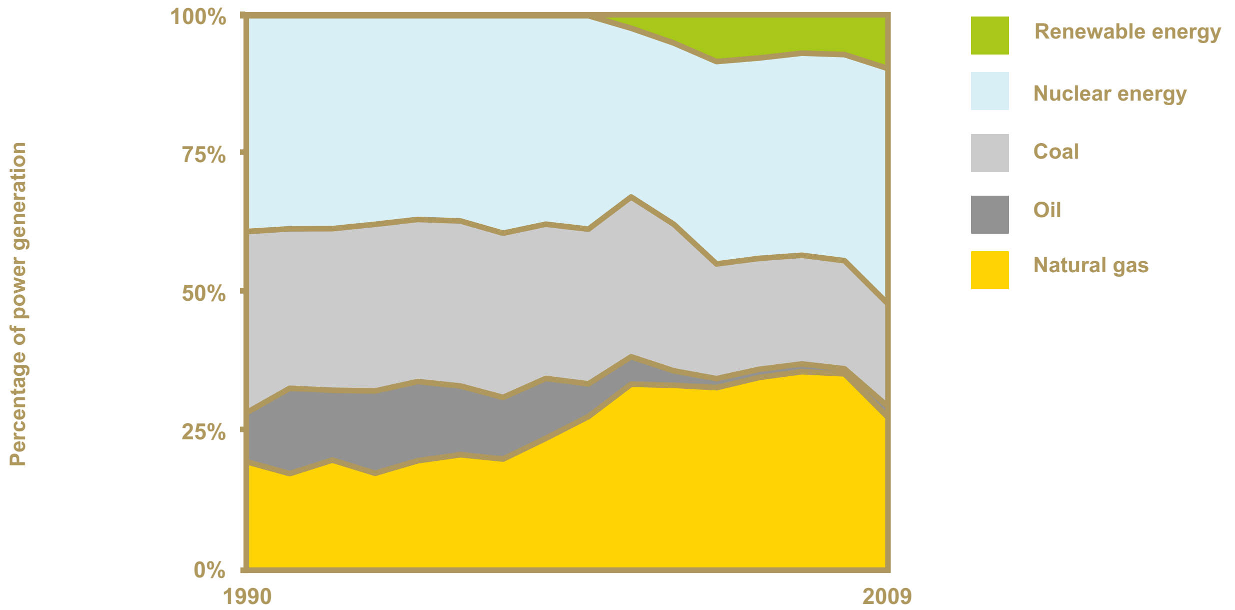

Figure 8: Electricity generation in Hungary
Source: Energy Centre Hungary.

nificant role in electricity generation, they are several decades past their envisaged service life and their efficiency, environmental parameters and CO_2 emission levels do not meet today's requirements. The unit efficiency of the power plants, that used to fit into the less integrated national market of a previous period, also fails to meet the competitive present-day level. Consequently, both their variable and fixed costs are over the benchmark, and therefore, with a few exceptions (the Paks Nuclear Power Plant and some gas-turbine units built during the past two decades) they are non-competitive by international standards.

The Paksi Atomerőmű Zrt. operating the nuclear power plant plays a crucial role in the Hungarian national economy and electricity generation, accounting for 42 percent of the latter in 2009 (Figure 8). Currently and considering future trends, the Paks Nuclear Power Plant generates energy at the lowest sales price (HUF 10.67/kWh in 2009) in Hungary. On the long term, it is an efficient tool for providing electric power at a competitive price and for reducing CO_2 emissions.

The safety system and the operation of the Paks Nuclear Power Plant are regularly monitored by both Hungarian and international organisations, including, for example, the World Association of Nuclear Operators, which conducted an on-site audit in Paks in 2005, while preparations are currently in progress for a new audit in 2012. The Paks Nuclear Power Plant is currently one of the safest power plants in international comparison, thanks to the safety-increasing improvements carried out in the 1990's, which considerably improved the conditions of the safe operation of the plant. It is essential to draw the conclusions of the comprehensive scientific investigation of the nuclear accident at the Japanese Fukushima Daiichi nuclear site, which should, in accordance with current practices, be applied by each country operating nuclear power stations for its respective nuclear sites with a view to increasing nuclear safety. In 2005, the Hungarian Parliament acknowledged the report on the extension of the service life (30 years) of the Paks Nuclear Power Plant by 20 years, as a solution required in order to ensure secure long-term electricity supply in Hungary. Similarly, pursuant to Parliamentary Decision no. 25/2009 (IV. 2), Parliament granted a preliminary theoretical consent to the commencement of preparatory activities for the construction of a new unit(s) at the site of the Paks Nuclear Power Plant.

In 2009, 8 percent of all electricity came from renewable sources, 68.5 percent biomass-based. Much of that energy is generated by the co-burning of firewood and coal in low-efficiency, obsolete power plants, which should be replaced for sustainability and energy efficiency reasons. Within renewable electricity generation, wind generators, hydropower, biogas and communal waste-based energy generation account for, respectively, 13.4%, 9.7%, 2.2% and 6.2%. Currently the biggest obstacles to the increase of the share of renewable energy sources are the disproportionate conditions of the feed-in tariff system, the unsuitable real-time controllability of the electricity grid and the bureaucratic and uncoordinated system of licences, involving several authorities.

3.4.3 HEAT ENERGY

Consumption is uneconomical due to the poor general condition of buildings.

In Hungary, 40 percent of the total energy consumption is currently consumed in buildings, about two-thirds of which goes for heating and cooling. 70 percent of the approximately 4.3 million Hungarian homes fail to meet modern functional technical and thermal engineering requirements, with a similar ratio for public buildings (Table 2).

In terms of communal energy consumption, adjusted for climatic differences, Hungary ranks among the ten highest consumers among the EU-27 (compared to the European average of 220 kWh/m²/year between

	detached houses	prefab blocks of flats	public buildings	recently built homes
average floor area (m²/home)	90	55	1200	80
average specific thermal energy consumption (kWh/m²/year)	320	200	340	100

Table 2: Estimated reference figures for the Hungarian building stock
Source: Hungarian Construction Industry Association, KÉK Working Group

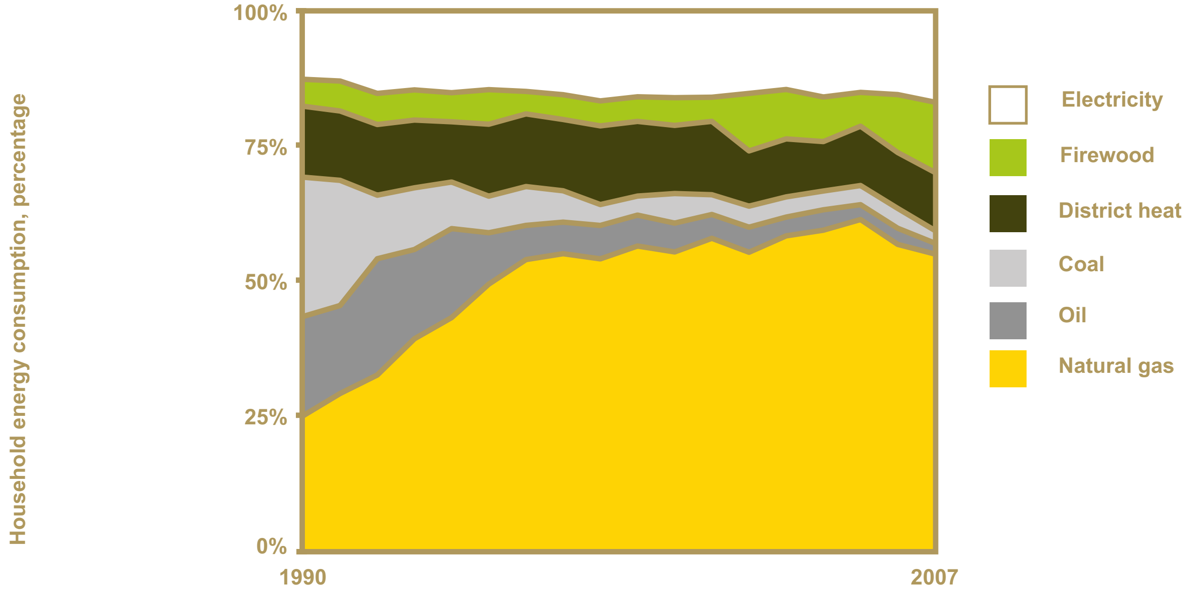

Figure 9: Energy consumption of Hungarian households by types of energy sources
Source: Energy Centre Hungary

2000 and 2007, the Hungarian average figure for retail consumption is 247 kWh/m²/year)[15]. While there has been an improving trend as the result of the communal energy efficiency programs implemented in recent years, no precise data are available due to the lack of a functioning system for the monitoring of the impact of the implemented projects.

Heat (space heating, hot water supply and cooking) accounts for about 80 percent of household energy consumption, supplied mainly through individual mains natural gas-powered heating apparatuses, firewood and communal district heating systems (Figure 9). The very high ratio of natural gas consumption in winter, mainly for heating purposes, presents particular regulation, reserve, capacity commitment and, consequently, supply security challenges to the Hungarian energy industry and economic diplomacy. The current situation could be considerably improved by an efficient and comprehensive building insulation and efficiency-improvement program for energy saving purposes, plus adequate motivation for a transition to renewable energy sources. At the current financing and techno-

[15] European Climate Foundation – Employment Impacts of a Complex, Large-Scale Deep Building Energy Retrofit Programme in Hungary, 2010

logical practices, the building energy renovation programs result in energy savings of 10 to 40 percent, as opposed to a potentially available level of 85 percent. Since the further complex retrofitting of a building, once it has undergone renovation, is out of the question for decades due to economy considerations, high costs and other difficulties, the current suboptimal renewal projects may 'lock in' Hungary on a still highly energy-intensive and high CO_2 emission trajectory. These considerations should also be taken into account on the planning of building programs. It requires an economic policy decision whether the energy bills of twice as many consumers should be reduced by 40 percent or those of half as many consumers by 80 percent.

Within final consumption, the share of district heating has declined from 12 percent in 1990 to 8 percent in 2007. Currently 15 percent of Hungarian homes, an overwhelming part of which (650,000 homes) were built with industrial technology, are connected to the district heating systems. Apart from communal consumption, about 12 percent and 25 percent of the total volume of district heat are consumed respectively by public and industrial consumers. About 6,000 homes are heated by geothermal energy. The share of renewable energy in communal consumption is difficult to determine precisely, due to the private, non-monitorable purchasing of firewood.

3.4.4 TRANSPORT

Increasing motorisation, a shift in freight transport toward energy-intensive and polluting road transport.

In Hungary, transport accounted for 68 percent of the total petroleum consumption in 2009. Due to the petroleum intensity of transport, the sector has a high level of GHG emission. In Hungary, transport-related CO_2 emissions accounted for 23.1 percent of the total in 2007.

According to an estimate of the European Commission, transport-related CO_2 emission increased by 24 percent between 1990 and 2008, representing 19.5 percent of the total GHG emissions of the EU. According to the White Book[16] of the European Commission, the CO_2 emissions of the transport sector must be reduced below 50-70 percent of the 1990 level, if the EU intends to meet its climate change targets for 2050. In order to meet those targets, the transport sector should be included in the trading of emissions, which may in turn increase the competitiveness of CO_2–neutral fuels.

Within the sector, vehicle traffic is the main emitter, accounting for almost two-thirds of the total emission of the sector. This ratio exists despite the fact that in Hungary the number of cars per thousand persons (2009: 300) is still well below the average of the EU-27 (2009: 473). While internal combustion engines have improved substantially in terms of efficiency and emission, this has failed to substantially affect emission levels in Hungary. This is due to two reasons: first, the average age of the Hungarian vehicle fleet is over 10 years and, second, the number of vehicles gradually approaches the Western European level.

Due in part to that shift and partly to the increasing number of diesel-powered vehicles, diesel fuel consumption increased at a substantial rate, the sales of the Hungarian Petroleum Association (HPA) member companies representing well the trends in the total consumption increased from 332 million litres in 1992 to 1,696 litres in 2009. That increase is virtually responsible for the total fuel consumption increment, as the volume of petrol sold has varied between 1,400 and 1,700 million litres (Table 3)

According to table 3. the respective fuel sales peaked in 2009 at an annual consumption level of 3,268 million litres. According to the data for the first nine

[16] Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system – COM(2011) 144 final

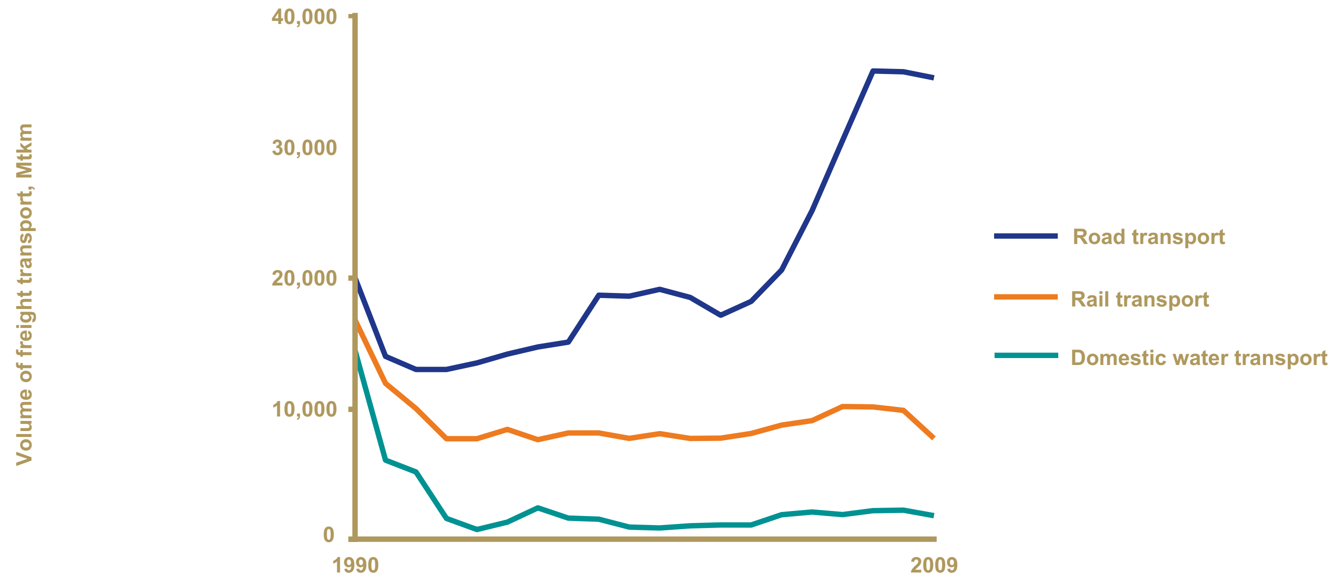

Figure 10: The distribution of freight transport in Hungary
Source: Energy Centre Hungary

months of 2010, that figure declined by 9.8 percent compared to the relevant period of the previous year. Experts estimate that the volume of autogas (propane & butane) consumed by road transport in 2009 was between 2.5 and 3 thousand tonnes. Officially, fifty thousand cars have been converted to LPG drive in Hungary.

The share of biofuels has been similar to the European average in Hungary. Currently, it is 4.2 percent on an energy content basis. In addition to blending, bioethanol trade is also typical in the form of E85 fuel (with a bioethanol content of 70 to 85 percent),

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Petrol	1604,7	1642,5	1692,7	1663,3	1616,8	1572,8	1647,0	1664,4	1612,6	1571,4
Diesel oil	1035,5	1090,9	1141,4	1158,1	1178,5	1272,9	1480,0	1574,2	1643,6	1696,3

Table 3: Fuel sales of the HPA member companies, million litres
Source: Hungarian Petroleum Association

even if it accounted for as little as 0.25 percent of the amount of petrol sold in 2009. In 2008, E85 consumption amounted to about 1.8 million litres, compared to which the 3.9 million litres consumed in 2009 represents an increase of more than 200 percent. The amount of ethanol required for the blending ratio prescribed by the EU is imported, whereas the E85 demand is satisfied from domestic production. The required ethanol is produced from maize, using first-generation technology. Such high rate of the increase of the share of E85 was made possible by the exemption of ethanol content from excise tax. However, due to the change of regulation in 2011, E85 is now competitive with a petrol price of about HUF 390-400/litre because of the excise tax imposed on ethanol (HUF 50/l), which will probably result in the decline of consumption and the shrinking of the domestic market.

Rail transport plays an indispensable role in reducing the energy consumption, environmental load and GHG emissions of the transport sector. At the same performance for a passenger kilometre, the energy demand of rail transport is a quarter of that of car transport and less than a twelfth of that of air transport. For a tonne-kilometre in freight transportation, this indicator is one-sixth of that a truck and twice that of boat transport. Taking the cost implications of externalities (including accidents, air pollution, nature and landscape conservation and noise pollution) into consideration, rail transport is still the best alternative. On a global scale, rail transport is gaining ground again with the emergence of the rapid rail system.

In 2008, 63 percent of the energy consumption of the Hungarian rail transport system was electricity, whereas oil products accounted for the rest. The latter type of energy, however, is used to effect only 10 percent of the transport capacity. Of the 7,718 km-long railway network, currently 35 percent is electrified, a great deal less than the 52 percent in the railway system of the EU-27. The comfort of railway travel is greatly reduced by the fact that only a small part of the network is suitable for a 160 km/h speed. On the whole, the Hungarian rail system is considerable behind the industrially advanced countries despite the fact that rail transport is the most advantageous transport mode after water transport in terms of energy consumption, environmental protection and other externalities.

4 PILLARS

'Our aim is to achieve a complex agriculture, environmental and landscape management, capable of producing valuable, healthy and safe food, local energies and various raw materials at the smallest possible burden to nature while preserving our soils, drinking water supplies, wildlife and natural heritage.'

(2010, The Program of National Cooperation)

The Energy Strategy should provide guidance in resolving the current energy challenges. If treated appropriately, today's problems will become tomorrow's potentials, not only for the energy sector but for the whole national economy and society.

In the light of the global climate protection challenges, the steadily shrinking global fossil fuel reserves and the competition for these reserves, the basic objectives of the long-term Hungarian Energy Strategy are, in accordance with the principles of the European Union, as follows:

• **Security of energy supply:** As a consequence of Hungary's geographical conditions and the lack of competitively extractable supplies of fossil energy carriers, the long-term maintenance of the security of supply remains a chief priority. Over the timeframe of the Energy Strategy, Hungary will probably continue to need to rely on energy import, which would not present a major risk if appropriately diversified supply routes and supply sources were available. However, Hungary is in a vulnerable situation in terms of the supply of traditional energy sources (particularly natural gas) due to the sources and transit routes available in the medium term. The most efficient and effective way, also viable in the short term, of increasing the security of supply is to reduce consumption and to treat energy savings and energy efficiency as priorities. However, the securing of natural gas supply from diverse sources and along alternative routes and the continuous maintenance of the existing infrastructure must also be continued. The fact that Hungarian energy policy is not on a path of inertia yet is due mainly to the still significant hydrocarbon, coal and lignite reserves, the Paks Nuclear Power Plant accounting for 42 percent of the Hungarian electricity production, our significant renewable energy potential and our commercial and strategic natural gas storage capacities that are outstanding by international standards. The limits of the utilisation of lignite and the extraction of the unconventional natural gas reserves (including, among others, the 340 billion m^3 Makó Trough deep gas deposit), however, are set respectively by the climate policy directions of the EU (the envisaged drastic reduction of CO_2 emissions) and the future competitiveness of the latter. With regard to a potential crisis situation, the extraction potentials, infrastructure and development of the Hungarian mineral deposits should be maintained.

• **Increasing of competitiveness:** The Hungarian energy sector can promote the long-term competitiveness of the Hungarian economy by the following:

- integration into the single internal energy market of the European Union and its prevailing prices;
- the new industries gaining importance, with particular regard to the utilisation of renewable energy sources, the improvement of energy efficiency and the related research and development activities;
- the appropriate management of domestic supplies and resources. Since mineral resources (particularly coal and uranium supplies) and the geothermal potential are a national treasure, they should be employed and developed nationally and treated partly as strategic supplies. The afforestation of land unsuitable for the cultivation of crops and the cultivation of energy crops, while giving priority to sustainability criteria, present a useful land utilisation alternative from environmental and social respects. These would enable the production of local energy sources and thus the mitigation of energy poverty, in addition to ensuring the availability of raw materials for other purposes.

Taking advantage of local conditions, including in particular the export of green products and technologies based on the biomass product chain, may increase the performance of the Hungarian economy provided that the required training, industrial and innovation knowledge base is developed. The most important role of the government in increasing the competitiveness of the economy, particularly of SMEs, is to ensure an attractive investor environment. Among other things, that can be achieved through long-term, stable and efficient legal and administrative regulation, the simplification and acceleration of administration and the maintenance, development and improved availability of infrastructures. From an energy point of view, competitiveness means that economic operators in Hungary should have access to the required energy at a high level of safety and, particularly as far as natural gas is concerned, at a price not exceeding the price level of the European Union. In other words, competition within the energy sector must result in a cost level acceptable to the economy. The business conditions of the energy sector and energy consumers will be determined by competition on the national, regional and, within a few years' time, the single EU markets, which essentially requires a Hungarian regulatory environment stimulating competition. In addition to the above, competition leads to increased consumer awareness and forces stakeholders to increase the efficiency of operation. In addition to the wholesale energy prices achieved on the single market, regulated network access fees also play an important role, as the former only account for a part of the value appearing on the energy bill. These price regulation methods and fees should be of a measure that stimulates network development, the propagation of smart measurement methods and the improvement of efficiency. Energy policy aims to establish transparent and non-discriminatory conditions for operators and consumers in Hungary. The required energy policy structure should enable the provision of high-quality energy services to the Hungarian society and economy.

• **Sustainability:** The combination of the issues of the environment and development can ensure continuous social wellbeing, the satisfaction of the needs of future generations and the preservation of our natural, social and cultural heritage. In other words, sustainable energy management must strike a balance between environmental (resource-efficient, climate-neutral), social (secure, accessible, non-harmful to health) and economic (cost-effective) considerations. It is based on the reducing of energy consumption and the production and transmission of the required energy in the most efficient manner possible, preferably from renewable sources, under strict conditions. Its implementation also requires a critical review of consumption patterns and their changing through awareness-raising. These efforts may enable the achievement of a living standard ensuring long-term sustainability and prosperity. As far as the required means are concerned, low CO_2-emission technologies must be supported, the spreading of smart grids and meters must be encouraged, the application, as soon as possible, of viable green innovations must be fostered and wide-ranging awareness-raising programs must be launched with a view to achieving a society conscious of its future and environment. The gradual reduction of the share of fossil fuels may alleviate the environmental load, which will in turn improve the quality of life. The development of sustainable energy management is facilitated by the quantification of the externalities related to the modes of energy production, particularly the use of fossil fuels (e.g. the trading of GHG emissions). In order to quantify the externalities and thus to arrive at realistic comparisons of the various modes of energy generation, technologies must be assessed through life-cycle-based cost analyses. As far as the use of conditionally renewable energy sources (biomass and geothermal energy) is concerned, it is increasingly important that environmental criteria should be taken into consideration and sustainability criteria, giving priority to water management and soil protection issues, should be employed.

These objectives must be asserted in the framework of the Hungarian economy and society, making the most of the country's natural, social and geopolitical conditions, at an optimal cost-benefit ratio (Figure 11). Energy policy is an organic part of industrial and development policies. The achievement of its objectives is therefore closely linked to other areas of the economy and should inevitably take into consideration the development strategies of the latter and the impact of energy policy on their development. The four most important related horizontal areas (rural development, education, training and employment, environmental protection and nature conservation, social and welfare considerations) are discussed in separate chapters.

Due to their nature, however, the targets cannot be met simultaneously. Since the short-term maximisation of competitiveness may result in the over-consumption of resources and overburden the environment, the contradictions between short and long-term competitiveness need to be reconciled. Excessive efforts to ensure the security of supply may also have an adverse effect on competitiveness and sustainability.

The contradictions between the objectives can be reconciled through employing the following measures at the

Figure 11: The pillars of the Energy Strategy

required weight. A SWOT analysis is used to show the possible extent these measures may contribute to the achievement of the targets as well as the obstacles to their use, on the basis of current practice. The detailed role of the five highlighted tools is discussed in the Vision 2030 chapter, broken down by the four sectors, and in the Role of the Government chapter.

• **Energy efficiency and energy conservation:** The most efficient ways of maintaining or even reducing the level of energy consumption are the minimisation of losses and the non-consumption of energy. Energy efficiency can be improved at the lowest cost, while achieving the highest social and climate protection benefit, through energy renewal projects in the construction industry. The implementation of an energy efficiency program encompassing an entire supply chain enables the reduction of increasing demand, particularly for heat energy, and the simultaneous reduction of the expenses of citizens. As far as electricity consumption is concerned, no substantial savings are expected due to the increasing number of household appliances. It is difficult to make predictions concerning the emergence of new IT, communication and media products, the number which has increased at a substantial rate in recent years. Also, the energy consumption of these appliances is difficult to reduce in an efficient manner, on account of the diversity of such products, the low priority attributed to their energy consumption when the decision on their purchase is made and various other reasons. Consequently, the electricity consumption of households and public buildings is expected to increase at a substantial rate, which increase can probably only be reduced to a small extent by public policies and other measures. Therefore, awareness-raising is an indispensable tool of promoting a low-energy lifestyle.

• **Renewable energy sources:** In European comparison, Hungary has a relatively good renewable energy potential in the fields of the utilisation of biomass, biogas, geothermal and solar energy, which potential, however, is currently not properly utilised. Reserve capacities also exist in the fields of hydro energy and waste to energy utilisation. In terms of utilisation, decentralised practices must be distributed and the required incentives must be provided, which should result in the increase of the share of renewable energy at least to the extent required by Hungary's international commitments. With regard to promoting the use of the various energy sources, the resultant efficiency of the energy transformation product chain must be taken into account, i.e. energy generation based on local heat utilisation should be given priority for the biogenic energy sources with a substantial potential in Hungary. The in-

Energy efficiency and energy conservation	Factors conducive to achieving the objectives	Factors hindering the achievement of objectives
Internal factors	**Strengths** Complex program spanning the entire supply chain; job creation; cutting back on consumption	**Weaknesses** Awareness-raising and social communication and the absence of follow-up monitoring
Basic conditions	**Opportunities** The priority role of energy efficiency within the EU	**Threats** Lack of proper funding

Renewable energy sources	Factors conducive to achieving the objectives	Factors hindering the achievement of objectives
Internal factors	**Strengths** Job creation; import reduction; local innovation	**Weaknesses** Complex legal background; adaptation of the existing network; substantial support of the use of fossil fuels
Basic conditions	**Opportunities** Appropriate domestic potential; increasingly strict climate policy; emission-reduction targets; technological development; funds from the EU and the Kyoto mechanism	**Threats** Lack of proper funding and financing schemes; real price of fossil fuels (externalities)

clusion of renewable energy sources in individual heat supply, e.g. by the use of heat pumps, will also reduce demand for natural gas.

· **Nuclear energy:** The use of nuclear energy makes a substantial contribution to the maintenance of the security of supply and, through its low operation cost, to the competitiveness of the national economy. The fuel rod reserves of the Paks Nuclear Power Plant are currently sufficient for two years. In the case of nuclear fuels, the cost of fuel per energy content is considerably lower than for fossil fuels. The cost of nuclear fuel rods, including the extraction and enrichment of uranium and the manufacturer of fuel rods, amounts to about 10 to 15 percent of the cost of nuclear electricity generation. The low unit cost of electricity generation makes up for the high investment costs of nuclear power plants. As nuclear power plants are almost emission-free producers of electricity, they are economical and efficient tools of meeting the environmental and climate protection targets. The need for the replacement and the potential expansion of the existing capacity by new units is underpinned by the need to replace the existing obsolete power stations, the expected average 1.5-percent annual increase of demand for electricity, the meeting of the increasing electricity demand as a result of the desired electrification of transport and heating/cooling and the shrinking of our import. The electrification of heating/cooling is due to the spreading of high-efficiency (COP>3) heat pumps and the increasing demand for air-conditioning. However, a new nuclear project requires a great deal of preparation and guarantees of safe operation, in accordance with strict regulations. Detailed information must be provided to the public on the construction of the new nuclear unit(s) in order to achieve the highest possible level of social acceptance. Therefore, the Annex to the Energy Strategy also includes an analysis of scenarios that do not envisage the increase of the current share of nuclear energy or even calculate with the elimination of nuclear energy in the country's energy supply.

• **Regional infrastructure platform:** Cooperation with the neighbouring countries (particularly in the framework of the North-South High-Level Group, the V4 and V4+) aims at ensuring price stability, the diversification of resources, the security of supply and the increasing of regulatory network capacities. The integration of the networks, market and trading systems of neighbour-

Nuclear energy	Factors conducive to achieving the objectives	Factors hindering the achievement of objectives
Internal factors	**Strengths** High share, existing background; energy import reduction, meeting of decarbonisation targets, increasing security of supply	**Weaknesses** Level of social acceptance; potential sense of danger; high investment demand and long installation process
Basic conditions	**Opportunities** Emergence of fourth-generation technology; meeting of emission targets	**Threats** Handling, transportation and export of spent fuel; increased danger in a disaster

Regional infrastructure platform	Factors conducive to achieving the objectives	Factors hindering the achievement of objectives
Internal factors	**Strengths** Existing domestic natural gas infrastructure, including storage capacities	**Weaknesses** The existing level and controllability of the electric grid; lack of electricity storage capacities
Basic conditions	**Opportunities** Similar efforts of the neighbouring countries and the EU; establishment of a single internal market	**Threats** Risk of the lack of political dialogues, financing and resource sharing issues

ing countries enables the establishment of a regional infrastructure platform and the resulting price competition. The existing national market sizes and production structures restrict the development of a genuine source-based wholesale competition. With regard to energy, the platform includes the regional integration of the natural gas, oil and electricity systems and the concept may be extended to include the rail and road transport networks, including in particular the development of rapid rail networks and the optimising of schedules. The share of nuclear energy and renewable energy sources will probably increase within the region, which requires closer cooperation in the fields of system management and energy storage. That would enable the increased utilisation of the renewable energy sources (and the hydro pump facilities) of the region and would, in general, increase the flexibility of the system. The possibilities of the joint management of the electricity grid will have to be examined in order to address these tasks. The implementation of projects with a view to diversifying the purchasing of natural gas also requires the strengthening of the regional role. The plans of the European Union also point toward the development of an integrated infrastructure, where regional action may be more efficient.

• **New system of the government's energy institutions and tools:** A system of institutions ensuring the predictability of the investor environment must be established. Lack of the above would weaken a long-term security of supply and result in the failure of indispensable energy projects. Permitting processes should be predictable, transparent and simple for investors. It is of crucial importance that the stability and credibility of the system of the government's energy institutions should be ensured in the long term in order that it should be able to put the Energy Strategy into practice and to monitor its implementation on an ongoing basis. The key to the sustainable operation of the energy sector is an independent, predictable, accountable and investment-stimulating industrial regulation in accordance with EU requirements and regional efforts and the corresponding stable support policy, having a clear direction. However, the system of regulatory tools may sometimes prove insufficient in order to assert public good and the national interest. The government should have appropriate information and ownership interest in the crucial industries in order to be able to influence negative market trends.

With a view to competitiveness, the security of supply and sustainability and taking into account the economic productivity of Hungary, the system of tools should be in accordance with economic considerations, international commitments, the principle of cost efficiency and the mitigation of environmental loads. Environmental and natural resource management criteria must be borne in mind with a view to meeting the sustainability criteria.

New system of the government's energy institutions and tools	Factors conducive to achieving the objectives	Factors hindering the achievement of objectives
Internal factors	**Strengths** Political commitment from the government; calculable and predictable business environment	**Weaknesses** Diverse interests; slow decision-making; lack of a consistent support policy; shortage of funds
Basic conditions	**Opportunities** Study of the properly functioning systems in other countries	**Threats** Narrowing room for manoeuvre of the member states in certain issues; economic pressure by energy exporter countries

5 BASIC CONDITIONS

„As peaking [of oil production] is approached, liquid fuel prices and price volatility will increase dramatically, and, without timely mitigation, the economic, social, and political costs will be unprecedented."

(2005, US Department of Energy)

"Without resolute counteraction, climate change will overstretch many societies' adaptive capacities. This could result in destabilization and violence, jeopardizing national and international security to a new degree."

(2007, WBGU)

In the light of the situation described above, it is obvious that energy consumption is influenced by a number of external circumstances beyond the control of Hungarian energy policy. These domestic or global trends must be analysed and synthesised, as the energy market functions in this environment. The following trends have been taken into consideration for the development of the Energy Strategy.

5.1 CLIMATE POLICY

While international negotiations are currently in progress in connection with the management of climate change, the relevant requirements will probably become increasingly tight in the future. With a view to mitigating the negative environmental effects of climate change and to adapting to such effect, prevention and preparation should be given priority.

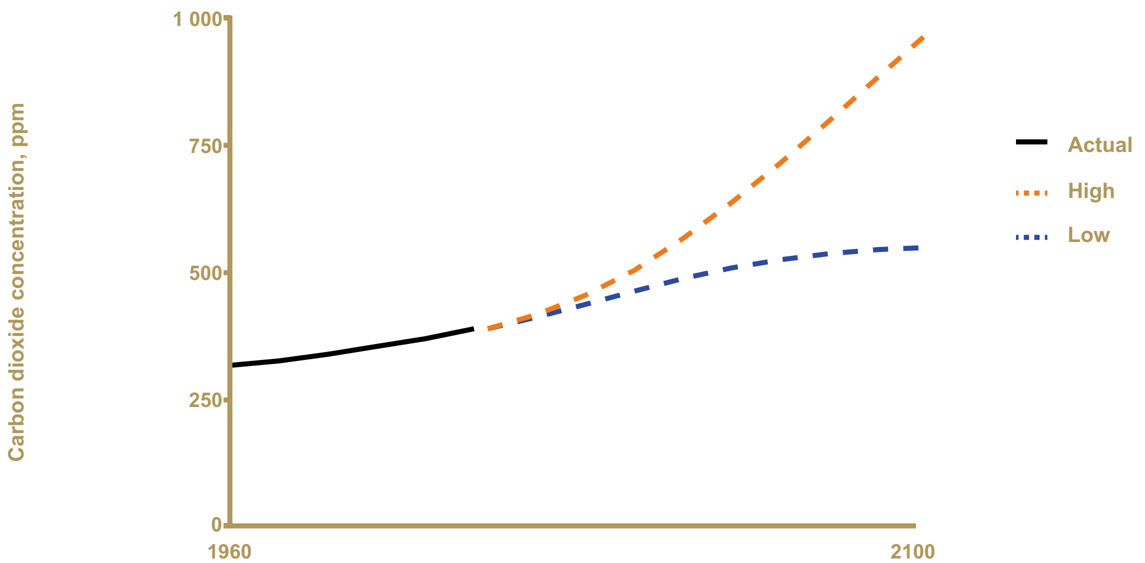

Figure 12: Two extreme scenarios of atmospheric CO_2 concentration
Source: UN, IPCC

In order to minimise the impacts of climate change, the atmospheric CO_2 concentration must be stabilised at a value not higher than 450 ppm, which requires the reduction of global emissions by 50 percent compared to the base year 1990, which translates to a reduction of 80 to 95 percent in the case of highly industrialised countries. That may help keep the rate of the increase of the average temperature below 2°C. While this threshold was determined on a policy basis, it also has a biomedical significance. Over that value, the mortality rate of middle-aged generations will also increase significantly, while the causes of death formerly characteristic only of the oldest generation will appear at an increasingly younger age. Without measures, the level of CO_2 will continue to increase, involving unpredictable meteorological and economic consequences (Figure 12).

For the first commitment period of the Kyoto Protocol, the EU-15 committed to a collective 8-percent reduction, broken down to member-state level through an internal division of the load. For Hungary, it specified a 6-percent reduction of emissions on average for the period 2008-2012, compared to the average of the period from 1985 to 1987. Since, as a result of the decline of heavy industry and the economic crisis, in 2009 the actual level of emission was 43 percent lower than the base, the international trading of emissions represents an important opportunity for Hungary. If we fail to seize that opportunity in the right way, the increase of prices due to the incorporation of externalities will have an adverse effect on Hungarian society. According to the envisaged regulation of Phase 3 of the EU ETS (Emissions Trading System), from 2013 free allocations will be completely eliminated in the electricity sector and certain currently exempt transport sectors may also become part of the scheme. In other industries, with the exception of the ones affected by carbon leakage, free allocations will amount to 70 percent, to be linearly reduced to zero by 2020. As far as the electricity sector is concerned, new EU members, including Hungary, may request a derogation until 2019 for high-efficiency co-generation power plants[17]. The industries affected by carbon leakage, i.e. the overwhelming part of industries in terms of emissions, will receive allowances 100-percent free of charge on a benchmark basis. In addition to the above, in Phase 3, national allocation plans will be eliminated. Instead, the rules of allocation will be directly determined by the European Union, member states determining the quantities on that basis.

The reduction of emissions on a global level remains a crucial issue. Since the European Union is responsible for slightly over 10 percent of global emissions, it will be unable to manage the process on its own. The issue of global treaties is significantly set back by the fact that various major stakeholders (including China) are pursuing double politics, i.e. while refusing to commit to mandatory targets under a global treaty, they make serious efforts in their domestic policies, even if the latter are motivated by energy policy and technological development rather than climate policy.

The negative economic impacts of climate change-related extreme natural occurrences are clearly demonstrated by the statements of insurance companies. In 2010, a total of 950 natural disasters resulted in 295,000 casualties and damages of $130 billion, $37 billion of which was insured. The increasing number of storms, extremely high temperatures and other climate-related

The basic condition	
is uncertain, because	• the implementation of international climate protection treaties is doubtful; stricter climate policy objectives must, however, be taken into consideration. • the declared policies of certain countries, as seen from outside, do not necessarily match their actual internal policies • developing countries are not expected to join global climate protection programs before 2020, while they have failed to make any commitments, e.g. in terms of reducing their energy intensity, other than the ones in connection with the Copenhagen Climate Summit.
expected consequences	• the energy consumption structure of the EU will change; at the same time, the extent of the transformation of the Hungarian energy mix depends on our national commitment. • while CO_2-free economic sectors gain a competitive advantage vis-à-vis competitors within the EU, they may suffer a significant competitive disadvantage in the short term vis-à-vis the economies of developing countries or those developed countries that have not committed to reducing emissions. The current investments, however, are made for several decades ahead and therefore the procrastination of action may result in considerably higher costs for future generations and the EU may fall behind in the competition for new technology development. • in the event of our failure to achieve the required international cooperation, we will have to prepare for adaptation to deteriorating living conditions; great emphasis must be laid on prevention and preparation.

[17] Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community

disasters are an indication to the fact that the climate continues to change. The number of natural disasters in 2010 greatly exceeded the annual average of 615 for the past 30 years. The number of the casualties is four times higher than the 66,000 average of the same period. In 2010, costs significantly exceeded the average $95 billion for the past 30 years.

The population of Hungary is already affected by the negative environment effects of climate change (inland waters, floods, droughts etc.). The remedying of damages requires an ever-increasing amount of budgetary funding. The increasing frequency of extreme climatic occurrences is expected to result in the impossibility of economic forecasts and the decline of crop security. However, since the output of Hungary is only a fragment of the global output, our main task is to prepare for adaptation. As far as the reduction of emissions is concerned, the primary objective is to meet our commitment as an EU member state. Hungary should therefore put great emphasis on preparation for the consequences of climate change and adaptation to such consequences. Besides the energy tasks, climate and energy issues are also affected by the measures in order to achieve environmental safety, promote the efficient management of natural resources and develop the environment. To that end, measures must be adopted and development programs must be drawn up in accordance with the objectives of the Energy Strategy and the National Climate Change Strategy.

While meeting the current targets does not present a challenge for Hungary, we need to prepare ourselves for a tighter climate policy trend and the definition of a new base year, which will no longer give us an advantage, unlike the benchmark year of 1990.

5.2 FOSSIL FUEL RESERVES

The availability of petroleum will become increasingly uncertain during the forthcoming decades, involving the risk of increasing price volatility. While the depletion of reserves is not an immediate risk, the demand-supply imbalance and the lack of accurate information concerning the volume of the reserves may lead to future disturbances of supply.

The complexity of the situation is aggravated by the fact that 70-80 percent of the existing petroleum supply is situated in the territory of politically unstable or authoritarian regimes. The resulting problems are clearly demonstrated by recent political events in the Arabic countries of North Africa. As far as the extraction of conventional oil is concerned, the peak of production was reached in 2006 according to the International Energy Agency, whereas the peak is predicted to be reached by most authoritative estimates before 2030 (Figure 13). This may also signify a radical transformation of the current economic and social structure and the start of the competitiveness of renewable technologies. Rather than the size of the available supplies, the time of reaching the peak depends primarily on global energy policy trends, the demand, the change of the price of oil and rate of technological development. By definition, the reaching of peak oil means that half of the available supplies have been extracted. The problem is that the remaining half can be extracted with more difficulties and at a greater cost in the future. Therefore, the continued high price of petroleum and, indeed, its further increase must be taken into account in the long term. While the size of oil supplies appears to be increasing, such oil is to be found mainly at smaller oil fields and unconventional sources. The smaller a field, the slower the rate of extraction and the sooner it is depleted, therefore the return on investment is more uncertain. The quantity and occurrence of unconventional oil and natural gas, extractable at a higher cost, have not been completely mapped and their extraction may involve a lot more environmental damage, which casts a doubt on their long-term competitiveness. As far as natural gas is concerned, the increasing diversification of resources and the availability of unconventional supplies (shale gas, tight gas) will result in the emergence of a buyer's market in the EU. However, the growing energy demand of China and India presents an added risk since, like Central and East European countries, they target Russia, Central Asia and the global LNG market as their primary source of supply. The German, Swiss and Italian nuclear phase-out and the tightening of the GHG emission reduction expectations will probably lead to a further increase of the demand for and the price of natural gas. They will drive demand toward natural gas from nuclear energy and the increasingly uncompetitive coal-burning power plants, respectively.

For Hungary, this may result in the increase of oil product prices and, in the case of a potential conflict, the uncertainty of supply. All efforts must therefore be done in order to reduce oil dependency. The most effective means to that end include the promotion of renewable and alternative forms of transport and the development of community transport, particularly of rail transport. As far as natural gas is concerned, if enabled by infrastructure development, it is expected that a buyer's market will emerge in the short or medium term and prices will temporarily decrease. In a longer term, however, market spot prices and the oil-indexed natural gas prices based on long-term agreements are likely to level off.

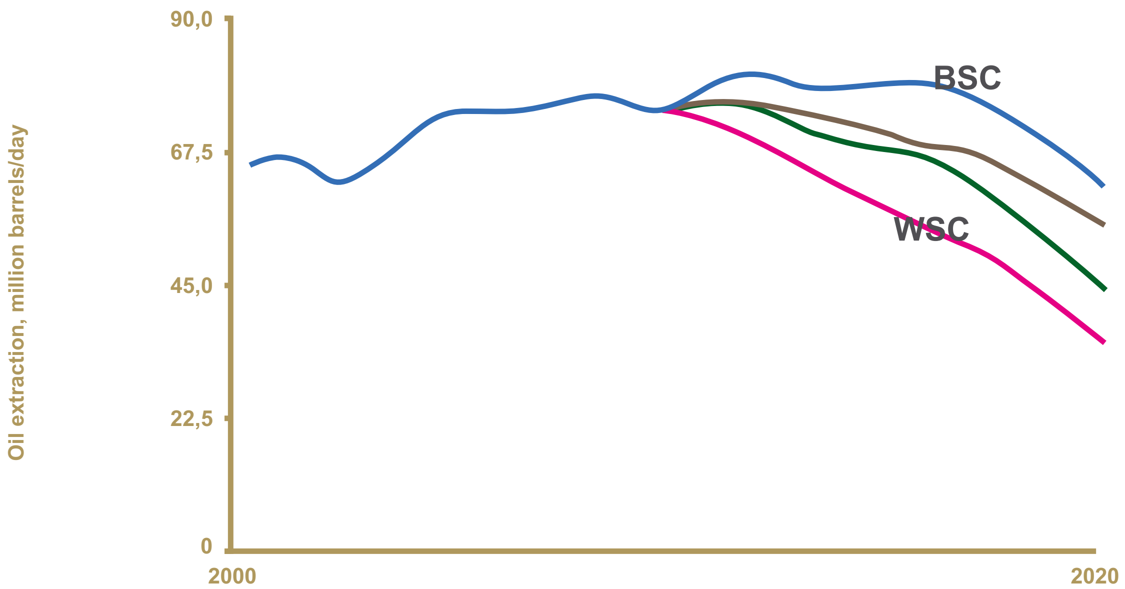

Figure 13: An example of forecasting peak oil – peak oil scenarios depicting depletion as a function of two variables, the new field database and the depletion rate of existing fields.
WSC: Worst Case Scenario, BSC: Best Case Scenario.
Sources: Energy Watch Group, Industry Task-Force on Peak Oil and Energy Security, Bundeswehr Transformation Centre

The basic condition	
is uncertain, because	• information on fossil fuel reserves are deficient due to the development of oil and natural gas extraction technologies, the increasing extraction of unconventional deposits and the withholding of production by exporting countries. • the countermeasures envisaged by governments are unknown.
expected consequences	• change of the transport structure, requiring international cooperation and political will: the gaining ground of electric and/or hydrogen power, biofuels and biogas and rail transport. • increasing reliance on electric heating/cooling (heat pump). • in the event of the actual tapering of supply, we need to prepare for adaptation to a new resource structure, which will lead to the increasing importance of domestic and local resources.

5.3 EUROPEAN COMMITMENTS

The binding targets based on the Directives of the European Union, with particular regard to emission reduction, energy efficiency and the share of renewable energy sources, have to be determined in accordance with our potentials, economic situation and conditions.

In 2007, ambitious energy and climate policy targets were adopted by the Council of the European Union: for 2020, a 20 percent or, if certain conditions are met, the 30-percent reduction of GHG emissions, the increase to 20 percent of the share of renewable energy sources and a 20-percent improvement of energy efficiency. These targets are confirmed in the EU2020 strategy[18] and the EU Energy 2020[19] strategy. With a view to boosting the trading of CO_2 emission allocations, the Commission proposed to reduce GHG emissions by 30 percent by 2020[20]. The confirmation, in any form, of the reduction target is given a framework by Directive 2009/29/EC[21] amending the ETS Directive or Decision 2009/406/EC[22] on the distribution of efforts.

On the level of the government, the following Directives must be taken into consideration:

Directive 2009/28/EC[23] lays down the conditions for the achievement of the binding target concerning the share of renewable energy sources. While the 20 percent share of renewable energy sources is an EU average, the commitments are broken down by member states. For Hungary, the target is 13%. Pursuant to the Directive, renewable energy sources should account for 10 percent of the energy consumption of transport on a uniform basis in each member state by 2020.

Directive 2010/31/EU[24] provides that the minimum requirements for the energy performance of buildings should be set with a view to achieving a cost-optimal balance between the investments involved and the energy costs saved throughout the lifecycle of the building. Pursuant to the Directive, measures are needed to increase the number of buildings which not only fulfil current minimum energy performance requirements, but are also more energy efficient. Member States are required to draw up national plans for increasing the number of nearly zero-energy buildings.

The Service Directive 2006/32/EC[25] intends to promote the improvement of energy efficiency in a cost-effective manner through an effort to improve the energy intensity of unadjusted final consumption, not falling under the scope of emissions trading, by one percentage point per annum. To that end, the Directive provides for the drawing up National Energy Efficiency Action Plans by the member states and their regular review. The action plans should aim at reducing final energy consumption, calculated in accordance with the Directive, by 9 percent up to 2016 compared to the average of the years 2002 to 2006. In summer 2011, the Commission commenced the review of the Directive and the repealing Directive is expected to be adopted by late 2012.

On its October 2009 meeting, the European Council called EU member states and highly industrialised countries to reduce their greenhouse gas emissions by 80-95% up to 2050 compared to the benchmark year 1990. That target is included in the 'Roadmap for moving to a competitive low carbon economy in 2050'[26] document, in an industry-specific breakdown (Table 4).

Regulation 713/2009/EC[27] of the European Parliament and of the Council established the Agency for the Cooperation of Energy Regulators (ACER), whose main task is to support the performance, at Community level, of the regulatory tasks carried out on a national level by the national regulatory authorities and to coordinate, if appropriate, the operation of such authorities and of the transmission system operators. Where the competent national regulatory authorities have not been able to reach an agreement on the issues concerning access to cross-border infrastructure or upon their joint request, the ACER shall decide on the conditions of accessing such infrastructure (the capacity allocation procedure, the time-frame for allocation, the shared congestion revenues and the charges of the use of the network). It may also decide, under similar conditions, on requests for exemption of new interconnector capacities, in accordance with the rules of the third energy market liberalisation (legislation) package.

The ACER is entitled to communicate opinions and make recommendations to the transmission system operators, the national regulatory authorities and the

GHG emissions compared to 1990	2005	2030	2050
Total	-7%	-40 to -44%	-79 to -82%
Sectors			
Power (CO_2)	-7%	-54 to -68%	-93 to -99%
Industry (CO_2)	-20%	-34 to -40%	-83 to -87%
Transport (incl. CO_2 aviation, excl. maritime)	+30%	+20 to -9%	-54 to -67%
Residential and services (CO_2)	-12%	-37 to -53%	-88 to -91%
Agriculture (non-CO_2)	-20%	-36 to -37%	-42 to -49%
Other non-CO_2 emissions	-30%	-72 to -73%	-70 to -78%

Table 4 – The decarbonisation schedule of the European Union

The basic condition	
is uncertain, because	• the most important existing and future documents (EU Energy Efficiency Action Plan, Energy Roadmap 2050) set the long-term course of energy policy. They may even require the review of the Hungarian Energy Strategy.
expected consequences	• our commitment toward the European Union determines Hungary's renewable energy and energy efficiency policies until 2020. The development of the documents to transpose these into the Hungarian regulation is currently in progress (National Action Plans, the New Széchenyi Plan and the National Reform Programme). • the second and third Energy Efficiency Action Plans will be drawn up pursuant to Directive 2006/32/EC. • the expected decline of the national regulatory role and the increasing influence of the ACER.

[18] Communication from the Commission – EUROPE 2020 A strategy for smart sustainable and inclusive growth, COM(2010) 2020 final

[19] Communication from the Commission – Energy 2020: A strategy for competitive, sustainable and secure energy – COM (2010) 639 final

[20] Communication from the Commission – Analysis of options to move beyond 20% greenhouse gas emission reductions and assessing the risk of carbon leakage, COM(2010) 265 final

[21] Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community

[22] Directive 2009/406/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community' greenhouse gas emission reduction commitments up to 2020

[23] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

[24] Directive 2010/31/EU of the European Parliament and of the Council of May 2010 on the energy performance of buildings

[25] Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Councul Directive 93/76/EEC

[26] Communication from the Commission – A Roadmap for moving to a competitive low carbon economy in 2050 (COM(2011) 112 final)

[27] establishing an Agency for the Cooperation of Energy Regulators (text with EEA relevance)

most important institutions of the EU, to adopt individual regulatory decisions in specific cases and to submit non-binding framework guidelines to the Commission.

For Hungary, it involves meeting a share of renewable energy production of 14.65 percent up to 2020. As far as energy efficiency is concerned, currently there are no binding targets for the whole of the EU. Voluntary targets by the member states will be examined by the Commission in 2013. Binding targets for the individual member states will be allocated by the Commission on the basis of the outcome of its review of the potential feasibility of the 20-percent energy efficiency target up to 2020. As regards climate policy objectives, while no decision has so far been adopted on the tightening of the current targets in order to bring them into line with the 2050 perspective, it will probably happen. In addition to the above, the regulatory efforts of the European Union would suggest that we will need to reckon with a gradually diminishing scope for national regulation due to the extension of the central regulatory competences in the fields of energy and financial policies and the strengthening of regional and European coordination.

5.4 TECHNOLOGICAL DEVELOPMENT

Certain renewable technologies will be able to enter market competition during the forthcoming decades without investment and operation subsidies, as a result of technological development and increasing manufacturing capacities. While costs will probably decrease at a particularly powerful rate in the field of solar energy utilisation technologies, other renewable energy sources will also become available at lower prices (Figure 14).

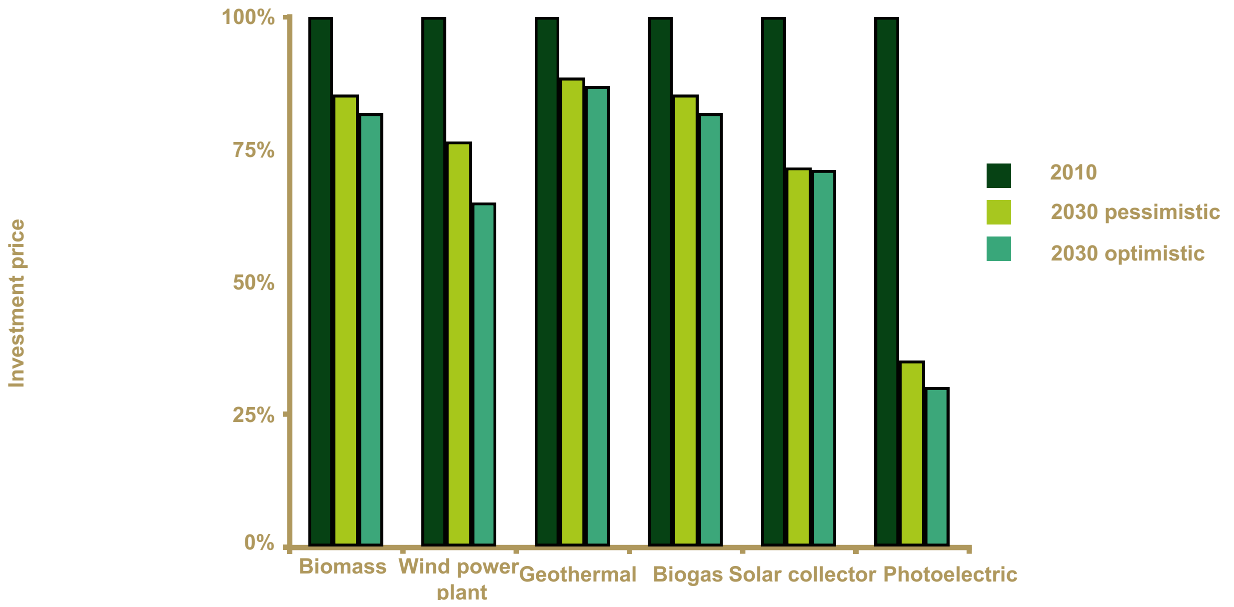

Figure 14: The expected reduction of the investment costs of alternative energy technologies
Source: IEA and Energy Watch Group

The growth of their market share can be accelerated through quantifying the externalities of fossil fuels (e.g. emissions trading with properly priced carbon prices) and a range of targeted aids. Fourth-generation technology may be introduced in the field of nuclear energy production, enabling a more efficient use of uranium supplies, thus multiplying the availability period of reserves. Technological development will also be of critical importance in terms of the extraction of unconventional fossil deposits, while the operation and further construction of natural gas, lignite and coal-burning power plants may be influenced to a considerable extent by the regulation of CO_2 emission and, in that context, the economy of CCS and clean coal technologies. Currently, however, CCS is one of the most expensive technologies in terms of its cost per unit of emission reduction, significantly exceeding the respective unit costs of renewable energy sources. Captured CO_2 is also a raw material of the chemical industry, whose utilisation may be more beneficial than its underground storage.

Apart from energy generation, however, the energy efficiency and environmental performance of energy-related products (including more than 30 groups of equipment) are also expected to improve, as stipulated for manufacturers by Directive 2009/125/EC[28]. Pursuant to Directive 2010/30/EU[29], the equipment shall be classified into seven product classes according to their energy efficiency (A+++ – G), which classification shall be indicated at the point of sale in order to provide information to consumers and increase the level of information consumer choices are based on (energy labelling). In addition to the above, smart metering and smart networks are also expected to improve, enabling the equipment to take part in the regulation of the electric grid.

For Hungary, this implies the availability of new alternative technologies. However, for certain technologies (including, for example, CCS and fourth-generation nuclear power), it represents a following policy only. Wherever possible, however, with particular regard to the utilisation of renewable energy sources, we need to exploit and put into practice the domestic R&D and innovation potential. This may help Hungary become an exporter of technology.

The basic condition	
is uncertain, because	• the potential fall in prices due to technological development and mass production will be determined by the energy strategies and development policies of the markets setting global trends. • unless innovation in the field of renewable energy focuses on lowering the cost of renewable energy, the positive discrimination of renewable energy production cannot be maintained in the long term. • it cannot be foreseen how long the current level of the cost of fossil fuels can be maintained under an increasing environmental pressure. If the price is burdened by externalities, alternative technologies will sooner become competitive without subsidies.
expected consequences	• on the basis of current international trends, significant competition and development are expected primarily in the fields of wind and photovoltaic power generation and electric and hydrogen-powered vehicles.

[28] Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products

[29] Directive 2010/30/EU of the European Parliament and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products

5.5 DEMOGRAPHIC INDICATORS

According to the forecast of the Eurostat, the population of Hungary will decrease by 4 percent by 2030, to approximately 9.5 million. Considering that household energy consumption accounts for a significant part of gross final energy consumption (34 percent in 2009), the population decline could even involve the decrease of the energy demand.

It must be taken into account, however, that the civilisation and consumption levels of substantial groups of the Hungarian society are below the accepted Western standards, their desired catching-up will result in the growth of energy consumption. The changing consumption patterns (including the increasing number of electric appliances and air-conditioning) and the increasing level of urbanisation are the demographic factors responsible for the greater part of that growth, particularly manifested in electricity consumption. Without policy intervention, the energy demand of heat utilisation and transport would also increase. The latter, however, can be controlled by established technologies and financing methods.

The basic condition	
is uncertain, because	• the population decline and the undesirable distortion of the age pyramid will require government measures during the timeframe of the Energy Strategy.
expected consequences	• since per capita energy consumption is likely to increase despite the energy efficiency measures, on the whole, at best, the stabilisation of household consumption can be expected.

5.6 ECONOMIC GROWTH

As far as economic growth is concerned, there are two indicators having energy policy implications. The first is the energy cost or energy consumption per unit of GDP change, which shows a declining trend.

The diverging trends of the GDP and primary energy demand in highly industrialised countries will continue, due to the change of the economic structure (the shift toward services) and the improving efficiency of production. Indeed, that process is expected to accelerate, since in the sectors that may become the potential driving forces behind economic development, profit is typically generated through energy efficiency and energy conservation-related investments (Figure 15).

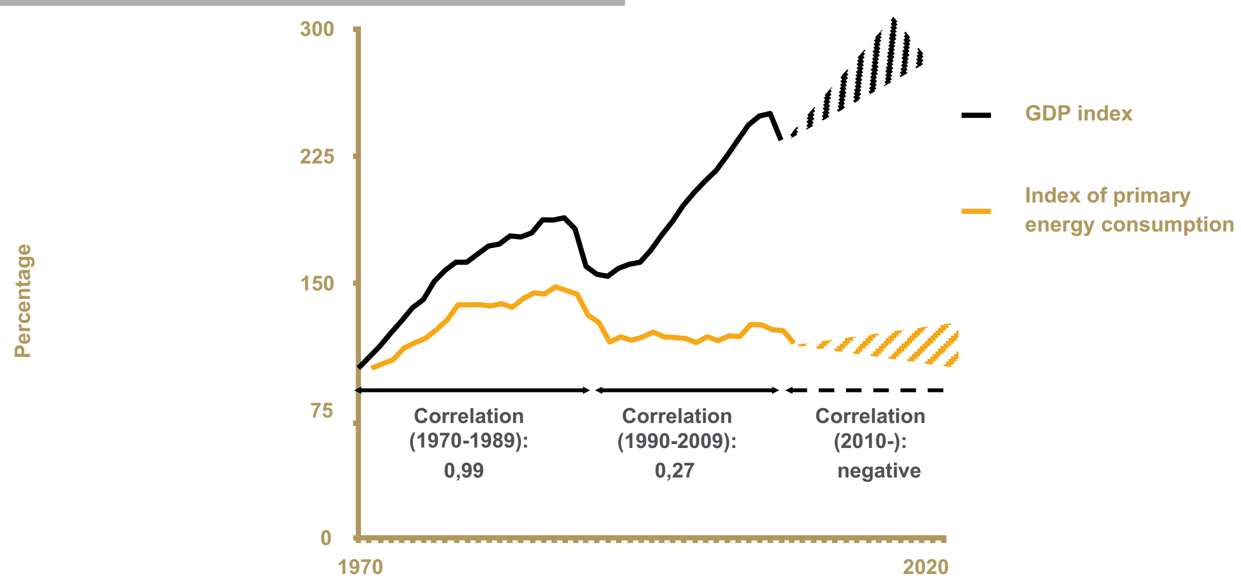

Figure 15 – Trends of the GDP and primary energy use in Hungary

In terms of per capita GDP, the current German level will probably be reached by 2030 if a steady and continuous rate of catching up is achieved. That will probably result in a gradual weakening, at least in the medium term, of the welfare aspect of energy supply. On the other hand, the strengthening of social inequalities and the further widening of the social gap would preserve energy poverty among certain social groups.

The basic condition	
is uncertain, because	• while the growth path of the Hungarian economy and its priority areas should be defined by economic policy, the emergence of a new global economic crisis cannot be ruled out
expected consequences	• a significant part of economic growth is generated by investments related to energy efficiency and renewable energy sources, the prerequisite of which is the establishment of a congenial economic environment facilitating our integration into technological development. • The growth of the share of renewable energies may have a stabilising effect on the economic path, since in this sector the number of projects has increased in the face of the crisis. Since that may result in the increasing divergence of the GDP and energy demand, the changes of the GDP has not been taken into account for the forecasting of the energy demands.

5.7 CONCLUSION

- While competition for energy sources will increase, its adverse effect can be mitigated by increasing integration, cooperation and solidarity within the EU.
- In the long term, the risks of the availability of energy sources will increase, and the emergence of an imbalance of the demand and supply of liquid hydrocarbons is expected during the timeframe of the Energy Strategy
- The environmental requirements concerning the production and use of energy will continue to tighten.
- As a result of the above, the costs of the extraction of energy sources and of the production of utilisable energies will continue to increase.
- As the result of the continued growth of the share of electric technologies, the share of electricity within the total energy consumption will increase steadily and new areas of application will emerge (transport, heating/cooling).
- One of the already noticeable consequences of climate change, the frequency of extreme climatic conditions will increase, while the accuracy of the prediction of such conditions will decrease. This will present difficulties for economic planning and threaten the safety of agricultural production. The prevention and remedying of damages will involve significant costs for the population and the budget.
- The extreme climatic conditions due to the climate change will have a significant effect on the secure operation of the critical infrastructure, including the energy supply systems

6 VISION

'The world in the 21st century is returning to the basics of humanity: land, water, food, and energy will once again be important. As strange as it seems, we Hungarians have an abundance of that which in the 21st century will become a major bottleneck in many places throughout the world. […] We have an abundance of alternative sources of energy, particularly in the areas of solar and geothermal energy, and bioenergy. And there may be additional gas stocks deeper below the ground. In order to succeed, however, in addition to material resources, intellectual and spiritual resources are also needed.'

(2010, The Program of National Cooperation)

The path to the future is to ensure the reduction of energy consumption as a result of energy efficiency measures and the application of innovative technologies and to increase the carbon consciousness of stakeholders through targeted awareness-raising campaigns.

It is the responsibility of the government to treat this question as a priority, to select and support the alternatives best suiting local conditions and to mitigate adverse external effects on the security of energy supply and market prices in Hungary. Hungary has an advantageous potential in terms of both knowledge capital and resources (drinking water, food, alternative and certain mineral energy carriers). These supplies represent strategic reserves and a potential at the same time, the future-conscious exploitation of which is the common interest and responsibility of all of us. The Energy Strategy should therefore aim at a synthesis of social and economic policy objectives and Hungary's national interests. The energy policy of the future should be developed on the basis of the answers to the most important domestic, European and global challenges and the energy policy efforts of the EU, also taking into consideration our specific geopolitical features. It should focus on achieving an energy infrastructure, service supply and market integration that encourage the growth of the Hungarian economy, ensure the accessibility of services and the competitiveness of the economy through regional market prices. The challenges related to the imminent change of the energy structure may be turned to the advantage of our country. In order to do so, however, we should be able to make the most of the opportunities, conducive to employment and economic growth, offered by energy improvements.

The change of the energy structure should include:

- (I) energy efficiency measures spanning the entire supply and consumption chain;
- (II) increasing the share of low CO_2-intensive electricity generation based primarily on renewable sources of energy;
- (III) promoting renewable and alternative methods of heat generation;
- (IV) increasing the share of low CO_2-emission modes of transport.

By achieving the above four objectives, we could take a significant step toward the establishment of sustainable and safe energy systems, paying special attention to increasing the competitiveness of the economy.

6.1 PRIMARY ENERGY

Energy conservation, efficiency improvement, the diversification of sources, locality and transparent competition

Using the pre-crisis (2008) domestic primary energy use figure of 1,126 PJ as a benchmark, we have compiled the change of primary energy use by combining the electricity mix and heat scenarios described in detail in the economic impact assessment and on the basis of a green scenario set of criteria[30], in order to obtain three scenarios (Table 5 and Figure 16):

1. 'Sitting and waiting'[31] scenario, i.e. conserving the current situation:

- increase of electricity consumption at a rate of 2 percent per annum
- building energy programs fail to happen
- minimum level of electrification in transport and no significant shift toward community and rail transport
- low share of renewables

[30]Based in part on Chapter 3.3.9 of the 'Strategic Environmental Assessment for the National Energy Strategy up to 2030, with an Outlook up to 2050 document and on the proposals of the Ministry of Rural Development

[31] The equivalent of a Business As Usual (BAU) scenario

	2008*	2020			2030		
		A	B	C	A	B	C
Heating, cooling & hot water	431	499	378	353	534	353	309
Energy sector	33	33	33	31	33	33	30
Agriculture	20	21	18	18	22	18	18
Retail and tertiary sector[a]	269	302	218	203	304	193	163
Processing industry[b]	109	143	109	101	175	109	98
Transport	192	262	224	200	285	212	190
Electricity consumption	144	182	158	159	219	198	178
Final electricity consumption	767	943	760	712	1038	763	678
Material and non-energy utilisation	83	83	83	83	83	83	83
Energy transformation loss	252	295	245	239	348	275	247
Grid loss (transmission and distribution)	24	28	25	25	32	26	26
Primary energy use	1126	1349	1113	1059	1476	1147	1034

Table 5 – Primary energy use scenarios

A – 'Sitting and waiting' scenario
B – 'Joint effort' scenario
C – Green scenario
[a] Households, services and public institutions, [b] Industrial heating and industrial technology, * Source of 2008 figures: Energy Management Statistical Yearbook 2008. (Energy Centre)

2. 'Joint Effort'[32] scenario in accordance with the threefold purpose of the Energy Strategy:

- growth rate of electricity consumption is 1.5 percent per annum, including the added energy demand of heat pumps and transport and the effect of energy efficiency measures
- comprehensive building energy programs are launched
- significant electrification in transport and a significant shift toward community and rail transport
- increasing share of renewables and the extension of the Paks Nuclear Power Plant before 2030
- significant reduction in power plant and grid losses

3. A Green Scenario, giving increased priority to sustainability considerations, whose implementation, however, requires substantial economic and development resources:

- an annual growth rate of 1 percent of electricity consumption – involving a powerful increase of the efficiency of economic processes. The corresponding six electricity mixes can be found in the economic impact analysis
- a significant reduction in the demand for road mobility and a significant shift toward community and rail transport
- comprehensive energy efficiency programs are

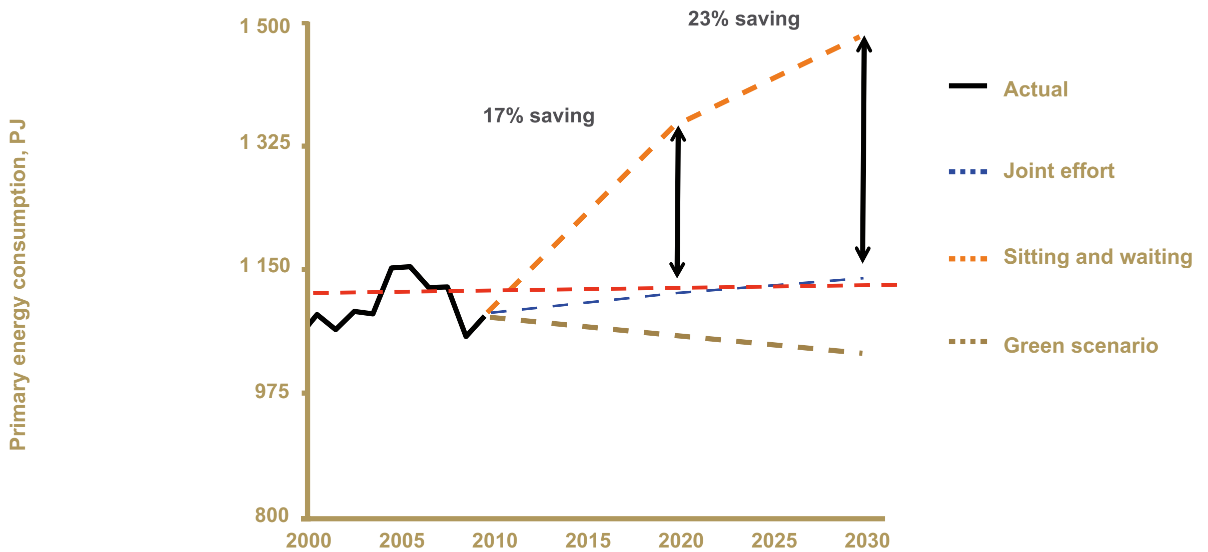

Figure 16: Expected change of primary energy use in Hungary

[32] The equivalent of a Policy scenario

launched, including the deep retrofit of buildings and the integration of renewable energy sources into heat supply

- increasing the controllability of the electric grid, resulting in a share of renewables greater than in the six electricity mixes under review, in particular with regard to wind, solar and biomass
- significant reduction in power plant and grid losses

As a result of the comprehensive energy efficiency programs of strategic importance, based on the benefits of the economic utilisation of the Hungarian savings potential, the country's primary energy use will probably not exceed 1,150 PJ/year by 2030.

- According to the energy vision of the National Climate Change Strategy, energy consumption must be reduced. Since, however, no benchmark year is specified, 2005, also referred to in the document, has been taken as the base – red dotted line.
- Hungary's National Reform Programme set an indicative, voluntary energy saving target of 10 percent up to 2020. According to the interpretation of the EU, this is the difference between two primary energy forecast paths. The objectives of the National Energy Strategy are in accordance with this, as the saving compared to 'Sitting and waiting' is 17 percent (Figure 16).

Primary energy supply	
will become competitive if	• new, long-term jobs are created in the energy sector, primarily in the fields of energy saving and renewable technologies, which may offset the energy price increase due to their increasing use. • a stable and transparent electricity and gas market situation is established as a result of the emerging internal market of the European Union. • local conditions (natural and social resources) are taken into consideration and made increasing use of – creating value locally. • consumer prices are not higher than the price level of the European Union.
will be sustainable if	• the primary energy requirement stabilises while demand continues to grow. • it is generated by low CO_2-intensity technologies, based primarily on renewable energy technologies, complying with the basic conditions of decarbonisation in the longer term (during their lifetime).
will be secure if	• it relies heavily on domestic energy sources. • sufficient reserves are available for contingencies. • import routes are diversified.
Tools:	• the implementation and continuous monitoring of the energy efficiency programs. • extension of the lifecycle of the Paks Nuclear Power Plant and the potential construction of new nuclear unit(s) • various fiscal incentives (including, for example, differentiated delivery prices, refundable and non-refundable investment subsidies, preferential tax and contribution schemes). • supporting renewable-based heat generation in addition to green electricity and the subsidised feed-in of biogas. • encouraging innovation technologies and manufacturing capacities based on the domestic knowledge base, an indispensable factor of the employment of highly skilled professionals. • a differentiated support scheme to promote the use of renewable energy sources (with particular regard to biomass and geothermal energy) and waste-to-energy. • The implementation of new developments in the form of pilot projects. • regional and European consultations and joint positions.

6.1.1 ENERGY EFFICIENCY

Due to the nature of the Hungarian energy sector, the improvement of energy saving and energy efficiency should be treated as a priority, as it holds the greatest potential for maintaining the level of primary energy demand and reducing import dependency. The entire supply chain must be taken into consideration in order that the level of primary energy use can be maintained through the improvement of energy efficiency, as the collective result of technological solutions, economic incentives and social awareness-raising. The key elements of the entire supply chain are as follows (Figure 17):

- Building energy programs: under 'Joint effort', heating energy demand could be reduced by 111 PJ compared to 'Sitting and waiting' through a powerful building energy program. According to the 'Green' scenario, industrial energy rationalisation programs, including energy innovations, will offset the increase of demand due to the growth of production and increasing electricity consumption.
- Modernisation of electric power stations and the grid: by replacing the current low-efficiency power stations up to 2030, 78 PJ primary energy could be saved compared to the current situation.

Potential energy efficiency projects (in an industry-specific breakdown and keeping the objectives in mind) must be considered on a return on investment basis, as the marginal saving on certain projects requiring a higher investment is negligible following the implementation of the project. To that end, the cost optimum (lowest cost - highest benefit) prior to implementation should be determined and minimum requirements should be specified, taking into consideration economy (return on investment) criteria. That would enable the assessment of the energy efficiency potential on a realistic cost basis. An important aspect concerning the support of energy efficiency projects is the multiple returns on investment in a relatively short time and also the collateral benefits (e.g. job creation and the reduction of import dependency).

The retrofitting of buildings and the modernisation of heating and cooling systems hold the greatest energy efficiency potential. The stabilisation of communal consumption requires a minimum of a 30-percent improvement of energy efficiency. That may primarily be achieved through the successful completion of building energy programs in accordance with Directive 2010/31/EU[33], which set building energy efficiency requirements for the member states. Energy efficiency measures should be adopted also in order to comply

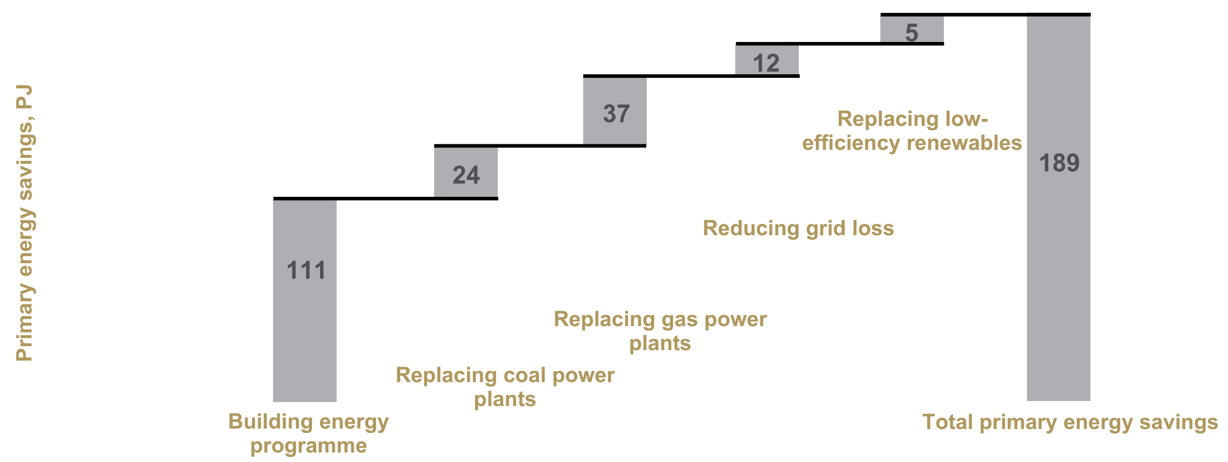

Figure 17: Milestones of the energy conservation projects up to 2030

[33]Directive 2010/31/EU of the European Parliament and of the Council of May 2010 on the energy performance of buildings

with Directive 2006/32/EC on energy end-use efficiency and energy services.

The most important indicator of the characterisation of building energy programs is the depth of retrofit[34], representing the average savings achieved on a system level (i.e. for all buildings of a particular type). In the modelling of building energy programs, 60 percent depth of retrofit is reckoned with on average up to 2030. On the planning of building energy programs, however, one needs to consider that the retrofitting of buildings will lock in the targeted sector on that level for several decades. However, with particular regard to the fact that financing sources are currently very limited, cost-effectiveness is one of the critical factors during the first half of the period up to 2020, while the depth of retrofit will have to be steadily increased after 2020. During the initial period, the average depth of retrofit is 50 percent. From 2020, it will reach 70 percent and even 85 percent in certain cases by the end of the 2030 timeframe. However, that requires a support and pricing policy encouraging efficiency in addition to direct investments. In addition to heat technology aspects, building energy programs should include, in the form of complex projects, the integration of renewable energy sources, the modernisation of heating and lighting systems and the development and implementation of IT-based services which demonstrably contribute to CO_2 reduction and the improving of energy efficiency. In that context, we rely on the creativity and active involvement of market stakeholders. These aspects should be brought in line with ensuring a healthy indoor environment, as the quality of the interior space has a significant influence on the health of residents. Such aspects should therefore be included in the research programs and the development of and instruction on new procedures.

Therefore, in cases where this is made possible by the available resources and is justified by the expected lifetime of the buildings and the expected extension, through the renovation, of such lifetime, a greater depth of retrofit and complexity should be encouraged instead of building renovations that are cost-effective in the short term and would only result in an improvement of up to 50 percent. Suboptimal renovations carried out taking into account the lifetime of buildings and the inadequate thermal technology parameters of new buildings may increase the costs of further decarbonisation in the longer term. A further advantage of deep retrofit is their greater job-creation potential compared to partial retrofit. Through the application and promotion of advanced technologies and the 'learning by doing' approach, the country may enter the group of technology developers. The evaluation of the Hungarian energy efficiency potential could also help the assessment of the viability of our relevant EU commitments.

There are considerable primary energy saving potentials in the modernisation of the electricity-generation and transmission and distribution systems. In 2009, the average electric efficiency of electric power stations was 33.5 percent. This would increase with the phasing out of the low-efficiency power stations currently accounting for nearly 60 percent of total electricity and the simultaneous deployment of new gas power stations of an efficiency of 50-60 percent. We also reckon with the reduction of the losses of electricity transmission and distribution, which holds a substantial potential in terms of primary energy. These will, however, be offset by the dynamic increase of electricity consumption.

The improvement of the energy efficiency of industrial and other economic stakeholders will make a great contribution to the achievement of energy efficiency targets. According to research, the most cost-effective solution is the application of energy management systems and regular energy audits. More specifically, the commitment of industrial stakeholders to energy saving is increased by their long-term agreements (LTA) with the government. Under the LTAs, industrial stakeholders will commit to a reduction of their energy consumption at a specific rate, the achievement of which earns them regulatory benefits. Hungary launched the Virtual Power Station Program in 2011, introducing the LTA scheme with the addition of pooling the savings of the completed projects in a virtual power station.

In energy intensive industries, the use of a sustainable, efficient and diversified fuel mix should be promoted. More specifically, the share of waste-based alternative fuels and biomass should be increased in the relevant industries. The most efficient way to attain that is through the systemic application of industrial ecology and the establishment of sustainable waste management, i.e. the environmentally conscious and efficient use of materials, including fuels, raw materials, products or wastes.

Of the branches of industry, the cement industry has been intensively cooperating with other industries for decades, as a result of which the wastes and by-products generated in various production processes have been utilised by the cement industry as waste-based alternative fuels, additives or raw materials. The cement industry BREF provides for the increase of the share of alternative fuels as a best available technique (BAT), which will in turn increase local supply security while reducing CO_2 emission through the partial replacement of fossil fuels.

Agriculture also has a significant potential in terms of increasing energy efficiency. First, there are significant differences in the energy demand of various agricultural technologies, as the different operational structures and cultivation intensities represent different consumption structures of mostly fossil fuels. On the other hand, the preference of local production and consumption may help cut back on transportation costs and energy as well as reduce emissions. However, in order to exploit that potential a change of structure is called for, the possibility and depth of which should be assessed through further interdisciplinary studies.

The development and implementation of a comprehensive energy efficiency program is the prerequisite of the exploitation of these energy efficiency-increasing potentials both in industry and agriculture.

Any savings in energy consumption will, however, be partly offset by the change of consumer patterns (the increasing number of household electric appliances and air-conditioning units) and the partial electrification of transport and heating/cooling (heat pumps). Consequently, electricity consumption is expected to increase dynamically, despite the fact that consumption per unit will decrease as a result of the tightening EU requirements (eco-design and eco-labelling).

Apart from technological development and the use of economic incentives, awareness-raising and personal involvement are also important. Consumers currently receive little information on their own consumption patterns and the external impacts of energy production. In addition to the above, the factors impeding the improvement of energy efficiency include consumption-stimulating support schemes, the high costs of energy saving investments and the fact that support schemes are difficult to access by the private entities. In spite of the above, environmentally conscious consumers require service packages that encourage and reward economy and information concerning their consumption. We are convinced that, in the possession of the required information and given the required incentives, consumption may be reduced without a decline in the standard of living.

In the future, one of the tools of reducing electricity and gas bills can be the introduction of smart meters, providing consumers with up-to-date information on their consumption habits. That, however, is only a technical tool for consumers. Consumers' attempts toward environmentally conscious energy saving should be encouraged by targeted awareness-raising campaigns. Fortunately, consumers seem to be sufficiently open to the introduction to such an application due to the increasing level of consumer awareness, price sensitivity and demand for information.

Smart metering enables consumers to optimise their energy consumption depending on the actual tariffs, making the most of the benefits of market competition. This makes them cooperating partners in the regulation of consumer requirements, which in turn increases the flexibility of the system and reduces demand for storage and the load balancing of power plants. The introduction of smart meters may help avoid that vulnerable consumers should run into debt as well as regulate consumption. In addition to the technical and economic difficulties of the launch of the system, data protection concerns should also be clarified through legislation.

Currently, however, the introduction of smart meters in

[34]the average saving of a building of a particular type in terms of specific heating energy requirements (kWh/m^2/year)

Hungary should be postponed until the available benefits become clear from the completion of the Hungarian pilot projects and international experiences, technology has matured and the benefits of the decreasing prices of devices due to mass application have manifested themselves, as this may help avoid excess costs to consumers. The rate of the launch will be determined by the results of continuous and regularly repeated cost-benefit analyses and the availability of the conditions required for the feasibility of the energy efficiency targets. The breakthrough based on current pilot projects is expected within the next ten years, provided that the required infrastructure projects are completed. The domestic manufacturing of smart metering appliances would make a significant contribution to job creation.

6.1.2 REGIONAL INFRASTRUCTURE PLATFORM

According to the European Council conclusions adopted 4 February 2011, the integration of national energy markets should be established by 2014. The rapid shift toward the single internal energy market and the full integration of wholesale markets, on the basis of the supply security, price stability and competitive benefits of such integration, must be considered a framework condition of the operation of the Hungarian energy markets.

Rather than to be treated as an external condition, the regional and then European integration of the national electricity and natural gas markets is a trend, which Hungarian energy policy should keep adapting to, proactively react to and promote. Therefore, as a party involved in as well as shaping the regional integration process, Hungarian energy policy will have substantial duties in energy market integration also in the short term. The establishment of an efficient regional market, capable of facilitating the assertion of consumer interests and contributing to the improvement of the competitiveness of Hungary, requires a more market-friendly regulatory environment in Hungary. From the point of view of the viability of medium-term objectives, i.e. the subsequent framework conditions, the responses of Hungarian energy policy to these integration-related challenges during the forthcoming years have crucial importance.

Hungary's natural gas infrastructure, which constitutes a significant element of the country's national wealth and which is at a much more advanced level of development and in a much better condition than the gas infrastructures of other countries in the region, will continue to make a significant contribution to the country's weight in terms of energy policy. Since Hungary has a comparative advantage within the East and Central European region as far as underground storage capacities are concerned, it may become a country of key importance in terms of the storage of gas. As a result of its geopolitical location (as both the envisaged North-South and West-East energy corridors are routed through its territory) and the infrastructure improvements, Hungary may become a strategic operator in regional gas supply.

Utilising commercial storage capacities and the storage potentials of depleted hydrocarbon fields for business purposes can become an advantageous supply security, competitiveness and GDP-generating factor as far as the trading of natural gas is concerned. On the basis of past research, the storage of 10 to 12 billion m^3 gas may be stored in certain types of geologic formations in addition to the current capacity of 5.8 billion m^3. The currently operating storage capacities exceed the average domestic winter demand in terms of both mobile capacities and withdrawal capacities, opening up a potential for offering such storage capacities for sale within the region for commercial or strategic purposes. From a strategic point of view, such natural gas storage capacities may even be offered as a barter value within the region, e.g. to offset electricity storage or LNG terminal capacities. However, that would require appropriate supply guarantees, including the technical solutions of all relevant issues concerning the withdrawal and transportation of the gas to the neighbouring countries even in crisis situations when the supply of priority domestic consumers may raise difficulties.

The achievement and maintenance of a balanced structure of sources in the long term are of crucial importance. Carrying out the measures required in order to diversify supply sources and thus generate a price competition as soon as possible is an issue of primary importance for Hungary. With a view to diminishing the country's energy vulnerability, the potential alternatives of obtaining natural gas from diverse sources and along alternative routes, relying primarily on the existing infrastructure, must be continuously explored. If viable new supply sources are found, the required and currently missing infrastructure elements should be built, the capacity of the existing pipelines should be increased and the pipelines should be made bidirectional, in accordance with the commercial demand, in cooperation with our regional partners (Figure 18). The scenarios analysing the impact of the supply alternatives are described in the 'Gas Market' chapter of the Annex, whereas the economic impact analysis of the Energy Strategy contains a comprehensive scientific study of the scenarios. Only the highest-probability scenarios are described in detail in the Energy Strategy. Following the recommendations of the EU, when considering the necessity of new investments, the distribution of the benefits and the possibility for the corresponding allocation of costs should be explored in cooperation with the neighbouring or regional markets concerned, with particular regard to the envisaged behaviour of supply and demand. That may help avoid putting a disproportionate burden on domestic consumers in that respect. Establishing and strengthening regional cooperation may represent a significant advantage during the negotiations concerning the renewal of the long-term gas supply contracts in 2015. Given that Russian gas is an unavoidable factor over that timeframe, Hungarian governments should pursue a consensus-based, pro-active energy foreign policy vis-à-vis Russia and Ukraine in order to ensure the continuity of supply and transit. In addition to the above, however, supply alternatives should also be investigated:

1. The completion of the Slovakian-Hungarian interconnector would truly enable Hungary to enter EU (primarily German) markets. Calculating with the Baumgarten/Moson link and the capacity of the Slovakian interconnector, the western import potential of 10-12 billion m^3/year covers almost our complete annual import demand. These improvements would make a great contribution to reducing the difference between oil-indexed and spot market prices.
2. The competitively priced continental and intercontinental LNG trade could play an important role in the diversification of Hungary's energy import sources. This could be achieved through the pipeline system of the EU, using an existing Italian and a future Croatian, Slovenian or Polish LNG terminals or under the AGRI (Azerbaijan-Georgia-Romania Interconnector) project, from the direction of Romania (Figure 18). Hungary should therefore consider a long-term lease or capacity agreement or the joint ownership of a nearby LNG terminal or participation in the construction of a new terminal or the potential co-financing of similar investments by the import-dependent countries of the region.
3. Since the sources of the EU-supported Nabucco project, of a planned annual capacity of 31 billion m^3, would be the countries of the Caspian Sea region (Azerbaijan, Turkmenistan, Kazakhstan and Uzbekistan) and Arabian (Iraqi) natural gas rather than Russia, it would represent a new source in addition to being a new transportation route (Figure 18). Currently the weakest point of the project is that its financeability requires substantial risk management assistance. Azerbaijan could become a viable supply source even in the medium term (Shah Deniz II), to be joined later on by other Central Asian coun-

Figure 18 – The diversification of natural gas sources and transit routes – A post-2015 vision

tries, primarily Turkmenistan, following the completion of the trans-Caspian pipeline.

4. In Poland, shale gas reserves of approximately 1,000 billion m^3 have been explored which, according to current estimates, could cover the country's energy needs for up to fifty years, while the surplus amount of Russian gas due to the reduced Polish import could be transported to Hungary along the Jamal pipeline from Poland/Slovakia. While substantial steps have recently been made toward extraction, applicability in Europe is limited by the fact that while in North America, extraction is mostly carried out in uninhabited areas, in Europe it would affect densely populated zones, raising cost-effectiveness and permitting issues. The current extraction technology also results in substantial methane leakage, which must be eliminated for climate protection considerations.

Following the completion of the legislative and infrastructure aspects of the internal energy market of the EU, the following supply sources may become available up to 2030:

- Norwegian gas through Austria/Slovakia, and
- North African gas through Italy/Slovenia/Croatia.

For Hungary, priorities include the initiatives potentially resulting in the diversification of sources as well as an alternative transportation route. Regardless of which alternatives are finally realised, the required infrastructure improvements, the extraction potentials of the exploitable domestic natural gas deposits, the implementation of new natural gas storage capacities and the regional supply and demand trends should be examined in detail. At the same time, it must be kept in mind that the success of major international projects (including Nabucco and the South Stream) depends on various external factors.

It must be emphasised that, based on the apparent global economy, extraction and supply/demand trends, Russian natural gas will continue to play a dominant role in the Hungarian and the wider East and Central European regional markets in 2030, while the above alternatives can be considered with at a smaller extent, as supplementary and back-up sources.

Establishing the required cross-border infrastructure prior to the expiry of the current long-term contract (2015) is an essential condition of supply diversification. The volume of our non-Russian supply sources is a critical factor determining our negotiation position for subsequent purchases. The network development projects examined in the Annex (Moson compressor expansion, HAG expansion and Slovakian-Hungarian interconnector) have a high social utility, since several times the investment value can be returned by the transition to spot market-based natural gas pricing.

The establishment of the single internal market of the EU will be another important tool for the stabilisation of the energy market. Hungary intends to play an active role in that process, as it may result in a price competition for both gas and electricity, serving the consumers' interests. At the same time, the fullest possible implementation of the internal market will ensure the sales potential of Hungarian producers. The latter may gain particular importance if, at any point in the future, nuclear energy production in excess of the domestic demand has to be sold abroad. In order to strengthen Hungary's regional role, strategic partnerships, based on mutual benefits, should be established between the relevant companies, which could be strengthened by strategic agreements with the government.

Another aspect of the strengthening of regional role could be the conscious development of industries related to the transition of the energy structure (including, for example, the utilisation of renewable energy sources and energy efficiency), which may enable the emergence of development and manufacturing centres. Taking advantage of these potentials would also enable the transfer of knowledge and technology.

6.1.3 RENEWABLE ENERGY SOURCES

With a view to sustainable supply, the share of renewable energy in primary energy use will increase from the present 7 percent to the neighbourhood of 20 percent by 2030. The envisaged growth up to 2020 (with a targeted share of 14.65 percent) is described in detail in the NREAP.

With a view to sustainable supply, the share of renewable energy in primary energy use will increase from the present 7 percent to the neighbourhood of 20 percent by 2030. The envisaged growth up to 2020 (with a targeted share of 14.65 percent) is described in detail in the NREAP. The system of incentives concerning the utilisation of renewable energy sources should be developed in a way that co-generating biogas and biomass power plants are given priority in the case of the co-generation of heat and electricity and that geothermal energy, also of primary importance, should primarily, but not exclusively, be used for heat generation. In accordance with and in compliance with the criteria of sustainability and energy efficiency, the local energy utilisation of the by-products of agriculture (e.g. straw and maize stalk) and sewage water and sludge in biomass power and biogas plants, among other options, are treated as a priority. The utilisation of communal and industrial wastes non-utilisable in their materials must be carried out in waste incineration

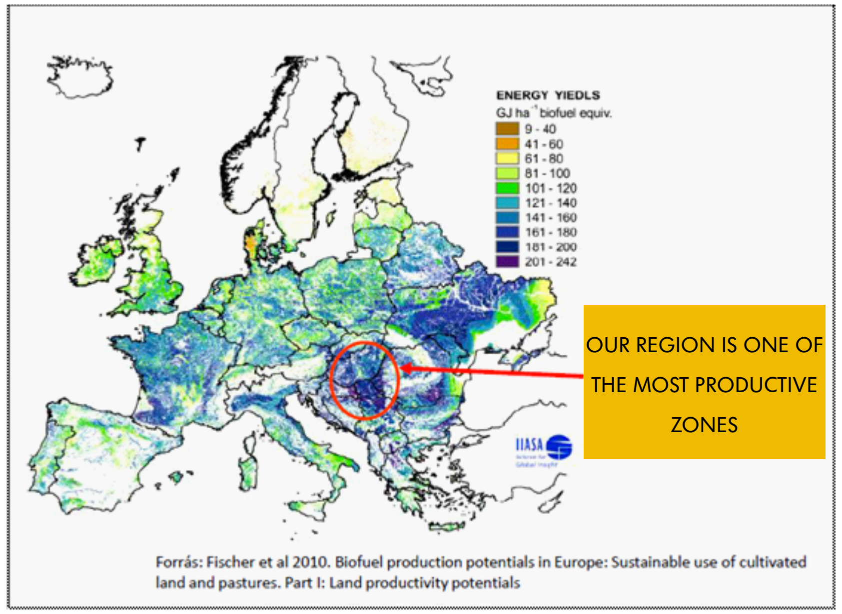

Figure 19 – Potential net energy gain (GJ/ha) of second-generation energy crops in Europe

[35] technologies to provide energy or energy sources through the use of by-products and marginal areas rather than crops and areas that could be utilised for food or fodder cultivation

plants operating under strict conditions and in compliance with strict environmental requirements. The upgrade of the biogas will enable the partial replacement of imported natural gas. The supporting of today's low-efficiency and large-scale firewood and coal co-burning electricity generation will be subject to meeting the efficiency criterion. Rather than large-scale co-burning, the main focus will be on the priority technologies and raw materials referred to above and the herbaceous and ligneous raw materials originating from second-generation[35] energy plantations located in areas that are considered marginal from an agricultural and nature conservation point of view. According to a study by the Imperial College (London, UK), a total of 40-50 million hectares of arable agricultural land is left uncultivated in the Central and Eastern European region. Through integrated regional utilisation, a major part of these areas and of the areas marginal for agriculture that have never been cultivated due to poor soil quality or their exposure to inland water could become a significant source of supplying the EU with green energy (Figure 19). In the case of energy crop cultivation, special consideration must be given to ecological impacts, soil and water management and the change of GHG emissions due to the land use change.

Hungary has an outstanding biomass-based green energy production potential in a European comparison. Based on the aggregate net energy gain of oil crops (rape, sunflower), first-generation energy crops (maize, sugar beet, etc., i.e. crops also playing an important role as food) and second-generation energy crops (energy poplar, energy reed, acacia, etc., i.e. crops not utilised as food), Hungary ranks second among European countries (Figure 20).

Various estimates have been published in recent years concerning the size of the Hungarian renewable energy potential and the exploitable supply. One of the most comprehensive studies was conducted by the Renewable Energy Subcommittee of the Hungarian Academy of Sciences in 2005 and 2006. It should be noted that the results of the survey concerned the total or theoretical potential of Hungary. On that basis, the total domestic renewable potential is estimated to amount to 2,600-2,700 PJ/year, approximately 2.5 times our current primary energy use. The potential assessed by the study is a theoretical figure, indicative of the country's renewable energy potential (Table 6).

Compared to the theoretical potential, the realistically exploitable potential is considerable lower, depending on the actual technology and economy considerations. Concerning the latter, however, there is a high variation in expert estimates, between 100 and 1300 PJ/year. The potential estimates are based on different assumptions concerning the future trends and composition of energy consumption in Hungary, the suitability for integration into the existing energy system, the expected availability of raw materials and the potential that can be economically exploited during the next 10, 15 or 20 years. The potentials have not yet been assessed in Hungary in terms of the potential exploitability of the Hungarian renewable energy sources on the basis of

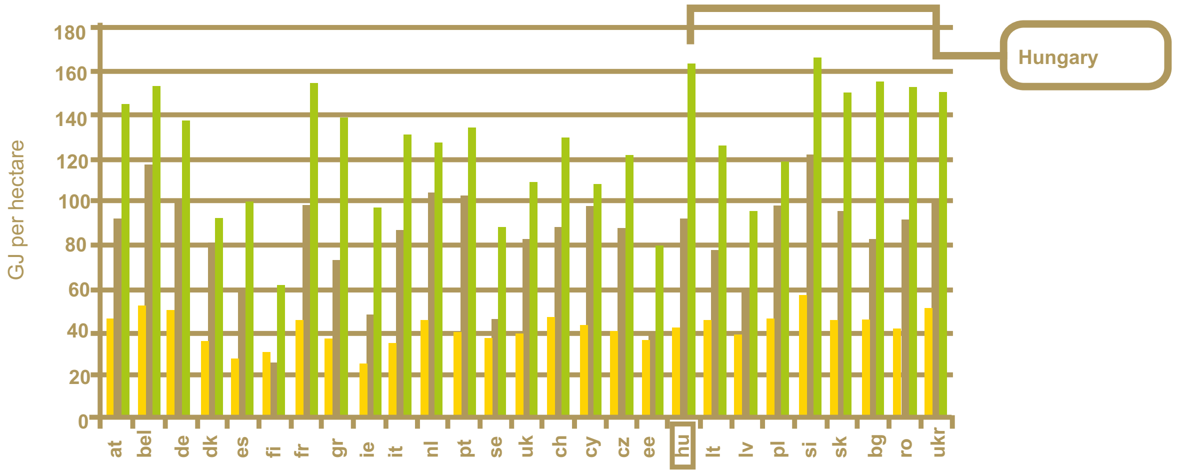

Figure 20.: ggregate net energy gain (GJ/ha) of oil crops and first and second-generation energy crops in Europe
Source: Fischer et al 2010 Biofuel production potentials in Europe Sustainable use of cultivated land and pastures.
Part I: Land productivity potentials

[35] technologies to provide energy or energy sources through the use of by-products and marginal areas rather than crops and areas that could be utilised for food or fodder cultivation

Renewable energy sources	Potential (PJ)
Solar energy	1,838
Hydro energy	14.4
Geothermal	63.5
Biomass	203-328
Wind energy	532.8
Total	**2,600-2,700**

Table 6 – Hungary's renewable energy potential
Source: GKM 2008 – Strategy for increasing the utilisation of renewable energy sources in Hungary, 2008 to 2020

technological, economic, social and environmental conditions. Such study, however, is a prerequisite of the establishment of a national decentralised renewable energy production network and, indirectly, of the implementation the Renewal of Hungary – Green Economy framework program of the New Széchenyi Plan. The existing estimates, however, demonstrate that Hungary has a considerable potential in terms of renewable energy sources, which would enable the production of a significant part of our primary energy use even at the current level of technology. Up to a certain limit, the potential will thus be determined by the objectives set or, to put it in a different way, the domestic potential does not impose an upper limit to consumption as far as availability is concerned. The limit is set by the aspects of economical, rational and sustainable exploitation and the opportunities available to users.

The theoretical maximum figures demonstrate that in Hungary, solar energy can potentially yield the highest amount of renewable energy. Similarly to the renewable potential survey, it would be worth launching a 'roof potential' survey program out of building energy considerations in order to total up, on a national basis, the potential building roof surfaces suitable for renewable solar energy production. It could, at some point in the future, enable the at least partial implementation of individual heat and electricity supply in urban areas. Apart from that, the widest gap between the potential and the actually available level of energy production is currently right in the field of solar energy utilisation. This is a result of the very high costs of energy production based on photothermal and photovoltaic devices and the load balancing-related problems due to intermittent nature. As far as wind power is concerned, the latter presents the main problem, as its production price could already be competitive. Therefore, a system of incentives should be developed in order to enable that the volume of electric power generated by solar-based heat and electricity and wind-generated electricity should increase along with the development of the controllability of the grid. After 2020, the Hungarian solar energy potential may be utilised at a greater extent directly in electricity generation, due to the potential price reduction of photovoltaic technology. While the reduction of the costs of technologies may be facilitated through supporting the relevant research, development and manufacturing, in many cases the trends are set outside Hungary in these markets. Following preliminary studies, new technologies based on domestic innovation should be given the opportunity to demonstrate their viability in pilot projects.

In terms of the estimates, the calculations concerning the Hungarian biomass potential constitute one of the most controversial issues. They show considerable variation from several aspects, a situation rendered more

Biomass	Quantity (thousand t/year)	Potential (PJ/year)
First-generation bioethanol raw material	1330	70
Biodiesel raw material	250	20
Solid (burning technology)		188
Biogas		25

Table 7 – The energy potential of biomass utilisation
Source: GKM 2008 – Strategy for increasing the utilisation of renewable energy sources in Hungary, 2008 to 2020

difficult by issues related to statistic classification (e.g. the classification of wastes of biological and non-biological origin). The estimate concerns the amount of potentially available biomass, disregarding any collection, transportation and logistics costs. Therefore, it is to be regarded as an upper estimate of the total exploitable biomass potential. Focusing on the three main types of the energy utilisation of biomass, the following figures were arrived at (Table 7).

An estimate of the Hungarian biomass potential was published by the European Environmental Agency (EEA), taking environmental considerations into account. According to the study of the EEA, the total Hungarian biomass-based renewable energy potential, taking sustainability criteria into consideration, is 145.5 PJ. In terms of its order of magnitude, it agrees with several Hungarian expert estimates for the actually exploitable biomass potential.

In order to disseminate the decentralised renewable energy production model, it should be a priority to make the legal environment (permitting, network interconnection and regulation) more straightforward and investor-friendly and to ensure the availability of the required technological conditions (connection to the network, network development). If the appropriate, stimulating investor environment is available, the rate of the spreading of the decentralised model will be determined by local conditions and heat demands and the effective local demand. In addition to the above, the establishment, start-up and servicing of small systems requires mostly skilled labour and the decentralised electricity production may also reduce grid losses. In addition to the exploitation of local conditions, the decentralised model is characterised by integration, i.e. the integration, into a single system, of various technologies and functions. Such a complex system can also enable the local integration of energy, waste management and rural development aspects, among others, while the generated profit will also accrue locally. However, the load-bearing capacity of the entire society must be taken into consideration when calculating the extra resources available for incentive purposes.

As the targeted share of renewable energy up to 2020 cannot be achieved without the energy utilisation, in accordance with sustainability criteria, of forestry and agricultural biomass, energy utilisation must be accompanied by sustainable forest management. First, the conditions of the energy utilisation of wood should be tightened in order to prevent the burning of wood products that can be utilised for other purposes, i.e. products other than firewood and forestry by-products. Second, a tighter control is required in the certification of sustainable forestry, particularly with regard to private forest farmers. Apart from sustainable forest management, it also means that in addition to the survival of the forest, the recurring use of wood must be ensured and thus the satisfaction of human needs arising from time to time should not pose a problem, contributing to the preservation of the natural CO_2 cycle and of the environment. The eligibility and professional competence of the organisations issuing certificates must be examined. For environmental reasons, the burning of the slowly renewing beech should be banned and greater emphasis should be laid on the utilisation of forestry and agricultural by-products and wastes and of energy plantations. The energy utilisation of forest firewood is therefore unacceptable unless the continuous renewal and expansion of forest stands is achieved under the National Forest Programme and the set of sustainability criteria of firewood production is developed and strengthened, along with the related system of supervision under the regulation. The increase of areas covered with forests may contribute to the increase of rural employment, provides job opportunities for people living in deep poverty, facilitates the mitigation of climate change by the absorption of carbon-dioxide and provides a low-priced energy source for local supply.

In large power plants, wood is utilised at a low rate of efficiency. The efficiency rate could be substantially improved through the development of primarily heat-geared decentralised heat production as opposed to the current system. In decentralised systems, there is no need to collect energy raw materials from and to transport the generated heat to large distances and there will be steady demand for the heat in the surrounding communities. Decentralised production also facilitates the returning of the ash into the soil, which will in turn reduce the need for fertilisers.

As far as the exploitation of the similarly substantial geothermal potential is concerned, utilisation fields other then energy purposes (drinking water supply, medical therapies, tourism) should also be taken into consideration, establishing the priority of such potentials. In the case of the utilisation of thermal waters, in addition to taking into consideration local conditions, the quantity of the thermal water supply available and exploitable without damage must also be determined (taking into consideration the amount of authorised thermal water withdrawal). That requires individual project assessment, the continuous recording of the quantitative state of water resources and the development of the legislative environment.

As far as private, communal applications are concerned, the increasing utilisation of solar energy and heat pumps is the most likely trend, whereas wind power may also play a significant role in off-grid operation, with particular regard to the electrification of small detached farms. This is primarily important at locations where the construction of the required electric network would have such high costs that their return is doubtful. In such situations, it is worth investigating the possibilities of local electricity generation from renewable energy sources, considering the costs of such systems.

6.2 ELECTRIC POWER

Network development, decentralisation, renewables and nuclear energy

- In the event transport and heating/cooling become significant electricity consumers and their consumption can be integrated into the system control through smart networks, the rate of the increase of the peak load could slow down and the daily fluctuation of the demand for electricity may decrease. That may have a substantial advantageous effect on the power station structure, system management, network development and the building of reserves.
- The diversification of supply routes and market price-based purchasing are essential for the future of natural gas-based electricity production in Hungary. If the international competitiveness of Hungarian gas-based electricity production remains weak in the long term, the development and the maintenance on the market of the power plant capacities required in order to maintain the back-up ratio will only be feasible through powerful government interventions. Therefore, the study of the energy mixes is based on the assumption that supply routes are diversified and that natural gas is purchased at spot market prices.
- The demand for fossil primary energy required for the production of a unit of electric power will decrease due to the improving efficiency of the system. In addition to the above, the high (10-percent) grid loss must be reduced, to be facilitated by the development-stimulating regulation of network tariffs.
- The assessment of the energy efficiency potential of industrial electricity consumers and the development of a legislative environment providing incentives to businesses may reduce the rate of increase of electricity consumption and level off the daily fluctuation of electricity demands. It is recommended that a standardised monitoring system should be developed for the national aggregation of energy savings.
- Six different energy mix scenarios have been examined concerning the electricity demand trends under ‘Joint effort’ (Figures 21 and 22):

  a) Nuclear-Green: The construction of new nuclear units at the Paks site and the extension of the renewable energy utilisation path set out in Hungary’s NREAP

  b) Anti-Nuclear-Green: No new units are built at the Paks site and the renewable energy utilisation path set out in the NREAP is extended

  c) Nuclear-Green(+): The construction of new nuclear units at the Paks site and a more ambitious renewable energy utilisation path than the one set out in the NREAP

  d) Nuclear(+)-Green: The construction of new nuclear units at the Paks site and also, after 2030, at a new site, plus the extension of the renewable energy utilisation path set out in the NREAP

  e) Nuclear-Coal-Green: The construction of new

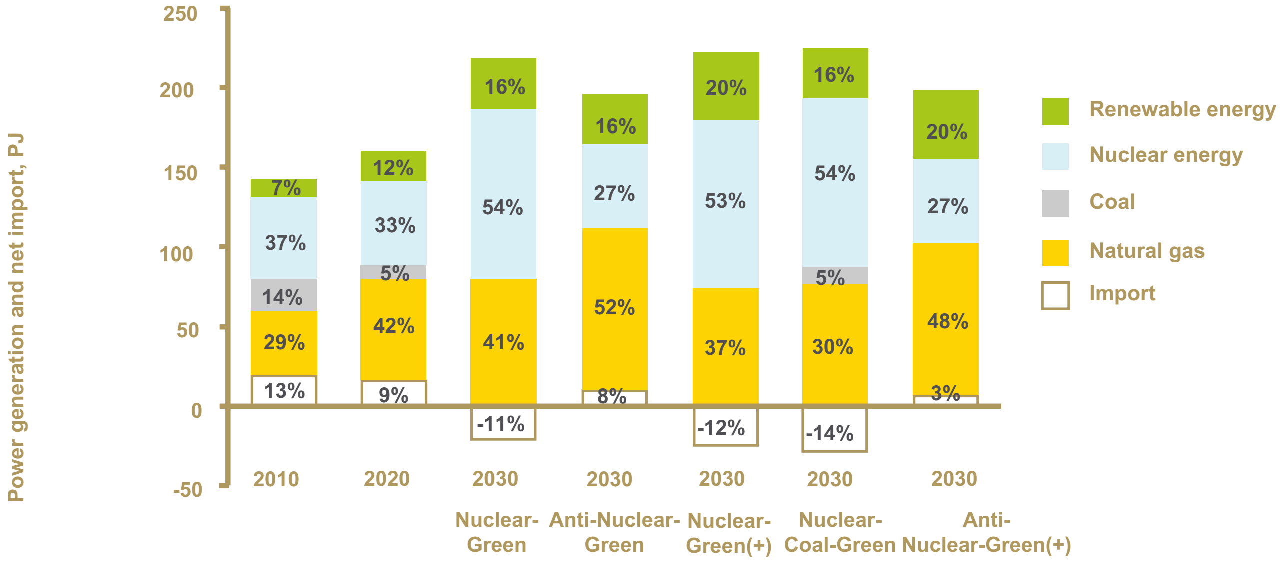

Figure 21: Hungary's expected electricity production, according to the various energy mixes
Source: REKK – Regional Centre for Energy Policy Research

nuclear units at the Paks site, the extension of the renewable energy utilisation path set out in the NREAP and the construction of a new coal power plant

f) Anti-Nuclear-Green(+): No new units are built at the Paks site and a more ambitious renewable energy utilisation path than the one set out in the NREAP is implemented

The production of the base-load power plants and the renewable energy sources is insufficient to cover the entire domestic demand. Additional power plants carrying out load-following and peak-shaving functions are required in order to meet the total consumption demand and to guarantee secure supply. The missing constituents of the electricity mix have been determined using a load-allocation model, which takes into account

- the forecasted electricity consumption and the annual peak load,
- the production of base-load power plants and the volume of imported electricity,
- the production and availability conditions of weather-dependent power plants (wind and solar,
- the technology-specific minimum level of the power plant capacity utilisation ratio required for the return of investment, and
- the back-up requirements of the uninterrupted and secure maintenance of electricity supply in the long term.

Regardless of the import balance, in our scenarios the domestic power plants have a capacity reserve equivalent to 15 percent of the peak load at any time. Load-following and peak-power functions are carried out by

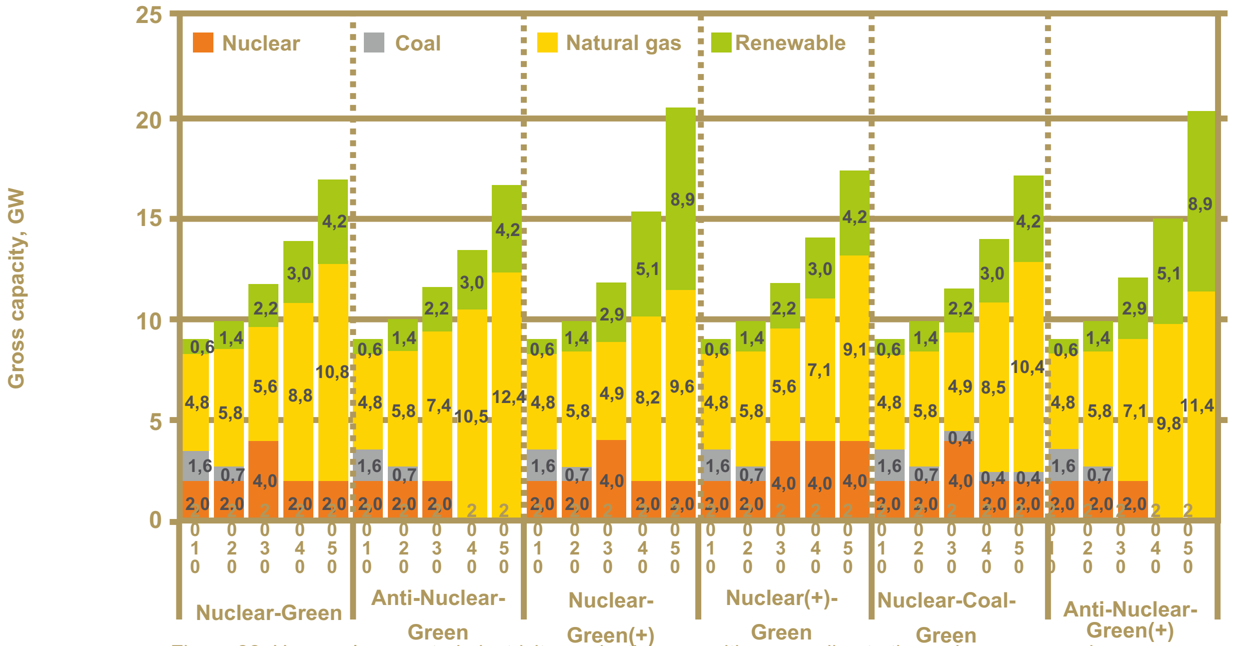

Figure 22: Hungary's expected electricity production capacities according to the various energy mixes
Source: REKK – Regional Centre for Energy Policy Research

combined cycle gas turbine (CCGT) plants, whereas peak and back-up power plant functions are performed by open cycle gas turbine (OCGT) plants. In the event the available nuclear and coal plant capacities are insufficient to supply the base-load demand, part of the CCGT plants are switched to base-load function. The revolving reserves required for system management are provided by CCGT plants. The minimum capacity utilisation level of CCGT plants is defined as 40 percent. 80-85 percent of the natural gas-burning power plants are CCGT, whereas the remaining 10-15 percent are OCGT plants.Each scenario includes the extension of the lifecycle of the Paks Nuclear Power Plant, as in the medium term there is no alternative for replacing the electricity generated by the nuclear power plant. In the timeframe up to 2030, the Nuclear-Green and the Nuclear(+)-Green scenarios yield the same results, as nuclear capacities to be established at a new site are only reckoned with after 2030. Only one of the above two scenarios therefore appears in Figure 22.

The 'Joint effort' vision, considered to be most realistic and therefore set as a target to be achieved, is reflected in the Nuclear-Coal-Green scenario, which includes the following elements:

- the long-term maintenance of nuclear energy in the energy mix,
- the maintenance of the level of coal-based power generation in order to preserve professional culture and the possibility of the utilisation of the domestic coal resources. The application of clean coal and CCS technologies is a condition of the increasing future level of utilisation,
- in terms of renewable energy, the linear extension of the NREAP after 2020, provided that efforts should be made to increase the targeted share depending on the meeting of the NREAP, the capacity of the economy and system controllability and technology development.

The preference of the Nuclear-Coal-Green scenario does not mean that the elements of the other scenarios are unrealistic. Under certain external and internal economic policy conditions, the government may even change its preference, as a different scenario may offer a more reliable guarantee for the security of supply in a changed situation. The biennial review of the Energy Strategy therefore remains an important element.

• Reducing CO_2 intensity from 370 g CO_2/kWh to below 200 g CO_2/kWh, depending on scenario, by 2030. Apart from the increasing efficiency of fossil-based power stations, the changing fuel composition will also contribute to the reducing of the adverse environmental effects of the power plant sector.

• Natural gas-based power generation will continue to be of critical importance in Hungary, regardless of the energy mix. This is partly based on the assumption that even if the integrated internal electricity market of the EU is established, the national energy policy will keep striving to maintain the country's capacity for self-sufficiency in terms of electric power supply, i.e. that Hungary should maintain a back-up power-generation capacity of 15 percent over the peak consumption demand. The transition to spot market gas prices after 2015 will essentially double the expected gas demand of the electricity sector. Depending on the evolution of gas prices and the electricity scenarios, current estimates of the gas demand of the domestic electricity sector in 2030 vary in the rather wide range of 4.0 to 5.6 billion m^3/year, compared to the current 3 billion m^3/year. In the current energy market situation (post-Fukushima, German, Swiss and Italian nuclear phase-out, tightening GHG emission reduction requirements and, as a result, the increasing competitive disadvantage of coal-burning plants), demand for natural gas will probably increase at a significant rate, leading to a levelling-off of spot market prices and oil-linked gas prices, which will in turn result in a demand balance at substantially higher gas prices. In this unstable situation, the alternatives resulting in the highest possible replacement of natural gas import appear to be a more reliable option. Therefore, we should not leave out of consideration the environmentally sound exploitation of the Hungarian coal and lignite resources, the current share of nuclear energy must be maintained in power generation and the share of renewables must be raised to the highest possible and still feasible level.

• The scenarios have been assessed on the basis of various criteria, indispensable for decision-making:

a) The decarbonisation of the Hungarian electricity sector requires (nuclear and renewable) production plants requiring a very high capital investment (but running at a low cost of operation) and the mass application of CCS. The most capital-intensive alternative is reflected in the genuine decarbonisation scenarios, i.e. the one containing a new nuclear capacity of 4,000 MW, substantial renewable energy utilisation and gas power plants equipped with CCS technology.

b) While the alternative free of new nuclear investments or CCS and containing a minimum level of renewable energy utilisation involves almost ten times as much CO_2 emissions, its costs are half of those of the former.

c) If the EU climate policy imposed a heavy reduction of the 1990 level of carbon dioxide of up to 90-95 percent up to 2050 in the electric power sector, CCS technology would have to be employed in fossil fuel-burning power plants. The application of CCS will normally reduce CO_2 emission under a particular scenario to a fourth and increase their capital intensity by HUF 1,000-1,500 billion.

d) As the analysis of electricity prices reveals, a greater share of renewable power generation results in a higher support demand, while the implementation of the Paks nuclear power plant expansion will increase the support needs of renewables through the reduction of prices on the competitive market. However, the achievement of the ambitious renewable power target is not unrealistic in the terms of consumer prices, as the support need of renewable power generation will remain within the HUF 1.5/kWh range, provided that an efficient support scheme is in place. This is because the support needs of the generation of a unit of renewable power will steadily decline during the forthcoming decades due to the continuous increase of the market price of electric power owing to the increasing oil, gas and coal prices.

•Two scenarios have been examined as far as the renewable electricity mix is concerned (Figure 23). However, the goal is to achieve a capacity distribution accurately reflecting the resource potential of the country, taking into account the actual capacity of the economy and the endurance of consumers. The main potentials are in the utilisation of biomass, biogas and various wastes and, from 2020, of solar energy. The importance of intermittent renewable energy sources (wind and solar energy) may significantly increase once the controllability of the grid has been attained. In order to achieve the above objectives, a transparent investment support scheme, a simplified and coordinated permitting system and a new, technology-specific feed-in tariff scheme will need to be developed. The potentially increasing net domestic power demand must be supplied by an essentially transforming power generation sector. It is assumed that decarbonised power generation will increase on the electricity market, i.e. decentralised power plants on renewable energy will be given priority in new developments. From a security of supply and commercial point of view, the volume of imported electricity will not change despite the foreseeable high level of market and network integration, provided that the price of available free capacities (and energy) stays higher on the regional markets than in Hungary. In the light of the

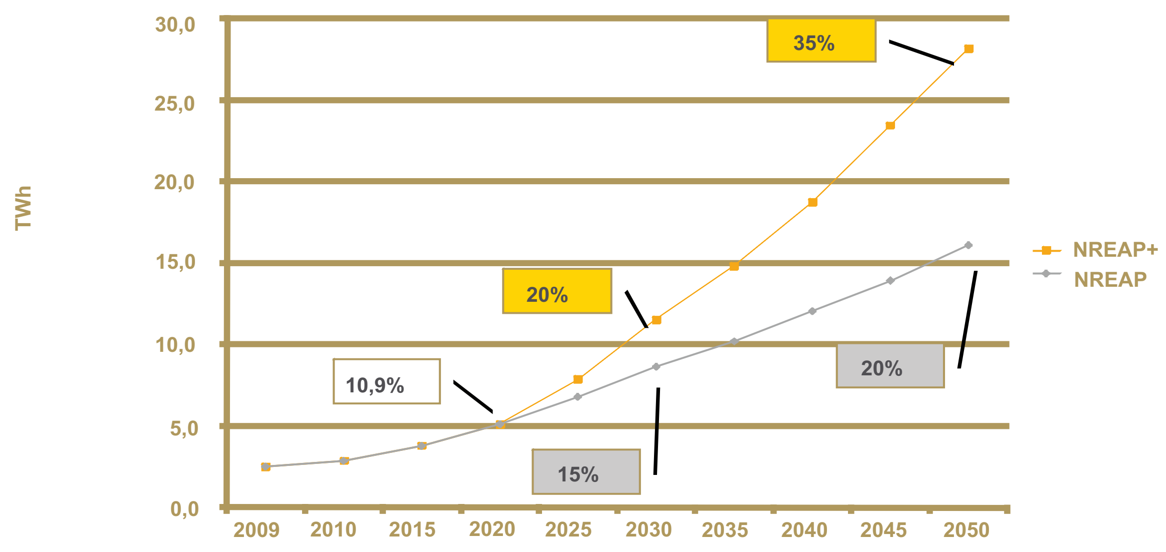

Figure 23: The share of renewable energy in electricity generation
Source: Hungary's NREAP and REKK – Regional Centre for Energy Policy Research

European Commission's Infrastructure Package[36], special attention should be paid to permitting, financing and cost-allocation issues related to the development of network devices, with special emphasis on the representation of legitimate regional and national interests.

Electricity supply	
will become competitive if	• we manage to turn the benefits of integration to the internal EU market to the advantage of domestic consumers. • the grid is advanced and its control capacity is increased within the framework of the regional infrastructure platform. • the price of electric power is lower than the regional wholesale prices even if subsidies is taken into account.
will be sustainable if	• the CO_2 intensity of power generation is reduced, primarily through the increase of renewable energy and nuclear energy capacities and, if appropriate conditions are available, the supplementary application of CCS. • the efficiency of production improves.
will be secure if	• the number and types of new power plants meet the demand, taking decommissioning into account • demand is supplied from domestic power plants based on domestic jobs. • system controllability improves, with particular regard to storage
Tools:	• simplified, investor-friendly permitting, network access and regulation schemes and a feed-in tariff system of a period set out in the law, in order to promote the penetration of alternative technologies. • the transparent allocation of the resources from emissions trading, in accordance with the targets of the Energy Strategy. • a clear and long-term set of criteria concerning the construction of power plants.

6.2.1 ENERGY EFFICIENCY

The coal and oil-gas power plants to be decommissioned operate at a low efficiency (typically around 30 percent), whereas the new natural gas-burning units to be built are of a high efficiency (combined cycle units are of an efficiency over 55 percent). As a result, the average efficiency of the Hungarian power-generation sector may increase significantly.

As a consequence of the above and the reduction of grid losses, the currently substantial difference between primary energy use and final energy consumption may be reduced in the face of the increase of final consumption.

The changing regulatory framework should encourage increasing reliance on smart consumer grids and smart metering solutions, which can make a significant contribution to optimising electricity consumption. The smart transmission grid also plays an important role in increasing electricity supply security and the potentials of international trade, e.g. in the transportation to the consumers of renewable energy generated in high volumes in a concentrated manner (wind and solar power). The Hungarian primary and main distribution grids already qualify as smart grids. For Hungary, however, the establishment of a pan-European smart transmission grid also involves risks, including for example the mandatory feed-in of certain energy products.

A smart distribution grid enables the expansion of the distributed storage of electricity and of the admission of power generated by small communities. The establishment of smart network areas should therefore be treated as a process guided by the mutual interest of the stakeholders (local energy producers and consumers), the legislative and regulatory framework of which must be developed. The development of the distribution grid is an inevitable requirement of promoting decentralised power generation.

Differentiated tariffs are another tool of the optimisation

[36]Energy infrastructure priorities for 2020 and beyond — A blueprint for an integrated European energy network (COM(2010) 677 final)

of the electricity consumption curve and of increasing energy awareness. The new technology, still not uniform from a number of respects, will probably gain mainstream in a gradual fashion.

The modernisation of lighting systems is an impressive and cost-effective method of both energy efficiency and the reduction of emission. The application of smart lighting systems (in street lighting and in buildings) and new lighting devices (e.g. LEDs) results in significant energy savings.

6.2.2 NUCLEAR ENERGY

As far as peaceful nuclear technology and nuclear energy-related decisions are concerned, the basic and most essential criterion is the safety and security of the health, life and property of the Hungarian population, which means that nuclear safety must have a priority above all other considerations.

The lessons of the detailed causal study of the Fukushima nuclear accident must be integrated into the international and domestic nuclear safety requirements. The regular auditing of the operation and safety of the Paks Nuclear Power Plant and the conditions of its operation must be continued. New improvements (whether technologic development or the appearance of a new standard to be enforced) must be taken into consideration in order that safety requirements are maintained at the highest possible level.

The request of the Paksi Atomerőmű Zrt. for the extension of the plant's life-cycle must be submitted before the end of 2011 as far as the first unit is concerned, and it should be assessed by the competent authority before the end of 2012. The implementation of the life-extension program will be continuously monitored by the Hungarian Atomic Energy Authority. Most of the investigations required for the submission of the lifetime extension request have been completed at the plant and the preparation of the documentation to be attached to the request is currently in progress. The enforcement of safety is currently guaranteed by the nuclear safety requirements related to the lifetime extension. In the light of the tightening international expectations, the authority must review the requirements, amending them if appropriate, while the Paks Nuclear Power Plant must comply with such requirements. Therefore, in order to ensure the return of investment, the possibility of cross-ownership should also be considered, in order to achieve a stronger position vis-à-vis suppliers, lower maintenance costs and a number of possible other benefits.

At the Paks Nuclear Power Plant, 4 units, of a capacity of 500 MW each, are currently in operation. Assuming an extension of 20 years, their life-cycle will expire between 2032 and 2037, which means that the Energy Strategy has to address the necessity of replacing the currently operating unit(s), with regard to the long implementation period. The scenarios outlined at the beginning of this chapter are therefore examined up to 2050. The findings of our study are described in detail in the Annex.

The theoretical basis of the scenario assuming the nuclear extension is provided by Parliamentary Decision no. 25/2009 (IV. 2), in which Hungarian Parliament granted a preliminary theoretical consent to the commencement of preparatory activities for the construction of a new unit(s) at the Paks Nuclear Power Plant. It is assumed that two new units of approximately 1,000 MW each[37] will be put into operation by 2030, i.e. the 4 Paks units currently in operation (2,000 MW) and the two new units (2,000 MW) will be operating parallel between 2032 and 2037 (the four current Paks units will be decommissioned until 2037). Consequently, Hungary is expected to have a temporary nuclear capacity of 4,000 MW in 2032. As a result of the newly built nuclear units, temporarily operating side by side with the existing unit(s) this scenario assumes the increasing share of nuclear energy within the total power generation output up to 2030 (Figure 24).

[37]the built-in capacity of the new power station units is an indicative figure, as no decision has yet been made concerning the size and the number of the new nuclear units to be added to the system.

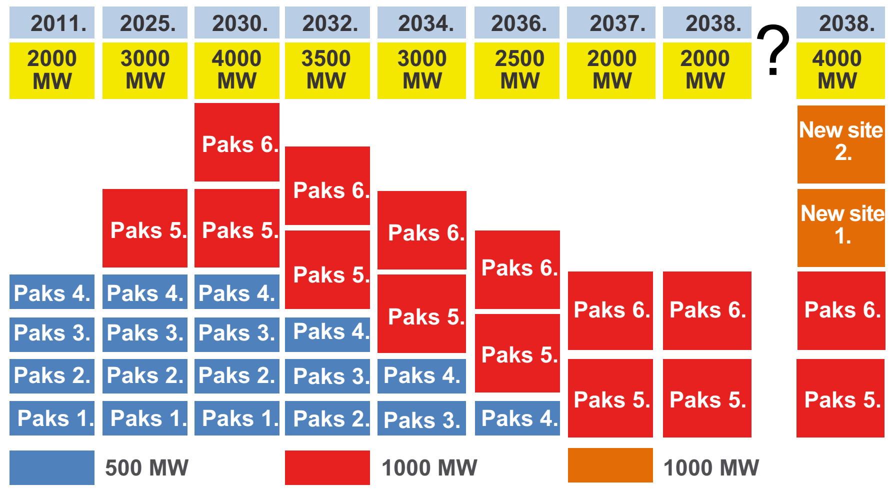

Figure 24. Hungarian nuclear capacities up to 2038
While the time of the entry of unit 5 and 6 are not specified in the Energy Strategy, they will probably enter into operation by 2025 and 2030, respectively.

The increasing share of nuclear energy may substantially improve supply security, since nuclear fuel elements are easy to stock (the Paks Nuclear Power Plant currently disposing of a two-year reserve of fuel element), and will reduce the use of natural gas in power generation. If a new project is launched, however, due attention must be paid to the open and appropriate information of the society in order to achieve as high a level of social acceptance as possible. At the same time, as far as the integrability of the new nuclear units is concerned, it is absolutely necessary to examine the controllability of the electric power system and the increased back-up requirements of high-capacity units. For both the currently operating and the potential new projects, their operation in compliance with the strictest possible safety requirements must be guaranteed and monitored, while the requirements must be reviewed on a regular basis.

Assuming the extension of their lifespan, the currently operating units of the Paks Nuclear Power Plant (4x500 MW) will be decommissioned between 2032 and 2037. (Unit 1: 2032, unit 2: 2034, unit 3: 2036, unit 4: 2037) Consequently, the nuclear capacity of 4,000 MW in 2032 will be reduced to the current capacity of 2,000 MW by 2037. Depending on the power demand of the post-2037 period, among a number of other solutions, one of the possible options may be the construction of additional nuclear capacities. The preparation of the decision alternatives should be commenced in due time, owing to the long implementation period (the appointment of the site of a nuclear plant).

Uranium prospecting is currently in progress in Hungary. The uranium content of the prospected ore in Southwest Hungary has been found to be approximately 1.5 times of the previously extracted quantity, and potentially even three times as high at some places of occurrence. The suitable technology may enable the recovery of ore from certain spoil tips, which may lead to the partial elimination and reclamation of the recultivated sites. Obviously, the resumption of uranium mining must duly take into consideration the strict environment regulations and suitable financial security must be provided by the companies involved.

In Hungary, the relatively high production and investment costs of uranium mining may partially be set off by the low risk of prospecting, as detailed data are already available concerning the mineral resources and the National Records of Mineral Resources are also available. The start-up investment of extraction could be reduced by the application of new mining technologies.

In Hungary, low and medium-activity nuclear wastes, including wastes from the demolishing of nuclear installations are finally dumped at the Bátaapáti National Radioactive Waste Repository, a new facility complying with all technical and safety criteria.

Taking into account any of the varieties of the nuclear fuel cycle, the temporary storage, over a few decades, of spent nuclear fuels must be taken into consideration as part of the cycle, regardless of which version of the closure of the fuel cycle will be opted for in Hungary. The temporary storage of spent nuclear fuel must be ensured by the expansion and continuous operation of the Interim Spent Fuel Store (ISFS). Arrangements must be made for the expansion of the ISFS in accordance with the extension of the lifecycle of the nuclear plant, including the renewal of the licences of the site.

6.2.3 REPLACEMENT OF LOST CAPACITIES

As far as the replacement of lost power-generation capacities is concerned, the factors to be taken into consideration include the efficiency, emission (or saving) and the envisaged capacity factor, the type of the relevant fuel and the issue of heat utilisation, all of the above under a lifecycle-based approach.

The consideration of the above-mentioned aspects is required in order to ensure the safe satisfaction of the increasing demand, establish a predictable investor environment and due to the increasingly tight environmental requirements.

It is foreseen that with the exception of the Paks Nuclear Power Plant and the following other plants, independently of the government, as a result of the market and investor decisions, the Csepel Power Plant, 1-2 new units of the Dunamenti Power Plant, the Debrecen, Gönyű, Kispest and Újpest power plants, all current large power stations will be either decommissioned or considerably refurbished up to 2030. Of that capacity, about 3,000 MW will probably be decommissioned before 2020. Therefore, in our scenario analyses, we also discuss the assessment of investment costs and the impact of the investments on the price of electricity. The details of the studies are set out in the Annex.

While the investment requirements are significant even in a timeframe of 40 years, it should be noted that the investments cannot be postponed as their costs will continue to increase over time. As far as operational costs are concerned, the purchase price and the actual system of feed-in tariffs represent an uncertainty factor in the case of fossil fuels and the utilisation of renewable energy sources, respectively. In the light of the budgetary burdens, in order to ensure financing for the investments from the financial markets requires a stable framework of regulation and incentives and the ensuring of access to the grid.

6.2.4 UTILISATION OF COAL RESOURCES

While Hungary has significant coal resources, coal can only be utilised in modern, high-efficiency large power plants. Because of its current high CO_2-intensity, however, carbon-based power generation will probably no longer be competitive.

That process may be accelerated by the increasing GHG emission-reduction targets from the 20-percent level envisaged for 2020, or if Hungary is not granted a derogation from the system of free allocations to be eliminated during Phase 3 of the ETS. While the utilisation of the Hungarian coal resources is not considered a critical element of the Energy Strategy, the relevant professional culture must be preserved as the coal resources are considered one of the safety reserves of the future. The Hungarian coal and lignite resources may enable the replacement of any energy source in the event of an intolerable price increase, long-term shortage or other emergency. Unless a breakthrough is achieved in terms of technology or commercial competitiveness in the fields of CCS and clean carbon technologies, in a purely market environment, the share of coal will gradually decrease in the energy mix. In order to preserve the professional culture, however, and based on the economically extractable coal and lignite deposits, extraction should be maintained and the existing infrastructure should be developed in accordance with environmental and economic criteria.

On the basis of development projects in progress, it is expected that in addition to the capturing of dust and sulphur, modern coal-burning power plants will be able to absorb the efficiency-reducing and investment cost-increasing impacts of the capturing of carbon dioxide, i.e. they will meet environmental and climate protection requirements. Achieving that is a prerequisite of a higher share of Hungarian coal in the energy mix. Under the current conditions, however, the construction of a power plant equipped with CCS technology would only be feasible with substantial support by the government, as the carbon capture technologies are not mature for the market and their investment costs are high, which means that they still do not have industry-scale references. Its market-based application is conditioned on the relatively low costs of the extraction and transportation of coal, advantageous site conditions in terms of the storage of CO_2, relatively high CO_2 quota prices and the substantial development of the technology. In Europe, the technology is not expected to reach maturity before 2025-2030. At that time, taking climate policy trends into account, it may become appropriate to set the application of the new technology as a condition of the operation of any fossil fuel-burning power plant. The impact of CCS technology on CO_2 emission and the costs of investment are discussed in the Annex to the Energy Strategy.

Currently, however, the Hungarian energy system is not under a constraint in this respect, since more advantageous alternatives of low CO_2-intensity energy production are available. However, with a view to the utilisation and future exploitation of the potential, the geological, technological, environmental and legal conditions should be further examined and their details elaborated, with particular regard to responsibilities, the results and data bases of geological research should be retained and the right of control over underground storage capacities as a national treasure should be ensured. The continuance of such activities is also indispensable for the implementation of a potential demonstration project.

In terms of CO_2 storage, Hungary has an extraordinary theoretical potential[38], which could be developed into a significant economic faculty, with regard to the tightening emission requirements set out in international treaties. The theoretical storage capacity is over 26 billion tons of CO_2. However, with regard to the environmental, health and safety risks of underground storage and the high costs of the related infrastructure, comprehensive additional research is still required in order to establish the actual potential. From an environmental point of view, it should be considered that injected CO_2 may contain various contaminants that may present a danger to the purity of the underground water base. Appropriate regulation must prevent such danger to the water base, since in the event of an unexpected pollution, the original condition could not be restored.

While salinous underground formations of a depth of over 1,000 metres represent the greatest potential (the storage of 25 billion tons of CO_2), we still lack sound geological knowledge with respect to the relevant technology. In the case of appropriate exploration, such strata may be suitable for the long-term storage of carbon dioxide, as they cannot be utilised for other purposes. In addition to the above, carbonaceous strata (717 million tons) and depleted hydrocarbon fields (469 million tons) are only capable of absorbing limited quantities. In certain cases, however, the CCS utilisation of depleted hydrocarbon fields may also supersede the storage of natural

[38] Fancsik Tamás, Török Kálmán, Törökné Sinka Mariann, Szabó Csaba, Lenkey László – Long-term opportunities for the depositing of carbon dioxide from industrial activities in Hungary

gas, representing a substantially greater business potential due to the continuous cash-flow from stockpiling and withdrawal. The capacity of depleted fields also suitable for the storage of natural gas is substantially lower than that of the formations suitable only for the storage of carbon dioxide. The more accurate definition of the well capacities suitable for the two types of storage would, however, require further research. In the light of such studies and on the basis of their contribution to the competitiveness of the economy, it should be considered whether preference should be given to the storage of natural gas at the relevant sites.

Apart from energy and climate protection considerations, the Hungarian coal resources and the captured CO_2 can also be utilised as base materials in the chemical industry.

6.2.5 RENEWABLE ENERGY SOURCES

The major part of renewable electricity is currently generated by the burning, at a low rate of efficiency, of biomass (primarily firewood) in antiquated coal power plants. The energy utilisation of biomass essentially requires the definition and application of sustainability criteria.

With regard to the above, the local utilisation of verified firewood purchased from forest farmers engaging in sustainable forestry, biomass from energy plantations and agricultural by-products should primarily be utilised, preferably in CHP plants. Wherever the geothermic potential is suitable for power generation, it should be combined with heat utilisation, due to the greater efficiency of combined systems. In the case of photovoltaic systems, the expected further technological development will enable the exploitation of the domestic potential, due to the lower cost of investment and purchase price. An important consideration, however, since the large-scale installation of photovoltaic systems should not be detrimental to green areas, brown field projects and roofs should be given preference. As far as hydro energy is concerned, the number of small-capacity power-generation units should be increased, as they are mobile, do not lead to irreversible environmental changes and do not require the construction of major aquatic structures.

The support of the feed-in of renewable-based electricity should be differentiated between the technologies in order to facilitate the development of the envisaged structure of renewable energies. Critical factors concerning the mainstreaming of intermittent renewable energy sources in power generation include the storage capacity and controllability of the system. The operation of the single electricity market will increasingly facilitate the solution of system controllability problems. The issue of the storage of electricity, however, cannot be avoided due to the increased utilisation of weather-dependent renewable energy sources. These conditions require that the establishment of wind farms and solar plants be accompanied by grid development.

Following the required transformation of the regulation of access to the grid, transmission system managers and distribution network owners should establish optimum conditions for the interconnection of decentralised renewable power generation. European examples demonstrate that the transformation of the present-day price regulation and incentive scheme is a prerequisite of the above. Regional grid integration enables the more efficient utilisation of renewable energy sources and the coordination of capacities and power plant construction projects.

6.2.6 ELECTRICITY STORAGE

High-capacity electricity storage is required in order to maintain the economy of an increased share of nuclear production and the deployment of additional intermittent renewable capacities. The potential down regulation of capacities can render the return of investments significantly more difficult.

Hydro pumped energy storage and the peak-time release and utilisation of the existing commercial natural gas storage capacities currently represent a full-fledged technological solution in the required capacity range of several hundred MWs. In addition to the above, regional electricity grids also offer an enormous potential.

Apart from the technical issues of domestic implementation, environmental considerations and conformity to the market should also be taken into account. In the event the viable project scale is unsuitable for the market, market-based system integration and joint regional development could be a solution. The application of a tariff system with an appropriate balancing function may enable the return on investment and even the profitability of hydro pumped-storage power plants.

Later on, exploiting surplus domestic renewable and nuclear capacities, hydrogen produced by electrolysis may also play a role in the storage of electricity as a strategic energy storage capacity.

The application of direct local electric energy storage solutions may also help address storage issues. As far as the latter are concerned, important considerations include a full-fledged technology based on operational experience and that legislation should apply economic means in order to compel the generators of storage demand to directly participate in storage and the financing of the required improvements. From a technological respect, battery solutions capable of the storage of energy equivalent to a 10 MW capacity may be used.

6.2.7 REGIONAL INFRASTRUCTURE PLATFORM

Regional market interconnection, as efficiently and as deeply as possible, is a top priority for Hungary. A regional market, operating efficiently and according to uniform rules, may facilitate producer and infrastructure investments and increasing competition on the regional market may press down prices to the vicinity of production costs.

The envisaged high and increasing share of nuclear energy, hydro and other renewable energy sources requires closer regional cooperation in system management and energy storage. Tighter integration would in turn enable the increased utilisation of renewable energy sources within the region. The establishment and assurance of regional real-time peak electric capacities will remain important priorities with a view to preserving the regulatory flexibility of the grid.

While hydro pumped energy storage would be technically feasible at various locations within Hungary, regional cooperation appears to be the most advantageous solution as agreements could be entered into with certain neighbouring countries concerning the availability of their pumped-storage capacities for Hungary. It is in our interest that Hungary should have access to low-cost regional hydro energy capacities with a view to the cost-effective regulation of the domestic electric grid. However, such international cooperations may involve certain risks, partly because the neighbouring countries concerned are faced with similar problems and partly because it would increase the vulnerability of Hungary, potentially involving security of supply and economic risks.

It is recommended that the issue of nuclear investments be handled in a regional context with regard to load balancing and the similar plans of neighbouring countries. Parallel regional nuclear power plant constructions involve a substantial risk of stranded costs if all of the currently planned regional power stations are built. Therefore, in order to ensure the return of investment, the possibility of cross-ownership or joint ownership should also be considered, in order to achieve a stronger position vis-à-vis suppliers, lower maintenance costs and the resolution of other emerging issues. Due to the market integration, Hungary will have a more certain regional market for its surplus nuclear energy. It is expected that the nuclear fuel rods required for the operation of the nuclear plant will continue to be available on the global market at a stable price.

The possibilities of the joint management of the electricity grid may need to be examined in order to address these tasks. While the required physical connections are in effect available within the region, the conditions of the integration of markets and regulatory harmonisation must be created.

6.3 HEAT ENERGY

Building energy programs – district heat network through development and the utilisation of renewable energy sources

Building energy programs – district heat network through development and the utilisation of renewable energy sources

- the achievement of national and EU energy targets,
- rationalisation of energy consumption,
- improving urban air quality,
- reducing import dependency, in particular natural gas and petroleum dependency,
- innovations and the implementation of the related advanced technologies,
- awareness-raising (energy – environmental awareness) and the utilisation of intellectual potential,
- accommodation of domestic and international businesses, resulting in significant job-creation and boosting the construction industry

• As far as the utilisation of heat energy is concerned, three scenarios have been examined for the household and tertiary sectors, depending on the building energy programs (Figure 25):

a) BAU: no energy efficiency programs, resulting in a slight increase of the total heat utilisation of energy up to 2030

b) Reference: a saving of 84 PJ up to 2030

c) Policy: a saving of 111 PJ up to 2030

• Among other criteria, the scenarios have been examined for cost, job creation, CO_2 emission and natural gas replacement. The relevant detailed scenario analyses are discussed in the 'Heat Energy Market' chapter of the Annex to the Energy Strategy, whereas the economic impact analysis contains a comprehensive scientific study of the scenarios.

• Of the two scenarios, the amount of available funds will determine the one to be implemented. In the case

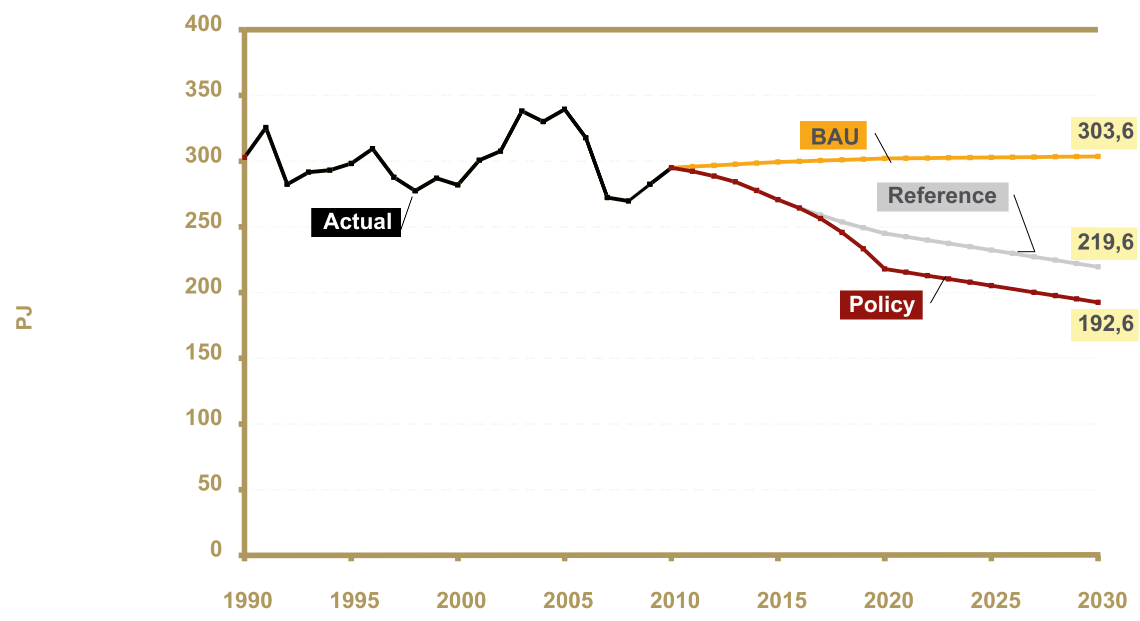

Figure 25: Household and tertiary heat energy consumption
Source: REKK – Regional Centre for Energy Policy Researchv

of 'Reference' household and tertiary heat energy consumption, the share of renewable energy sources in the segment is 32 percent, i.e. 25 percent for overall heat energy consumption. Oil and coal-based heating will in essence cease (Figure 26). The units of natural gas power plants not participating in system control should, if possible, be connected to heat consumers, whereas industrial utilisation should be linked to district heating wherever this is feasible.

The 'Green' scenario reckons with more ambitious savings and a higher share of renewable energy sources which, however, appear to be a potential rather than a realistic option under the current fiscal policy. If additional resources become available for the implementation of building energy programs, the feasibility of this scenario should be considered in any case.

- The potentially increasing use of heat pumps and air-conditioning units will increase the share of electricity used for heating and cooling, a fact indicated at electricity consumption.
- District heating systems will play a very important role in the renewal of heat energy supply due to their ability to admit heat from virtually any heat source, transmitting it to the end users.

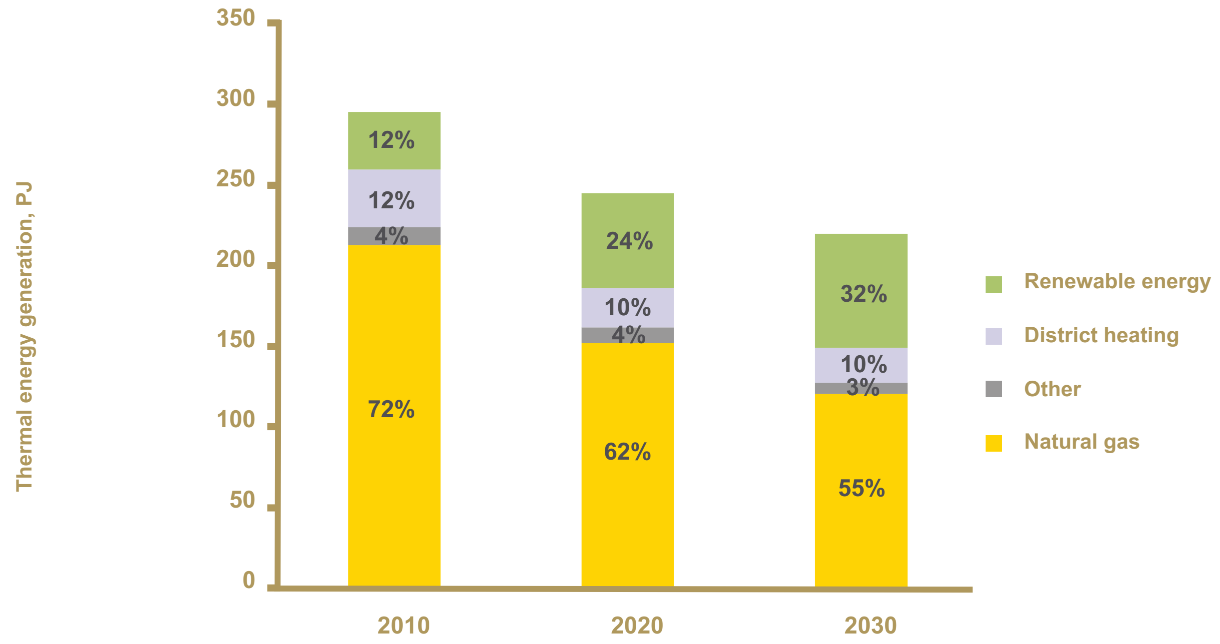

Figure 26: Envisaged household and tertiary heat energy consumption in Hungary, based on the 'Reference' building energy scenario
Source: REKK – Regional Centre for Energy Policy Research

Heat energy supply	
will become competitive if	• the technical standard, efficiency and the coverage of the district heating service increase. This essentially requires quality improvement and the full satisfaction of the comfort requirements of consumers (e.g. controllable heating and cooling). • the share of local energy sources increases.
will be sustainable if	• the share of renewable energy sources increases as far as both district heating and private heating systems are concerned. • biomass is utilised in strict compliance with sustainability criteria.
will be safe if	• development projects are accompanied by building energy retrofit programs.
Tools:	• simplified permitting, regulation and feed-in tariff system in order to encourage the increasing use of alternative technologies (in addition to green electricity, the supported feed-in of heat generated by renewable energy and upgraded biogas fed directly into the natural gas system). • multi-tier program package geared to target user groups in order to support the improvement of energy efficiency. • introduction of efficiency incentive support system

6.3.1 ENERGY EFFICIENCY

The heat energy demand may primarily be reduced through increasing energy efficiency. Almost 70 percent of Hungarian homes are obsolete in terms of thermal technology.

As far as building retrofitting is concerned, buildings other than the ones built using industrial technology should also be taken into account, since only 650,000 of a total of 4.3 million homes fall into the latter category. In addition to residential buildings, special attention must also be paid to the energy efficiency retrofitting of public buildings, as this can demonstrate commitment by the public sector. The projects requiring the smallest investment, where the investment is returned out of the reduction of consumption should be given preference, as it is at such projects that the cooperation (including the financial involvement) of building owners and the participation of private investors can be expected. At the same time, if the capacity of the budget enables, a shift should be made toward deep retrofitting, taking into consideration the expected useful life of buildings, through which the problem could be resolved in the long term. It should be noted, however, that both residential and public buildings include a large number of elements of the architectural heritage. In the case of the architectural heritage, the possibilities of implementing environmental and energy targets should be individually assessed in each situation in order that the implementation should not endanger irreplaceable heritage items and should not hinder the unfolding of their value. Special attention must be paid to the preservation of the heritage items of World Heritage sites.

The practice of third-party financing (ESCO) must be promoted, ensuring the possibility of government participation, in the modernisation of either private or district heating systems, enabling the achievement of fundamental requirements and the following additional objectives with a view to meeting the requirements set out in the applicable EU Directives:

- improving the energy efficiency of public institutions (increasing the district heating potential),
- reducing summertime specific cooling energy consumption,
- supporting green urban management.

In addition to meeting energy targets, the following programs may result in additional results having a multiplicator effect:

- improvement of air quality (elimination and restructuring of air-polluting point sources),
- reduction of consumer energy costs,
- reduction of the specific costs of municipal governments (managers - owners)

Since low-efficiency district heating systems have a significant effect on the energy classification of the buildings, the energy audit of district heating systems and establishing the efficiency of their retrofitting are issues of key importance. Energy audits facilitate the possibility of the utilisation of renewable energy sources and increasing the efficiency of the existing systems.

As a technological solution, the modernisation of heating systems and the replacement of doors and windows are investments that can be carried out on a large scale, yielding return on investment within a relatively short time. With a higher level of support, this represents an energy saving of 15-20 percent in itself. Based on experience to date, the present-day prefab block-of-flats program shows a favourable picture according to the price/aid/result group of indicators, and is accompanied by energy savings of around 50 percent. The modernisation of heating system and equipment and the utilisation of local renewable energy sources make a further contribution to the improvement of energy efficiency. An additional saving of up to 85 percent could be achieved through the use of deep retrofit technologies. While they have the downside of higher short-term costs, they offer a solution for the long term and therefore the amount of funds available and the expected useful life of the buildings must essentially be taken into consideration with respect to such projects. Various types of new financing mechanisms should necessarily be developed in order for retrofitting of such depth to gain ground. On launching retrofit programs resulting in a greater depth of retrofit (>50%), the principle of cost effectiveness and the probably decreasing investment costs must also be taken into consideration.

Directive 2010/31/EU[39] provides that all new buildings after 31 December 2020 should be nearly zero-energy buildings. For buildings occupied and owned by public authorities, the corresponding date is 31 December 2018. In the case of such new buildings, the purpose of the aid is to encourage construction of an energy efficiency level higher than the regulations, of a target value of 25 kWh/m^2/year. Consequently, in new buildings, including public institutions and commercial buildings, the rate of the increase of efficiency should reach 60 to 80 percent. While there is no accurate information available on the number of nearly zero and low-energy buildings, there are typically very few such buildings in Hungary (not more than a few hundred). The demand for new low-energy buildings will probably increase at significant rate between 2015 and 2020. It is estimated that between 100 and 1,000 such new buildings a year will be built at the middle of the decade. After 31 December 2020, about 30,000 to 40,000 new buildings will probably be built a year, taking into consideration the normal rate of constructions, four-fifths of which will be residential buildings. For these projects, minimum requirements resulting in an optimum cost level should be defined. These requirements should preferably also be applied to the significant retrofitting of the existing buildings if this is feasible from technical, functional and economic respects. In order to prepare a realistic and scheduled annual plan and to provide an estimate for the results, the real estate market and the position of building owners and developers must be assessed.

In addition to the demand for heat, the increased demand for cooling (air-conditioning) and the likelihood of the continued growth of such demand must also be taken into consideration in terms of estimating the en-

[39]Directive 2010/31/EU of the European Parliament and of the Council of May 2010 on the energy performance of buildings

ergy demands of the building stock. The latter demand is mostly supplied by incidental poor-efficiency systems. While the energy efficiency retrofitting of buildings will also reduce the demand for cooling energy, the installation of heat-pump systems capable of cooling should be facilitated. In addition to the above, the EU will probably extend ecodesign requirements to air-conditioning systems. In any case, it must be taken into consideration that cooling demands can only be satisfied through the use of electric power, which means that the emergence of weather-dependent peaks are to be expected in electricity consumption. The increasing use of individual photovoltaic systems may be a suitable alternative in order to manage such peaks.

The efficiency of heat utilisation and generation is an important issue in both industry and agriculture. In industry, process optimisation and the utilisation of waste heat, whereas in agriculture, natural gas-independent plants utilising local thermal resources can be taken into consideration. The promotion of the use of low-carbon, best-available (BAT) and trigeneration technologies in industry, the promotion of low-carbon agro-technologies in agriculture and the supporting of geothermal energy-based greenhouses and the encouragement of organic farming are among the priorities of the government. A standardised monitoring system should be developed for the national aggregation of energy savings.

6.3.2 RENEWABLE ENERGY SOURCES

Natural gas vulnerability in heating/cooling may be reduced primarily through the use of renewable energy sources (biomass, biogas, solar and geothermal), whereas appropriate price and support policies are required in order to ensure the competitiveness of investments.

In any case, in terms of the use of renewable energy sources in heat generation, the priority of energy efficiency must be taken into consideration. Developing the support and incentive scheme, the prices of natural gas will be critical in terms of the competitiveness of renewable energies. In the long term, consumption-based support may represent an increasing fiscal burden due to increasing global natural gas prices. Implementing efficiency incentive aid schemes may, however, offer a solution to that situation.

In the case of district heating systems, pipelines and the heat centre network must essentially be modernised, renewable energy sources, primarily biomass and geothermal energy must be used and communal wastes non-utilisable in their materials must be utilised for energy generation. As far as individual systems are concerned, the share of energy generated from biomass, by solar collectors and heat-pumps must be increased through the development of the applicable regulation. For biomass, individual supply being quality and logistics-intensive, the boosting of the domestic pellet manufacturing capacities may offer a solution. The utilisation of natural gas for heating may be reduced by the use and the feed-in, in compliance with the applicable standards, of biogas and landfill gas.

The growth of the size of the district heating system will result in the reduction of both fixed costs and direct costs (due for example to lower specific heat loss). In that approach, the strategy must focus on the increase of the efficiency of the district heating service, encouraging technological modernisation and the support of heat generation relying on renewable energy sources.

With a view to specifying the future directions of district heating and combined energy generation, a district heating development action plan is called for (including in particular a development plan for Budapest). Improving the technical standard of the service can no longer be postponed (insular operations interconnectable in the long run, transition to low-temperature secondary service, assessing the possibility of district cooling, developing a service quality control system, setting up a system of efficiency criteria, individual controllability and metering and the development of village district heating systems). The action plan should also indicate that the declining demand for heat may lead to the reduction of heat generation provided that the technical standards of district heating systems improve and building renovation projects are carried out. Due to the significant fixed costs of district heating providers, this may even render the district heating service uncompetitive in certain settlements because of the increase of costs per consumer unless a low-cost or subsidised (renewable-based) heat source becomes available.

We should also get prepared to the situation that the consumers worst hit by the expected continuing increase of the global market price of natural gas will be the retail consumers constituting the overwhelming majority of district heating customers. A reasonable solution and a possible natural gas alternative could be the increased utilisation of thermal waste utilisation (waste incineration), subject to strict environmental requirements, in district heating, which may even offer a solution to the problem of declining heat demand. Based on the positive experiences of a number of large European cities, the combination of the two technologies also substantially increases the cost-effectiveness of the district heating service. Consequently, strategic objectives will also include supporting the development of waste-to-energy technology and awareness-raising programs demonstrating the social benefit of waste processing/recycling. This is compatible with the National Environmental Protection Program, which prescribes a 10-percent energy utilisation in waste management, and with the targets of the National Waste Management Plan, according to which wastes non-utilisable in their materials should be utilised for energy purposes at the highest rate possible. As far as the incineration of wastes non-utilisable in their materials is concerned, a set of strict legislative rules concerning the licensing of such activities should be established in order to prevent the illegal incineration of hazardous wastes, which may have an adverse effect on other elements of the environment.

6.4 TRANSPORT

The electrification of road transport, second-generation biofuels in public transport & rail transport development

- In accordance with the applicable EU Directives, the share of renewable energy will reach 10 percent by 2020. This will be achieved primarily through the use of biofuels.

- Since there are technical obstacles to the blending of biofuels into traditional fuels, particularly as far as the Hungarian vehicle stock is concerned, the blend-in rate probably cannot exceed 10 percent. By 2030, the share of biofuels will reach 14 percent. In terms of biofuels, the most important objectives are to meet EU targets while resolving the contradictions vis-à-vis primary food and fodder production. The desired higher share can be achieved through switching public transport systems and agricultural equipment over to locally produced second-generation and biogas fuels. For passenger cars, meeting the updated EU targets in terms of the share of electric and/or hydrogen-propelled vehicles by 2030 is a top priority.
- With a view to increasing energy efficiency, the diversion of road transport toward rail and water transport is of strategic importance. Shifting public road transport to a renewable and electric (electric and hydrogen) energy basis.
- As a collective result of the above, the transport energy mix in 2030 will be as follows (Figure 27). Bio-

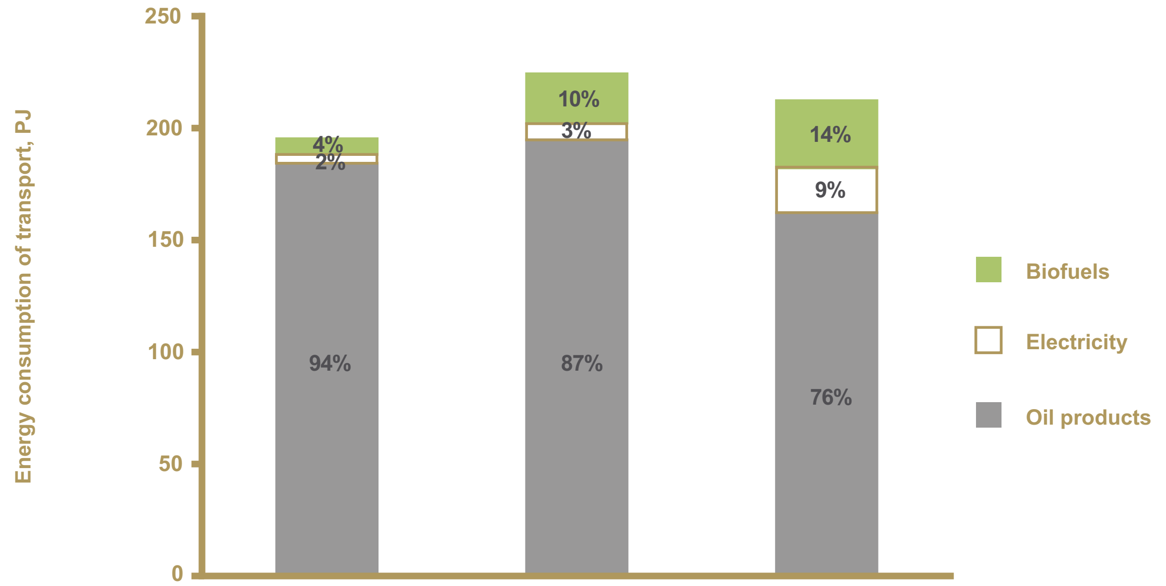

Figure 27: The expected energy source distribution of transport in Hungary

fuels include bioethanol, biodiesel and biogas fuels, whereas electric energy also includes hydrogen.

While transport is currently mostly hydrocarbon-based, a potential oil peak and the tipping over of the demand and supply balance may result in prices getting of hand. Due to the already felt price sensitivity of the society, this could lead to reduced mobility and faltering supply. In all likelihood, while transport will continue to be hydrocarbon-based, a potential transition must be prepared for and alternative technologies must be given opportunities in the form of pilot projects. In individual transport, the biggest manufacturers will probably launch electric cars and start powerful marketing activities around 2015. While in Hungary, the mass penetration of technology may take place a decade later, the prices of electric cars will in all probability be competitive around 2025-2030, i.e. their use will increase on a market basis, without government intervention. The change of the transport structure will result in a significant increase of the demand for electricity due to the emergence of electric vehicles. The most important steps, requiring government involvement, of the preparatory process include rolling out the infrastructure, achieving the controllability of the grid and establishing the required production capacity. This is properly complemented by and is compatible with nuclear improvements, i.e. the utilisation of base-load power plants is increased by the growing share of electricity-based transport (1,000 MW night-time nuclear power plant capacity enables the full charging of approximately 200,000 electric passenger car – about 5 percent of the assumed number of passenger cars and 50 percent of the envisaged number of electric cars). In the event these vehicles are loaded on a network that has not been properly prepared and being of insufficient capacity, a situation may arise where the network and domestic production capacities required in order to meet the demand are not available.

The energy supply of transport	
will become competitive if	• transport evolves along a path that integrates transport, energy policy, rural and urban development, job-creation, foreign trade and training targets. • high transport costs do not reduce the competitiveness of Hungarian export.
will be sustainable if	• both oil dependency and CO_2 intensity are reduced. • the role of rail transport increases in freight and passenger transport. • alternative fuels (electric and hydrogen power, biofuels) qualified according to the appropriate set of criteria become dominant. • bioenergy production and utilisation do not endanger the agricultural environment and food supply and do not go against rural development efforts.
will be safe if	• preparation for the post-oil peak, transition of the transport structure and the development of electric, hydrogen and biofuel infrastructure is started in time.
Tools:	• the joint support of alternative fuel production and vehicle development in terms of both research and development and manufacturing. • encouraging the establishment of decentralised plants supplying local needs. • quantifying the externalities caused by fossil fuels.

6.4.1 ENERGY EFFICIENCY

The following options are available to reduce the energy consumption and the environmental load of transport:

1. Reducing the demand for mobility, including the reduction of the need for transport and the shortening of distances travelled: awareness-raising campaigns and urban development considerations may be used in order to reduce mobility needs. However, it should be taken into consideration that the reduction of mobility has powerful social (falling-behind regions, urbanisation, the increase of agglomeration zones, individual freedom and requirements) and economic (tourism, transportation) implications. Increasing reliance on infocommunication technologies and digital services (video conferencing, online administration, teleworking and e-learning) and the shift toward a sustainable approach (the increase of bicycle transport and the increasing value of locality, e.g. preference for locally produced food) also have a mobility-reducing effect. Within urban transport, the use of bicycles should be encouraged through infrastructure development and regulation.
2. Shift to more efficient modes of transport: this should primarily include the increasing role of rail transport in both passenger and freight transport. It is also important to increase the share of public transport, which is possible through development projects, increasing the quality of service and by establishing a value-for-money tariff system.
3. Optimisation, i.e. the better utilisation of the existing capacities: such solutions (including, for example, the coordination of time-tables) mostly fall into the competence of the companies involved, as it is in their interest to minimise idle capacities. Smart systems and the planning of corporate mobility and corporate vehicle fleets may also contribute to the optimisation of transport management.
4. Fiscal instruments: financial instruments enabling the calculation of the prices of the high external costs (e.g. road toll, restriction of access), increasing the competitiveness of more environment-friendly solutions.
5. Vehicle development and alternative technologies: manufacturing trends and requirements indicate the increasing efficiency of internal combustion engines and the increasing popularity of hybrid vehicles, re-

sulting in the reduction of specific consumption and emissions. That, however, will probably not result in the decline of energy consumption since the number of vehicles per 1,000 persons is expected to increase.

The government is capable of influencing the reduction of the energy demand of transport and the improvement of energy efficiency mainly through public transport (primarily through a modal shift and the use of alternative technologies). The development of urban and suburban public transport, rendering it attractive, comfortable and clean, is an absolute necessity. In local public transport, the importance of biofuels is expected to increase in the long term, due to their local availability, with particular regard to the technologies relying on second-generation or alternative raw materials. The experiences and initiatives of the EU have indicated that the use of electric, hydrogen and hybrid-fuel vehicles should first be encouraged in the public transport of big cities, as their increased use requires substantial infrastructure investments. In urban public transport, mature solutions exist for various such technologies. Their viability should also be demonstrated in Hungary through pilot projects (to be launched by 2015 at the latest). It requires the cooperation of the government, a local government, the electricity sector and Hungarian bus developers and manufacturers. In combination with public transport, incentives to promote the production and utilisation of renewable and zero-carbon fuels should therefore soon be commenced, offering a modernisation opportunity by replacing the antiquated bus stock of Hungary, which will in turn contribute to the improvement of the comfort of travel in addition to serving energy and environmental targets.

While the role of rail transport should be increased significantly, this requires a substantial improvement of the quality of the current services, with particular regard to the coordination of time-tables, the creation of a suburban rapid transit railway network and the reduction of access times.

6.4.2 RENEWABLE ENERGY SOURCES

In terms of biodiesel production, the domestic capacity is sufficient for the production of the quantities in accordance with the relevant Directives, whereas there is a surplus bioethanol production capacity based on surplus quantities of maize.

From an economic point of view, added value can thus be generated through Hungarian jobs out of the surplus export maize. It should also be noted that stillage, a by-product of ethanol production, is an excellent and exportable fodder. Experiences to date have shown that while bioethanol manufacturing capacities are established with no direct investment support, the market for volumes of bioethanol in excess of the blend-in demand must be ensured. This can be achieved by supporting the entry to the Hungarian market of the E85 fuel and by export production. In accordance with Directive 2003/96/EC[40], overcompensation for the extra costs involved in the manufacture of bioethanol should be avoided. In the EU, no biofuels should be manufactured or exported unless they comply with the criteria of sustainability. Therefore, the manufacture and use of only those biofuels should be supported that are genuinely sustainable (i.e. have a positive energy and emissions balance). With regard to the fact that the production of high quantities of first-generation biofuels may compete with the production of food and fodder, there are limits to their use. Therefore, in addition to economic and sustainability considerations, the criteria of food and fodder production should also be taken into account, by the analysis of market trends, in terms of the supporting of maize-based (first-generation) ethanol production. In the long term, waste and by-product-based biogas, second-generation biofuels and first-generation base materials (e.g. sweet sorghum and Jerusalem artichoke) that can be grown on marginal and degraded agricultural areas (e.g. ones exposed to inland water) should have priority.

Road freight transport is mostly carried out by Diesel vehicles. Since in Hungary, the production of first-generation biodiesel cannot be increased at a significant rate based on domestic raw materials, the share of rail and water transport should be substantially increased in the sustainable transport of goods, which would help achieve the energy efficiency and CO_2 emission-reduction targets.

The conversion of vehicles used in agricultural production to fuels prepared from locally grown crops, primarily rape, should be facilitated. That will contribute to rural self-sufficiency, help keep locally produced commodities at their place of origin, while on the level of the national economy, it will reduce the use of fossil fuels.

[40]Council Directive 2003/96/EC of 27 October 2003, restructuring the Community framework for the taxation of energy products and electricity

6.4.3 REGIONAL INFRASTRUCTURE PLATFORM

In order to achieve the above, the current trend should be reversed, i.e. the weight of road freight transport should be reduced. It can be attained by diverting part of the freight transit from the road to the rolling highway and by promoting combined transport, container transport in particular.

In addition to its energy policy benefits, it would relieve roads of their current load and result in the improvement of the quality of life in areas hit by transit traffic, in particular as far as air pollution and the noise load are concerned. In order to achieve these objectives, the external costs caused by transit traffic (road load, pollutant emissions, environmental load affecting the population) should be incorporated in motorway and other public road tolls for transit goods traffic, which will ensure the competitiveness of the rolling highway and container transport. As a fundamental energy and transport policy instrument, this enterprise must be established with majority public ownership. The construction of terminals and the continued electrification of the rail network must also be ensured. Since at shorter distances the importance of road freight transport will continue, the target in that respect is to improve logistics (the vehicle fleet and its degree of utilisation).

Operation should be developed on cross-border lines also in order to increase the share of passenger transport by rail, with particular regard to the establishment of links to high-capacity Western networks.

7 HORIZONTAL ISSUES

„The pessimist sees difficulty in every opportunity. The optimist sees the opportunity in every difficulty.”

(Winston Churchill)

7.1 RURAL DEVELOPMENT

Bipolar agriculture with low-carbon technologies

In the future, renewable energy sources of agricultural and forestry origin (primarily biomass) may play a major role in the complex regional development of rural areas, the utilisation of land no longer used for food production, in addressing the environmental problems of rural settlements and increasing their population-retaining capacity and in the creation of new jobs in rural areas.

Bipolar agriculture is essentially about the establishment of a system of economic incentives and support enabling a flexible switch between food and energy farming according to the actual requirements of the market. Further important prerequisites of the success of the green development program include following the decentralised implementation model, since this is the only way the increasing of the capacity of small rural areas to attract workforce and the revitalisation of falling-behind small agricultural areas can be realistic targets. The decentralised model of operation also has secondary social/welfare externalities such as increasing rural employment and the integration of groups living in permanent deed poverty in the world of labour as well as supplying such groups with affordably priced renewable energy. In that context, the model of bipolar agriculture should be developed so that it includes the production of high added-value products as well as the full utilisation of the by-products generated (supply chain approach). The local utilisation of agricultural by-products, according to local needs, is conducive to the shaping of the vision of a renewing economy. The competitiveness of the supply chain can be increased by the identification of by-products and waste materials recyclable in industry (primarily in the pharmaceutical and fine chemicals industries), since it would enable the extraction of considerably higher added-value products, such as pharmaceutical products and fine chemicals in addition to energy utilisation. Locally available energy can contribute to the development of agriculture, e.g. by enabling the production of higher-value products in glasshouses heated with geothermal energy throughout the year. From the point of view of the protection of the water base, however, such glasshouses should only operate in compliance with the applicable legal regulations and the set of sustainability criteria.

In the cultivation of biomass for energy purposes, with particular regard to the production of first-generation fuels, it should always be kept in mind that is should not compete with the cultivation of crops for food and fodder. The utilisation for such purposes of marginal or degraded areas, not representing a nature conservation value (including for example areas exposed to inland water, located in floodplains or being of low productive value) should have priority. Areas withdrawn from farming and not used for other purposes but suitable for conversion to arable land through recultivation can be added to the areas suitable for green energy crops. Rather than the planted varieties, bioenergy production should therefore be assessed on the basis of the nature of the area concerned (the type of former activity being replaced by it, assessment of alternative uses, job creation), the available biomass yield and the place and nature of the utilisation of the biomass produced (decentralised and sustainable model). The varieties applied should be selected in accordance with local conditions, always taking into consideration the sustainability criteria and, in the case of alien and invasive species, the existence of protective zones. Since high-quality soils are one of Hungary's greatest treasures, the definition and application of sustainability criteria should be a key priority in terms of the energy utilisation of biomass. The proper management of soil as a strategic asset is an essential factor of the establishment of bipolar agriculture.

The gaining ground of organic farms relying on local demands and opportunities is a prerequisite of sustainable development and in particular of sustainable and competitive agriculture. Rather than end-of-pipe solutions focusing on pollution management, the goal is to support the innovation and catching on of preventive, low-carbon technologies throughout the entire lifecycle. While traditional agrotechnological practice is responsible for 13-15 percent of the total GHG emissions, that figure may be reduced by the use of existing low-carbon technologies. Since organic farming reduces GHG emissions due to minimum reliance on agrochemicals and its high labour intensity, the supporting of these sectors is a priority in terms of both the improvement of energy efficiency and the reduction of GHG emissions.

7.2 TRAINING AND EMPLOYMENT

Job creation and vocational training in the energy sector, primarily according to the needs of renewable energy production plants

After the fall of Communism, research and development activities and mechanical engineering in the energy sector were almost completely discontinued in Hungary.

However, it is the companies of the countries engaging in the development of renewable technologies that reap most of the economic benefits of the shift to a sustainable energy economy. In order that energy policy should be part of industrial development and make a substantial contribution to economic development and job creation, pilot projects and technologies based on domestic research and development and innovation must be promoted. While on the selection of energy R&D programs and projects to be supported by government tools, their potential contribution to the objectives of the Energy Strategy must be taken into consideration, feasibility analyses should be conducted in each case. It is recommended that a monitoring and evaluation scheme be implemented for the assessment of cost-effectiveness.

The application of renewable energy sources and the manufacture of technologies have a significant effect on job creation. According to a 2008 analysis of the UN Environmental Program (UNEP), a significantly higher number of jobs per unit of capacity are created by the domestic utilisation of solar, wind and biomass energies than coal or natural gas power plants. Consequently, in terms of operation only, the energy utilisation of biomass and the operation of solar panels have outstanding implications on employment (Figure 28). With a view to exploiting the full job-creation potential and the economic criteria, supporting domestic manufacture is the top priority. The substantial increase of the use of innovative technologies may require the establishment and enlargement of manufacturing capacities potentially producing for export. Therefore, as far as industry policy developments are concerned, potential investment-stimulating opportunities in the field of energy manufacturing should also be borne in mind and their achievement should be promoted through an investor-friendly regulatory environment. With a view to reducing adverse effects, a support policy should be developed to facilitate the participation of the Hungarian professional background to the greatest extent possible and job creation in Hungary during the implementation and subsequent maintenance and operation of technologies.

In mechanical engineering, bus manufacturing, a traditional Hungarian industry currently producing mainly for export, may be of primary importance, with

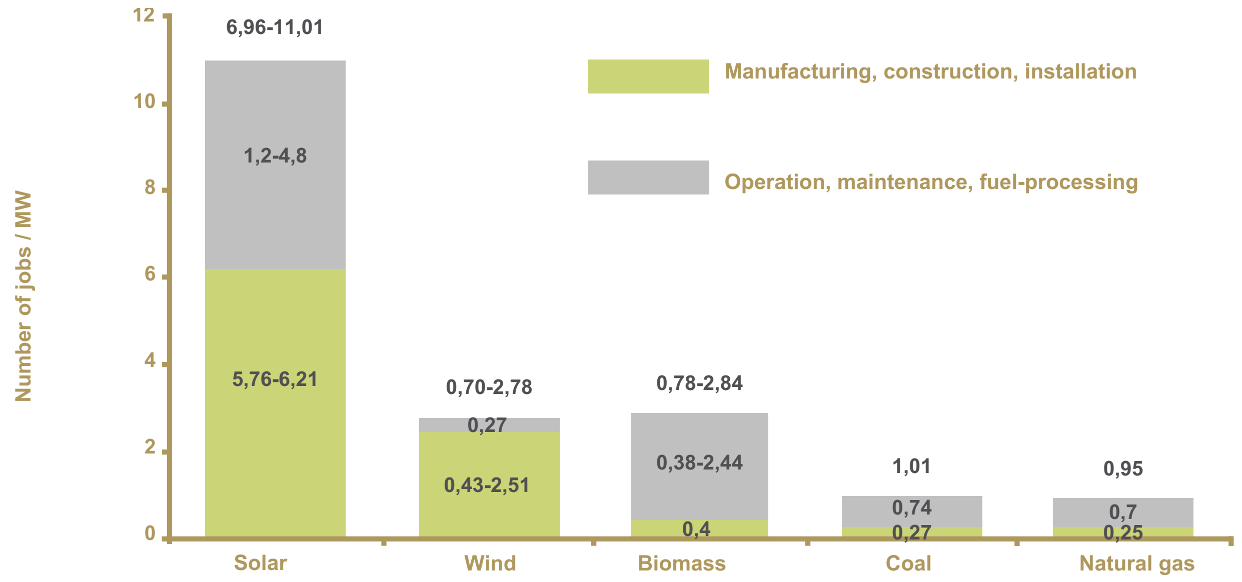

Figure 28: Estimated specific job-creation effect of various energy-generating technologies
Source: UNEP, Green jobs: Towards decent work in a sustainable, low-carbon world

particular regard to the unavoidable replacement of the antiquated Hungarian bus fleets. The modernisation of public transport will also require buses of alternative (biofuel, hydrogen and electric) drives. The operation of a specific proportion of such buses must be one of the criteria in manufacture and supply tenders. This will also have a positive effect on R&D in the automotive industry. In addition to the above, new opportunities may arise primarily in the development and manufacturing of biomass and waste utilisation (boilers, pyrolysis units), geothermal, photovoltaic and energy storage systems. With the increasing penetration of smart meters, the meters currently in use will need to be replaced. Taking all public utilities into consideration, that would require the scrapping of about 15 million equipments. The manufacture, installation and the potential servicing of the new meters may be an extraordinary opportunity for Hungarian industry. The establishment of a job-creating Hungarian background industry (manufacture, service) should be treated as a priority in all other cases, too, which requires an investor-friendly and investment-encouraging industry policy environment.

With regard to building renovations, possibilities of the application of traditional, environment-friendly architectural practices (adobe, straw, passive houses and other innovative buildings) and local, renewable and waste (e.g. paper)-based insulation technologies and individual solutions and harmonious shapes related to the energy improvement of the built heritage must be researched and developed. In that context, the system of research needs to be developed, a support scheme in order to implement pilot construction projects must be established and introduced and the results of research must be used with a view to their dissemination as widely as possible.

In Hungary, the highest number of employees is currently employed by small and medium enterprises (SMEs). The government support of energy companies is only justified if the activities of the energy company in question contribute to the achievement of the objectives of the Energy Strategy, it engages in R&D activities of an innovation potential, establishes a production capacity in Hungary and/or employs a significant number of workers. The government support of the energy efficiency investments of consumers is only justified if their activity generates innovation and facilitates the development of domestic manufacturing capacities and the creation of jobs in the SME sector. On the basis of the above considerations, the top priorities of the future Green Development Fund will include the financing of the capital needs of Hungarian SMEs actively involved in the green economy. The Green Development Fund will be a form of financial support specialising in the support of investments resulting in the development of climate-friendly technologies and the utilisation of renewable energy sources. Since it is of essential importance that energy-related Hungarian intellectual products and innovations should contribute to the strength of the Hungarian economy, possible cooperation with the Hungarian Intellectual Property Office (formerly: Hungarian Patent Office) should also be considered.

In the energy sector, the significant increase of employment can primarily be achieved through improving energy efficiency, the use of renewable energy sources, the development of green industry and agricultural energetics and by a potential new nuclear project based on the involvement of Hungarian suppliers. Consequently, a system of energy engineer training should be established in cooperation with higher-education institutions and the energy sector in order to facilitate the achievement of the objectives of the Energy Strategy. The multi-level education of experts skilled in the mapping and exploitation of renewable energy sources as soon as possible is an essential prerequisite of the establishment of innovation technologies and manufacturing capacities based on a domestic knowledge base and the actual mapping of the renewable energy source potential. Only that map can enable the attainment of the principle of the lowest cost, the exploitation of local conditions to a considerable degree and the development of the corresponding regional strategies and measures.

The designing of a high number of small-capacity energy plants is an important task, burdened by various difficulties. Lower-capacity energy facilities are expected to be established mainly in the field of renewable energies and their complex, high-quality design is a condition of the successful completion of the NREAP. The complex, high-quality design of energy facilities implies coordinated planning by various technical fields (including for example, mechanical engineering, architecture and chemistry) to ensure the optimal design, the coordinated connection and the economic and safe operation of the various equipment and of the system. The planning of regulation, metering and automation is also of increasing importance. Complex planning should take national and public interest into account and should primarily support Hungarian mechanical engineering, local opportunities and job creation.

In addition to alternative technologies, both the energy efficiency measures and the new nuclear projects require the existence and development of background industry and the appropriate modification of the training of professionals and the restructuring of education are essential in order to enable their implementation. Taking into consideration the time required for the training of an expert (including in particular professionals with a college or university degree), new courses should be launched as soon as possible in order to avoid the shortage of experts. Their current numbers are insufficient to meet expected future demand on a time proportion basis. Apart from the training of new experts, attention should be paid to the further training and qualification of experts already skilled in the field of energetics, including in particular the utilisation of renewable energy sources and building energetics, as well as the special supplementary training of experts concerning individual solutions, techniques and the use of materials that can be applied in traditional architecture and the built heritage, which may include purpose-made industrial design.

7.3 ENVIRONMENTAL PROTECTION AND NATURE CONSERVATION

Awareness-raising, the reduction of emissions and adaptation to the climate change

The reduction of the energy-based pollution of the environment would entail the mitigation of air pollution, currently heavily affecting the entire population.

The electrification of transport and the gaining ground of public transport would significantly contribute to the improvement of urban air quality and thus to the repression of the related diseases. Even at the present-day power plant structure, the gaining ground of electric vehicles is sustainable and more efficient than hydrocarbon-based transportation. The increasing role of rail transport would reduce noise load since, assuming the same transport capacity, rail transport generates about one-fifth of the noise of road transport.

With respect to the extracting and production of fuels, including in particular biomass (e.g. energy plantations) as well as to the planning, construction, operation and maintenance of energy-generating facilities, attention should be paid to the application of solutions complying with the criteria of landscape and nature conservation in accordance with the environmental assessment drawn up on the basis of the relevant Strategic Environmental Study. During these activities, special attention should be paid, according to the principles of sustainable use and precaution, to the protection of protected natural areas and Natura 2000 areas and the protection of biological diversity.

Reducing the pollution of our natural environment has outstanding importance also in the case of the built heritage (including the real estate heritage) and open-air works of art for both heritage protection and economic respects. In particular, the repairing of damage caused by air pollution, such as discolouration of facades, crumbling and frost erosion and the damages of open-air works of art/statues involves substantial expenses. Particular attention must be paid to the preservation of the heritage items of World Heritage sites.

Awareness-raising plays an important role in reducing the pollution of our natural environment: education should help as many people as possible to become conscious consumers. In that context, apart from training and education, the media also plays a part. Environmental consciousness and climate protection start at home, at the level of the individual. The shaping of an environmentally conscious approach must be commenced in a playful fashion as early as at kindergarten (a good practice and basis could be the ‘Green Kindergarten’ title and the related conditions, tasks and obligations and their improvements), and should be incorporated in the curricula of all primary, secondary and tertiary schools. The development of science education is indispensable in terms of the training of experts required for energy development and the raising of the environmental awareness of the population. With respect to the success of communal energy efficiency programs, awareness-raising campaigns must be conducted on the basis of the existing national government and non-governmental networks (eHungary sites, Integrated Community Service Spaces, library associations, etc.). Qualified and locally renowned consultants are available at these network nodes to inform the public and small businesses of the opportunities and to assist in the dissemination of an approach ensuring the achievement of energy efficiency, climate protection and sustainable development.

Through the printed and electronic press and infocommunication channels, most people can have access to the awareness-raising programs and trainings. In addition to reducing individual energy consumption, awareness-raising also contributes to the reduction of emissions. The campaigns affecting energy consumption patterns should be combined with programs concerning the transformation of waste and water management habits, as this provides a complex system for environmental education. Such complex systems would also enable the population to understand the role of consumer behaviour in the emergence of environmental problems and the necessity of adaptation to climate change.

The most effective way to achieve the personal involvement of individuals could be the establishment of a secondary economic circle based on specific energy quotas available for consumption by particular groups of consumers. Energy efficiency compared to the quota could then be exchanged for bonuses suitable for the purchasing of low-carbon products originating from producers involved in the scheme. While this ‘energy cafeteria’ scheme could operate similarly to holiday cheques, it cannot be implemented without the smart metering system being introduced first. Through the application of a tariff system based on individual consumption habits; smart metering will also increase consumer energy awareness and promote energy-efficient behaviour patterns.

7.4 SOCIAL AND WELFARE CONSIDERATIONS

Managing energy poverty and supporting the underprivileged

In Hungary today, about 200,000 people live off the grid and several times more people are unable to access these basic services due to their social situation. It is, however, difficult to accurately assess the number of households concerned, since energy poverty has various other aspects in addition to the financial considerations.

Consumers in need may follow various strategies in order to address the problem of lacking the resources needed for purchasing the required amount of energy. They may

- reduce their household consumption, a strategy typically followed by the elderly, with all of its quality of life and health implications;
- consume the required amount of energy, even at the cost of increasing indebtedness, a strategy typically opted for by families with children;
- resort to alternative solutions (stealing lumber or electricity), with all of their harsher risks and other types of costs (effort taken, risk of prison, other hazards, etc.).

The increase of household electricity prices during the 2002-2007 period provides an expressive example to illustrate the increasing rate of the spreading of energy poverty. While the price of electricity rose by 51 percent during five years, the minimum wage increased by only 31 percent during the same period.

In the future, social benefits targeting the elimination of energy poverty should be allocated on a needs basis. While social policy interventions should be adapted to energy policy, they should not be entrusted to energy providers. Most importantly, consumers expect energy prices to be as low as possible, while at the same time they also expect a secure service, appropriate service quality and reliability. In the case of certain groups of consumers, subsidised energy prices may encourage excess consumption. On a system level, this may lead to problems in terms of the security of supply, since the revenues will not cover the costs of the implementation of new capacities. Therefore, it is recommended to move toward support schemes furthering savings through energy efficiency rather than consumption. Such solutions include, for example, third-party financing mechanisms (ESCO), the increased use of which may also alleviate social and welfare-related problems.

In the medium term, a consumption-based, differentiated tariff system requires some further fine-tuning. For the consumer groups in need a limited minimum amount of energy indispensable for basic subsistence should be supplied at a price significantly lower than the market price. The lost revenue will be compensated by the other consumer groups. Wealthier consumers will thus be involved in the financing of energy efficiency and renewable energy utilisation projects that can be implemented on a market basis.

In the long term, however, welfare considerations should be completely dissociated from energy objectives since, under the current regulatory framework, neither consumers nor energy market operators are interested in giving preference to consumer awareness.

8 THE ROLE OF THE STATE

'A balanced state is needed which encourages everyone to act together. A strong state which above all serves public interest and the interest of our nation, not the business interests of a privileged few'.

(2010, The Program of National Cooperation)

The study, published by the ESMAP (Energy Sector Management Assistance Program) in October 2008, enables an international comparison concerning the extent and the method of the role of the government in the energy sector and the required system of institutions, at the level of the models followed by the various countries. As a general conclusion, the system works satisfactorily in countries with transparent and normative legislation and law enforcement systems. These include the Nordic countries, Germany, the Netherlands (NOVEM), the United Kingdom (DECC) or the PUC and FERC schemes in the US. In these countries, the requirements against legislation and public administration clearly go beyond declarations of principle; instead, they represent specific obligations concerning the operation and cooperation of the authorities involved in the energy sector. That practice should also be adopted in Hungary.

The whole system of relations of the energy sector has changed and become more complex as it now has links to other policies (transport, environmental protection, agriculture, water management, education and employment). The energy policy and the role of the government must therefore adopt a complex approach, also extending to other areas. In addition to the classic fields of energy policy, the role of the government should have a proactive effect on awareness-raising, R&D and innovation activities.

Appropriate government measures can ensure in the long term that the energy sector should continue to operate as a sustainable and secure sector, serving the purpose of economic competitiveness to the greatest extent possible. To that end, it is of critical importance to restore and later to increase the stability and credibility of the government system of institutions in charge of energy policy. The key to the sustainable operation of the energy sector is an independent, predictable, transparent, accountable and investment-stimulating industrial regulation in accordance with the requirements of the European Union and regional efforts.

In the field of energy efficiency, the government should set an example, in particular building energy programs should be implemented, smart building and smart grid solutions should be tested and promoted also in the public sector, and the experiences of these efforts should be disseminated as widely as possible.

8.1 OWNERSHIP

The presence of the government is currently rather moderate, and therefore very important, on a market-oriented, liberalised and highly privatised energy economy.

Recently, the lack of the government surveillance of the market has led to a serious economic crisis, whose effects are still being felt. Market operators have applied to the government for support and received such support in order to alleviate the impacts of the crisis. While opinions are still divided as far as the role of the state as owner and direct regulator is concerned, including in the energy sector, it has been demonstrated that public good and the national interests cannot be efficiently represented on a purely market basis. The following options may, among others, be suitable for the more efficient representation of national interests:

- Acquiring minority ownership in energy companies. That measure may help in the re-negotiation of expiring gas supply agreements.
- Both the trans-regional trade of LNG and the need for the diversification of resources and transit routes justify the necessity of joint regional action. It would therefore be important to establish a conciliation forum for regional energy companies, in which the governments affected would act as catalysts. It may be worth initiating the re-negotiation of import agreements on a European or regional level and supplementing the import agreements with agreements between the various EU member states.
- The strengthening of the role of state-owned energy companies. Among other things, that objective can be achieved by reconsidering their operation, reducing loss-making activities and diversifying their activities.
- The government should have exercise much more powerful control over our limited geological fuel resources and declare the treatment of mineral resources (particularly of coal and uranium) as national treasures and partly as strategic resources. Accordingly, the conditions of their domestic utilisation, as the circumstances may require, and development should be developed.
- With a view to helping the decentralised system to gain ground, the municipal right of disposal over the local energy infrastructure must be strengthened.

In addition to the above, the transport infrastructure, i.e. public roads, rail tracks, local transport (tram) networks owned by municipal governments and navigable rivers, are all state property elements. Since access to these networks is of public interest, the government must assume a critical role in their development, representing the needs of the society, as external needs. Therefore, with a view to achieving the objectives of the Energy Strategy, the development and the better utilisation of transport, of rail transport in particular, are essential.

8.2 REGULATION

It is the duty of the government to ensure the coherence of the legal and economic conditions falling into the scope of energy policy with a view to fully asserting national interests. To that end, a more definite, efficient and predictable government regulation is required, one that is in accordance with the European regulation and takes consumers' interests into account.

Environmental criteria must be borne in mind with a view to meeting the sustainability criteria. That would ensure long-term, balanced planning and would make the development trends manifest. Permitting processes should be transparent and simple for investors. The actual efficiency of regulation will increase investor confidence and the volume of investments.

Since in certain member states of the EU, the unjustifiably complicated and lengthy permitting procedures of renewable energy projects have caused a problem, Directive 2009/28/EC[41] puts strong emphasis on the simplification of public administration procedures with a view to reaching, by 2020, the mandatory share of renewable energies of 20 percent for the average of the EU and 13 percent for Hungary. The permitting procedures currently in effect and the measures to be implemented with a view to simplifying such procedures are described in detail in Hungary's NREAP.

It is considered important, in particular in the field of renewable energy utilisation, that the current legislative anomalies should be eliminated, the regulations currently impeding the related projects without due reason should be amended and the licensing procedures should be simplified. The permitting procedure is made simpler by omitting permitting requirements below a certain limit and converting to a reporting obligation in the case of certain procedures. The integration, in an efficient manner, based on partnership and consultations, of public administration procedures in the planning process would facilitate the licensing process of projects, which requires the increasing of the role of the government and the professional level and efficiency of the system of institutions.

However, the deregulation of administrative pro-

[41]Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (text with EEA relevance)

cedures should not result in the increase of the environmental risks of the facilities and activities. Environmental impact studies must continue to be in place in order to ensure the definition of the conditions concerning subsequent planning phases, preventing damages to the environment that are either irreversible or can only be made good through substantial investments.

8.3 SYSTEM OF INSTITUTIONS

A system of institutions ensuring the predictability of the investor environment must be established. Lack of the above would weaken a long-term security of supply and result in the failure of indispensable energy projects.

It is of critical importance to ensure, in the long term, the stability and credibility of the government system of institutions in charge of energy policy. The key to the sustainable operation of the energy sector is an independent, predictable, transparent and investment-stimulating industrial regulation in accordance with the requirements of the EU and regional efforts. The Hungarian Energy Office (HEO) should have a broader mandate, should become capable of carrying out planning duties requiring the implementation of the Energy Strategy and of eliminating the obstacles before the achievement of an energy policy based on the minimum cost principle, while paying increased attention to environmental aspects. It is recommended that the responsibilities of further background institutions be expanded, primarily in accordance with the implementation of the Energy Strategy.

With a view to informing consumers and motivating them to increase energy efficiency, an energy consultancy system (network of energy engineers), reaching a large proportion of the population, must be established on local government level. This network would be able to help individuals and businesses to answer questions concerning the development of pilot projects, the forms of support and the selection of technologies. The energy engineer network will be responsible for the direct information of and providing professional advice to the persons interested in energy tenders and support and development opportunities, which could accelerate and facilitate the progress of projects. Also, they should be involved in activities (including, for example, the organisation of trainings and conducting campaigns) to further the increase of the knowledge and environmental awareness of energy consumers and the dissemination of energy saving initiatives. Increasing consumer awareness and the persuasion of consumers are indispensable in order to achieve the objectives. The success depends on the cooperation and concentration of forces of the government and the stakeholders, including the non-governmental sector. The monitoring of achievements is of primary importance in order to ensure that genuinely effective solutions that are efficient in terms of the utilisation of resources, are introduced.

The monitoring of the implementation of the Energy Strategy requires the operation of a faster and more accurate statistical and IT data system, freely accessible to all. To that end, in the future, the HEO will be in charge of the management of the uniform national energy statistics.

With a view to performing sound strategic planning activities and establishing the conditions of sustainable energy management on a scientific basis, planning and analytic background activities ensuring the implementation of the Energy Strategy must be reinforced, into which the background capacities carrying out climate protection planning, analytic and assessment activities should be integrated.

An example must also be set on the level of municipal governments in the field of the improvement of energy efficiency (including in particular the appropriate conversion of inefficient public lighting, awareness-raising programs and the retrofitting of public buildings). In addition to the above, cities and municipal governments should be encouraged to introduce energy efficiency systems: one of the primary objectives of the envisaged 'smart cities' initiative is to support cities that commit themselves to the implementation and promotion of energy efficiency (e.g. smart building) and smart transport systems.

8.4 FINANCING

During the forthcoming decades, the implementation of the Energy Strategy will require substantial investments, even if cost-effectiveness continues to be a top priority.

Following European trends, market financing is targeted to the greatest possible extent, which essentially requires an investment encouraging and predictable regulatory environment. While the achievement of the objectives of the Energy Strategy is currently not possible in a pure free-market environment, with the exception of the utilisation of EU funds for the appropriate purposes, the role of the government in financing cannot be supported as a general solution. The government should depart from market solutions in particular in the following cases:

1. The system of support related to the use of fossil fuels should be transformed in a manner that it encourages efficiency rather than consumption. Apart from the support of final consumers (e.g. differentiated gas prices), the support of service providers and producers (including for example low mining allowances and tax concessions, feed-in tariff system, 'coal penny'), should also be reconsidered. It would be reasonable to treat the welfare allowances determined in order to mitigate energy poverty independently from energy policy objectives.
2. There are various ways of financing the use of renewable energy sources and the improvement of energy efficiency (including tax allowances, investment support, feed-in tariff, the polluter pays principle). However, the main purpose is to explore and encourage the optimum balances that can be achieved in the long term at the lowest cost (including the avoidance of external costs), with the greatest possible economic and social benefits (with particular regard to job creation) and the smallest possible environmental load. Since this opportunity is determined at any time by the volume of available resources and the investment and operational costs and the carbon dioxide balance of technologies, a constant, professionally sound and well-prepared review is required in this context (including in particular the tax allowances of biofuels or the feed-in tariff system).
3. As far as nuclear projects are concerned, the fact that high investment costs are accompanied by calculable and low costs of operation in the long term (as opposed to fossil fuels) must be taken into consideration. The costs of storage and of the treatment of spent fuel and other small and medium-activity materials are covered by the annual payment into the Central Nuclear Financial Fund. When developing the financing structure, the possibilities of involving external partners (energy industry companies, large consumers and energy providers) should also be examined.
4. In order to exploit the Hungarian R&D and innovation potential, the implementation of pilot projects must be ensured and the practice of 'learning by doing' must be promoted. It must be examined in advance which solutions should be given priority, may facilitate the achievement of the Energy Strategy objectives or may reach the appropriate level and standard of commercial competitiveness.

As far as energy investments are concerned, with particular regard to improving energy efficiency and reducing emissions, financing and incentive systems should be examined and applied, including the development of their legislative background, in order to encourage market operators to participate in financing.

It is of essential importance to involve, in a more systematic manner, Hungarian energy providers, financial institutions and third-party financiers in the energy efficiency improvement tasks the country faces. Two examples of such systems:

- Third-party (ESCO) financing: during the past fifteen years, the Hungarian ESCO sector (which is typically more mature than those of the neighbouring countries) has played a significant role in the rationalisation of the energy consumption of businesses and municipal governments. At the current limitations of financing, the ESCO prefinancing model may also be useful in connection with further efficiency improvement tasks. Since communal energy efficiency improvement projects typically do not ensure the required economies of scale benefits to the profit-based ESCOs and because the government has access to funding at a lower cost than the ESCOs, the possibility of setting up a (partly) state-owned ESCO specifically for the improvement of the energy efficiency of the residential and the public sectors must be considered.
- With a view to involving energy providers, some European countries have taken similar measures. In such cases, the regulator in charge expects a significant communal energy efficiency and emission reduction performance (including, for example, the CESP and CERT programs in the UK).

With regard to the specific fields and prior to the decision-making points, the forms of financing, the required system of support, its implications to the budget and the potential tender schemes will be described in the action plans.

8.5 INTERNATIONAL RELATIONS

Governments are responsible for the establishment, maintenance and deepening of international economic diplomacy cooperation.

The integration of the networks, market and trading systems of neighbouring countries enables the establishment of a regional infrastructure platform and the resulting price competition, taking consumer interests into account. That process must be carried out on a political level and the government is also responsible for its supervision.

8.6 DECISION-MAKING POINTS

Any forecasts are burdened with significant uncertainties due to the potential radical changes in the energy sector. Therefore, the periodic review and updating Energy Strategy is called for, in particular on the basis of the latest international developments and technological innovations.

Detailed impact analyses will be required prior to each specific point of decision, providing the widest possible range of the latest data and information for the preparation of decisions, as we must find the point in time when the investment costs are in proportion with the economic and social benefits following implementation. Apart from that, a number of milestones are already taking shape, where specific measures will have to be taken due primarily to the country's international commitments. The following milestones and decision-making points are already known:

2010	• Hungary's NREAP • New Széchenyi Plan
2010-13	• Gradual phasing-out of the current feed-in tariff system, establishing a new structure and group of players and developing the incentive system of renewable-based heat generation.
2010-15	• Action plan for the increasing the number of nearly zero-energy buildings (2010/31/EU) - only zero-energy new buildings will be allowed after 2020[1] • Decision on the long-term gas supply contract expiring in 2015[2] • Establishing a single European energy market
2011	• National Reform Programme (Europe 2020 Strategy) • 2nd National Energy Efficiency Action Plan (2006/32/EC) • Administrative decision on the extension of the lifecycle of unit 1 of the Paks Nuclear Power Plant and the construction of one or more new nuclear unit(s) at the Paks Nuclear Power Plant site • UN Climate Conference (COP17), where a new climate treaty may be signed • At EU-level, the following documents: • Infrastructure Package • Review of the Energy Efficiency Plan • Decarbonisation Roadmap 2050 • White Book on Transport
2011-12	• Review of the National Climate Change Strategy • Development of the National Sustainable Development Strategy • Development of the National Adaptation Strategy • National Decarbonisation Roadmap and industry-specific roadmaps
2013	• Start of phase three of the EU's Emissions Trading Scheme (ETS) and the start of the sharing of efforts scheme concerning the non-ETS sector (with annual emissions limits for each member state)
2014	• 3rd National Energy Efficiency Action Plan (2006/32/EC)
2015-18	• Decision on the construction of nuclear capacities at a new site

[1]Directive 2010/31/EU provides that member states should draw up national plans and policies for increasing the number of nearly zero-energy buildings. In addition to the above, national plans must include the member states' detailed application in practice of the definition of nearly zero-energy buildings, reflecting their national and local conditions. The definition shall include a numerical indicator of primary energy use expressed in kWh/m^2/year for such buildings. Intermediate targets shall be established for improving the energy performance of new buildings by 2015. Member States shall draw up, by 30 June 2011, a list of measures and financial instruments that promote the objectives of the Directive. By the above date, a comparative methodology framework shall be set up by the Commission to identify cost-optimal levels of energy performance requirements for buildings and building elements. With regard to subsidies to new buildings and renovations, member states shall take into consideration such cost-optimal levels of energy performance. Furthermore, the Directive provides that after 31 December 2018, new buildings occupied or owned by public authorities must be nearly zero-energy buildings whereas by 31 December 2020, all new buildings must be zero-energy buildings.

[2]The long-term gas supply contract will expire in 2015. In order to achieve an advantageous re-negotiation position, measures should be taken as soon as possible. Such measures may include the joint position of the regional infrastructure platform and the implementation of large-scale gas projects of non-Russian sources (with the purpose of the diversification of sources).

[3]In the manner set out in Directive 2006/32/EC, the date of the review of the first Energy Efficiency Action Plan, i.e. the date of the submission of the second Action Plan. The actual action plans should evaluate the experiences of the measures of previous plans and include the summary of the related monitoring reports. Following the strategic review, the appropriate modifications must be carried out with a view to achieving the objectives set as quickly and efficiently as possible. The date of the review of the second Action Plan, i.e. the date of the submission of the third Action Plan, is 30 June 2014.

9 OUTLOOK 2050

„The difference between what we do and what we are capable of doing would suffice to solve most of the world's problems."

(Mahatma Gandhi)

„I believe that water will one day be employed as fuel, that hydrogen and oxygen which constitute it, used singly or together, will furnish an inexhaustible source of heat and light."

(1874, Jules Verne)

China is already the greatest user of fossil energy. The amount of coal it will use for electricity generation in 2035 will be two times the total amount used by the OECD, consisting of the countries with the most advanced economies of the world (Figure 29). Considering the diminishing fuel resources and the continuously increasing consumption demand, we will have two options. We either move into a future burdened with ongoing and increasingly harsh conflicts or try to become as independent from global trends as possible. We will have five tools in order to do so: energy saving, the highest possible share of renewable energy, safe nuclear energy, integration to the European energy market and the establishment of bipolar agriculture.

The energy dependence of the advanced world

According to the forecast of the independent European policy analyst group LEAP/E2020, we have reached a new frontier in terms of the realignment of the current geopolitical world order. The post-World War II bipolar world power structure lasting until the disintegration of the Soviet Union was replaced, for a short period, by the military and economic superpower hegemony of the US.

However, the G-20 Seoul summit (11 and 12 November 2010) indicated that the economic superpower structure had become multipolar, including China, the economically once more powerful Russia and the EU, while the hegemony of the US has survived in the field of military policy. Consequently, the US is no longer capable of dominating global politics on its own through economic means; it can only achieve that through military pressure or as part of alliances. This has two essential consequences in the short term. First, the role of regional powers on the threshold of superpower status, e.g. China, increases and, second, the EU has a chance to assume a more independent role in shaping global politics, provided that it manages to significantly accelerate its decision-making mechanisms. At any rate, economic future studies do not reckon with the economic strengthening of the EU. According to Pricewaterhouse Coopers, in 2050, the national income TOP 10 list will be as follows: 1. China, 2. USA, 3. India, 4. Brazil, 5. Japan, 6. Russia, 7. Mexico, 8. Germany, 9. the UK, and 10. Indonesia. Of the EU-27, only two countries will be on the list.

It is thus not a surprise that, according to the current trends, the energy demand of developing countries will account for two-thirds of the estimated 50-percent increment of the global energy demand up to 2030. The question is whether the required energy resources will be available and whether the various regions and countries will have safe access to them. According to UN data, natural resources are already being used up at a rate as if we had 1.5 Earths instead of one.

In such a situation, it is understandable that energy security is increasingly becoming a geopolitical rather than a merely economic issue. According to the data of the DG Energy of the European Commission, by 2030, the dependence of the EU on imported gas will increase from the current 58 percent to 84 percent. In particular, the share of Russian gas import will rise to 60 percent from the current 42 percent. Therefore, with a view to the security of the petroleum and natural gas supply of the EU, both supply sources and transportation routes will need to be diversified in the medium term. This is all the more true of Hungary, one of the most vulnerable countries of the continent as far as traditional energy resources are concerned, being particularly dependent on Russian energy exports.

Because of the depletion of the North Sea oil and natural gas deposits, the EU-27 itself is thus becoming increasingly dependent on Russian energy import. While the diversification of supply is a legitimate interest, the expansion of the group of potential importers is equally important from the point of view of Russia.

The emergence of China and India on the global energy market

It is a well-known fact that, since the 1990s, the centre of gravity of global economic growth has moved to Asia, primarily to China and India. The economic crisis only added to that shift of the centre of gravity: China has been one of the winners while Europe has been a loser of the crisis. Not even the global financial and economic crisis has been able to halt the 8 to 10-percent rate of the growth of the Chinese economy. According to official data, more than three hundred million Chinese people have left behind poverty during the past twenty-five years, while per capita national income has increased by four times. With USD reserves in excess of 3,000 billion, China tops the world in terms of currency reserves. In 2011, China had the second most powerful economy in the world and also ranked second in terms of incoming foreign investment. In terms of export, it has outstripped Germany: its annual positive external trade balance has approached US$300 billion. In 2009, most cars were produced in China: its output of 13.5 million exceeded the production of the US. Despite that, the number of cars per 1,000 persons was only 30 in 2010, while the corresponding figure is 500 and 700 respectively in Europe and the US. That fact alone gives a clear indication of the extent of the potential raw material and energy needs of the catching up of the Chinese standard of living and the resulting load on the environment.

Its export-oriented economy and increasing energy import forces China to diversify its resources, secure its marine transport routes with naval forces and transact its energy import from Central Asian countries through oil and gas pipelines along terrestrial routes. In addition to the above, China has also launched targeted renewable energy programs, primarily in order to reduce its dependence on external energy import rather than out of climate protection considerations.

As part of that strategy, China is developing its multilateral and bilateral relations with the institutions and countries of the Middle Eastern region taking into consideration its national interests, energy import demand and the economic, financial, investment and raw material supply opportunities offered by the region. While almost half of its oil import is already sourced from Middle Eastern countries, its focus increasingly encompasses African and Central Asian countries, too. While in 2004 the volume of Chinese-Arabian trade was around $ 36.7 billion, it reached $132.8 billion by 2008.

Apart from the African and Latin American expansion, the Chinese energy doctrine also includes opening toward Central Asian countries (Kazakhstan, Kirgizstan, Tajikistan, Turkmenistan and Uzbekistan), justified by the strategic geographical position of and the wealth of natural resources in these countries. The countries in question have significant petroleum and natural gas resources and other valuable minerals (gold, zinc, uranium and molybdenum) and hydro energy resources, the exploitation of which is an aspiration of many, from the United States to Europe and Russia to the Far East. Owing to the increasing demand for oil and natural gas, incoming foreign investments and ongoing development projects, regional economic growth has been around 9 percent in recent years. While in the 1990s it seemed that Central Asia would be the scene of increasing competition between the US and Russia, now it appears to be more likely that the Chinese influence will continue to increase, eclipsing the former two powers. This new situation raises

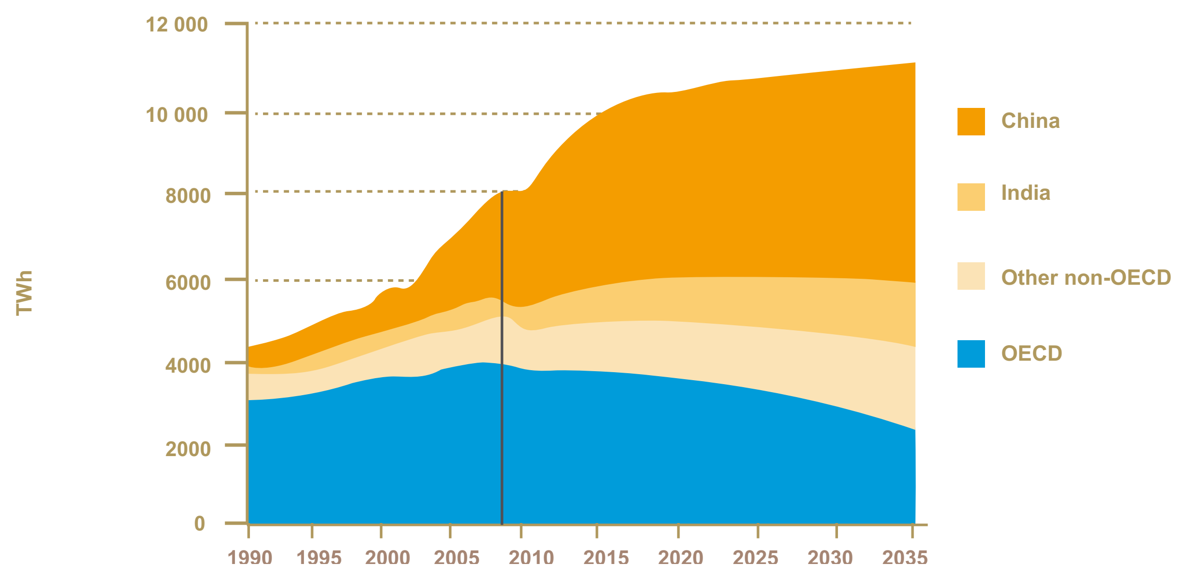

Figure 29 The share of coal in electricity generation in the highly industrialised OECD members (blue) and in developing countries (various shades of yellow and orange). In 2035, China alone will use twice the amount of coal for electricity generation than all OECD members together.
Source: World Energy Outlook 2010.

a number of questions of a geopolitical nature. Central Asian states, politically having drifted with the current for a long time, may now play a leading role in the decision of important issues such as energy policy, with China becoming the main regional partner, able to assert its influence also with regard to these issues.

The primary energy production of India is currently based on low-quality domestic coal, which accounts for 67 percent of the final energy consumption. The volume of coal extracted per year is presently 450 million tons, which, considering the current rate of growth, should be increased to 2 billion tons per year by 2016-2017 if the current share of coal is to be maintained. India's demonstrated coal deposits amount to 250 billion tons, plus a reserve of 102 billion tons of extractable, unexplored coal. Climate protection considerations aside, these coal supplies would be sufficient to satisfy the country's needs at this level for a long time. The situation is different as far as hydrocarbons, accounting for 25 percent of Indian energy consumption, are concerned; the domestic oil and natural gas supplies are sufficient to meet the current demand for 19 and 29 years respectively. The depletion of hydrocarbon resources already necessitates a significant volume of import of 120 million tons/year of petroleum and 15 million tons of oil products a year. Due to the ever-increasing price of import, India intends to rely on the development of nuclear and renewable energy capacities in the longer term in order to replace the depleted hydrocarbon resources and to meet new demand.

India cherishes ambitious plans concerning the use of nuclear energy. It is envisaged that the built-in capacity of nuclear power plants will be increased from the current 4.5 GW (representing a 3-percent share of India's current electricity production) to 35 GW by 2020 and to 63 GW by 2035. That figure represents 16 percent of India's then estimated electricity demand of 400 GW. The country also has extremely good conditions in terms of renewable energy sources. Among the countries having the highest wind power potential, India ranked fourth in 2009 with a capacity of 8,700 MW (i.e. 3 percent of the global wind power capacity). In addition to the development and implementation of a self-sufficient low-carbon energy strategy, the incredible practicality and cost-efficiency of the Indian approach to problem management are exemplary and worth taking seriously. Let us only emphasise two of the numerous examples. A self-respecting Indian household will now be in possession of a family-scale biogas generator, providing heat and lighting energy (Figure 30, Panels A and B). Rather than in high-end luxury cars, hydrogen power was first used in a dairy tricycle (Figure 30, Panel C), and used the experiences gained to produce a low-end 'people's car' (Figure 30, Panel D). A change of approach in Hungary, i.e.

Figure 30. The 'flow chart' of a family-sized Indian biogas generator (A) and its modernised commercial version (B). Hydrogen-powered three-wheeled utility vehicle (C) and the similarly hydrogen-propelled Indian 'people's car' (D).

following the Indian approach instead of the permanent pleading of the shortage of funds, could also facilitate the achievement of green economic programs.

100-percent renewable energy scenario

Currently, Hungary has two alternatives in terms of the shaping of its energy policy. We can choose either to face a future burdened with ongoing and increasingly harsh conflicts or try to become as independent from global trends as possible. We will have five tools in order to achieve that goal: energy saving, the highest possible share of renewable energy, safe nuclear energy and the related electrification of transport, integration to the European energy market and the establishment of bipolar agriculture.

To start with the most extreme alternative, there is a 100-percent renewable scenario, according to which 15 percent of the total European primary energy demand is supplied from the supergrid link from Concentrating Solar Power (CSP) plants in North Africa, while 5 percent would come from geothermal energy, North European tidal, wave and wind power stations, with increasing reliance on the hydro energy potential of the Nordic region and the Alps and the biomass and biogas producing capacities of Central and Eastern Europe (Figure 31).

The other key to achieving the 100-percent renewable energy scenario is the 30-percent reduction of the primary energy demand, which would enable the full elimination of e.g. nuclear energy up to 2050 (www.rethinking2050.eu). In our opinion, the 100-percent renewable concept goes against the general philosophy of renewable energy generation. The centralised production and long-distance transport system is a definite step backwards from decentralised small-region energy generation, based on the utilisation of own energy resources, which may result in the emergence of a new kind of energy dependence. Renewable energy utilisation is a capital-intensive project. If a country short of funds, such as Hungary, should be unable to meet its own commitments, in the future the EU may, among other things, compel it to import high-priced green electricity generated in North Sea wind power plants, which would set back the development of the Hungarian green industry while preserving the country's energy dependence.

According to current knowledge, renewable energy capacities have theoretical upper limits, the most important of which is the market and agronomy interference with food and fodder production. A significant number of experts therefore consider that the share of renewable energy cannot be increased beyond a certain level. Instead, they suggest that the use of nuclear energy should be increased in order to fill the gap (Figure 32). That requires the increasing of the safety of nuclear power plants and the disposal of radioactive wastes and the extensive use of fourth-generation nuclear reactors. According to the optimistic scenario of the Nuclear Energy Agency, there will be 1,400 nuclear reactors

Figure 31 2050: vision of a zero-carbon Europe
Source: www.roadmap2050.eu

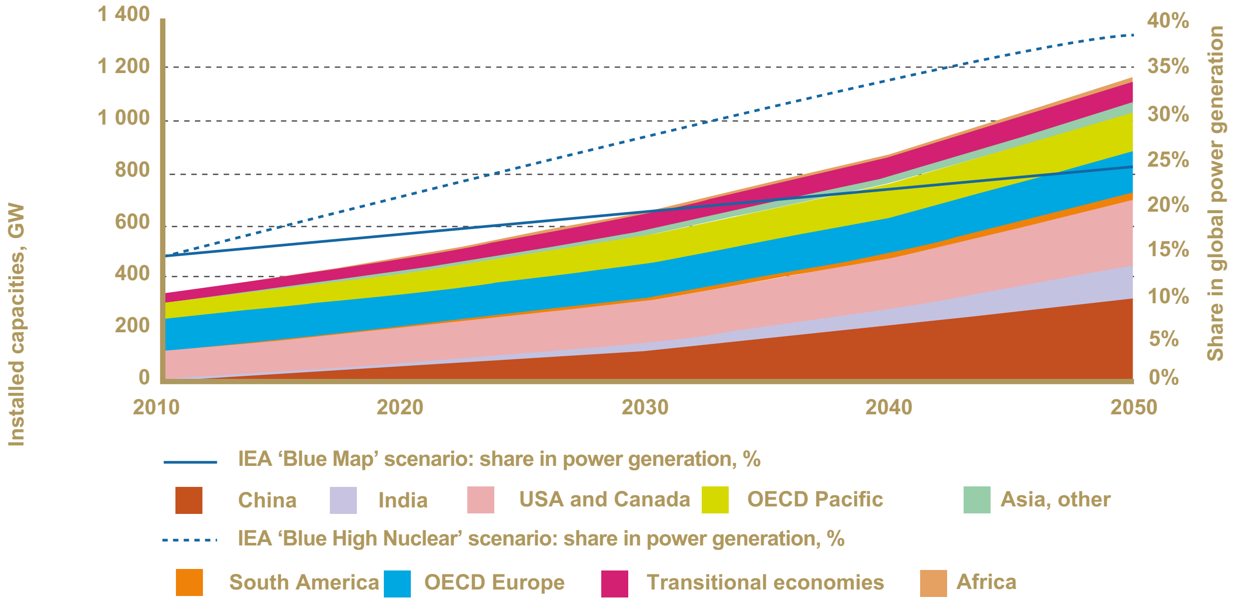

Figure 32 Nuclear 'renaissance' scenario: the rapid increase of the share of nuclear energy in global electricity generation up to 2050
Source: IEA, NEA

in 2050 instead of the current 439, if the current rate of adding 30 new power plants a year continues. Since of the high-capacity energy sources, only nuclear energy is considered carbon dioxide-free, the envisaged number of reactors in 2050 would meet the UN's CO_2 reduction target of 14 million tons. Further arguments in favour of nuclear energy are that uranium is available from politically stable countries and the electricity so generated is insensitive to the market price of uranium. What gives rise to public concern is undoubtedly the risk of incidents similar to the Chernobyl and Fukushima reactor accidents and the safe dumping of contaminated nuclear plant wastes. The latter problem will be resolved by technological development, as the recyclability of such wastes will probably be resolved in the not so far-away future. However, the existing theoretical probability of nuclear accidents necessitates the analysis of alternative scenarios.

Hungary 2050

Discussing the potential Hungarian energy policy scenarios, it should be pointed out in advance that we envisage the future of Hungary in a cooperative regional environment (V4, V4+), giving preference to the rational collective exploitation of the mutual economic benefits. A coordinated regional energy policy would enable joint energy projects (jointly built and owned nuclear power plants and the rational integration of peak and baseload capacities), the downsizing of parallel capacities, joint infrastructure improvements and the optimisation of cross-border capacities.

Apart from the regional economic policy environment, the future rate of innovation and the technological framework determined by the former provide the clues in shaping our energy policy vision. It is important to point that out because from 2030, the utilisation of fossil fuels (including hydrocarbons, coal and lignite) can only be envisaged together with CCS and clean coal technologies. Failing the above, the decarbonisation plans cannot be implemented and if the environmental externalities of energy production are incorporated in the prices, fossil fuels may be at a significant competitive disadvantage vis-à-vis nuclear and renewable energy sources.

Looking ahead until 2050, Hungary's dilemma is whether it should let natural gas to gain further ground or it should make a gradual shift toward increasing the use of nuclear energy after peak oil? It is taken for granted that the share of renewable energy will be the potential and still financeable maximum under either scenario. Both scenarios have their respective advantages and drawbacks. The advantages of nuclear energy include low GHG emissions, low electricity production price and the fact that no political or economic risks are involved in the purchasing of the fuel. Its disadvantages include the high investment requirement, requiring a government security even if the investment comes

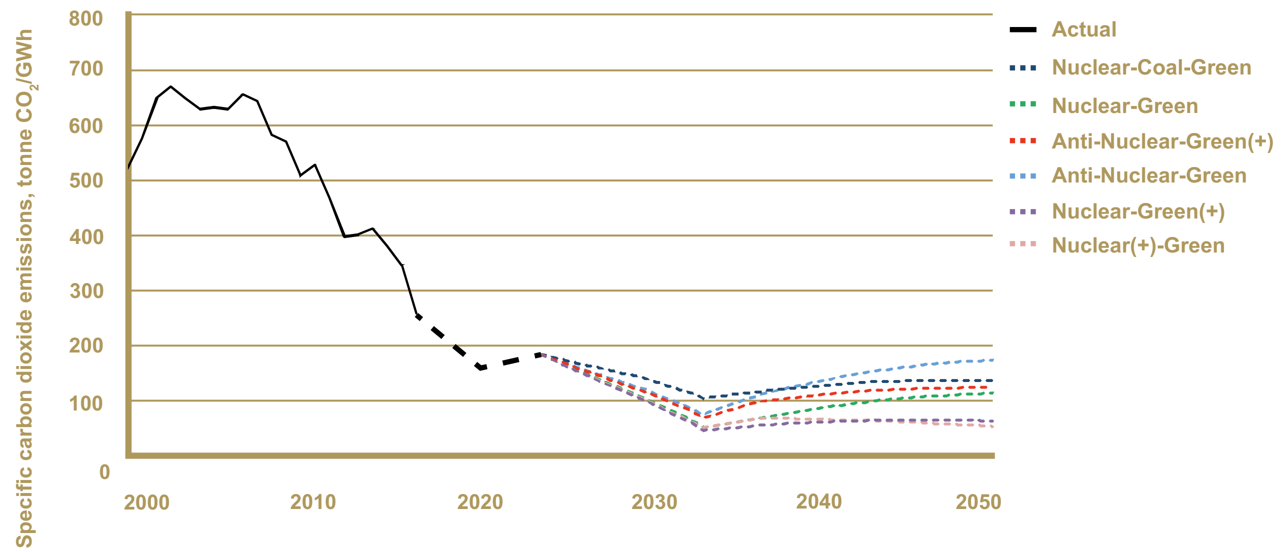

Figure 33 – GHG emissions of power plants
Without replacing Paks Nuclear Power Plant, the reduction of GHGs will be 10 percent instead of the potential 50 percent in the energy sector up to 2150
Source: REKK

from the private sector (i.e. an item increasing the deficit of the budget) and the high environmental risks of a potential breakdown. In the case of power plants demand for natural gas, expected, in the long term, to increase many times the current level without nuclear energy, disadvantages include vulnerability in terms of sources, the high oil-linked purchase price and the high level of GHG emissions compared to nuclear energy (Figure 33).

The advantage of natural gas is that its disadvantageous qualities can be improved. Dependence may be reduced by the diversification of sources, its price may be reduced by discontinuing its price being linked to that of oil and through the appearance of North American unconventional gas on the global market, whereas its GHG emissions can also be significantly abated by CCS technology. Obviously, that scenario assumes the availability of a marketable CCS technology (Figure 34).

The natural gas and/or nuclear energy-dominated scenario is all the more likely because the share that can be covered from renewable energy sources is limited (economic and technological maximum), even if the market-based utilisation of renewable energy sources meanwhile becomes competitive to a certain extent. Moreover, the increasingly frequent extreme weather conditions as a result of the climate change and their consequences (extreme heat or cold, heat waves of extreme duration, too much or too little rain, floods and inland water, salinisation, desertification,

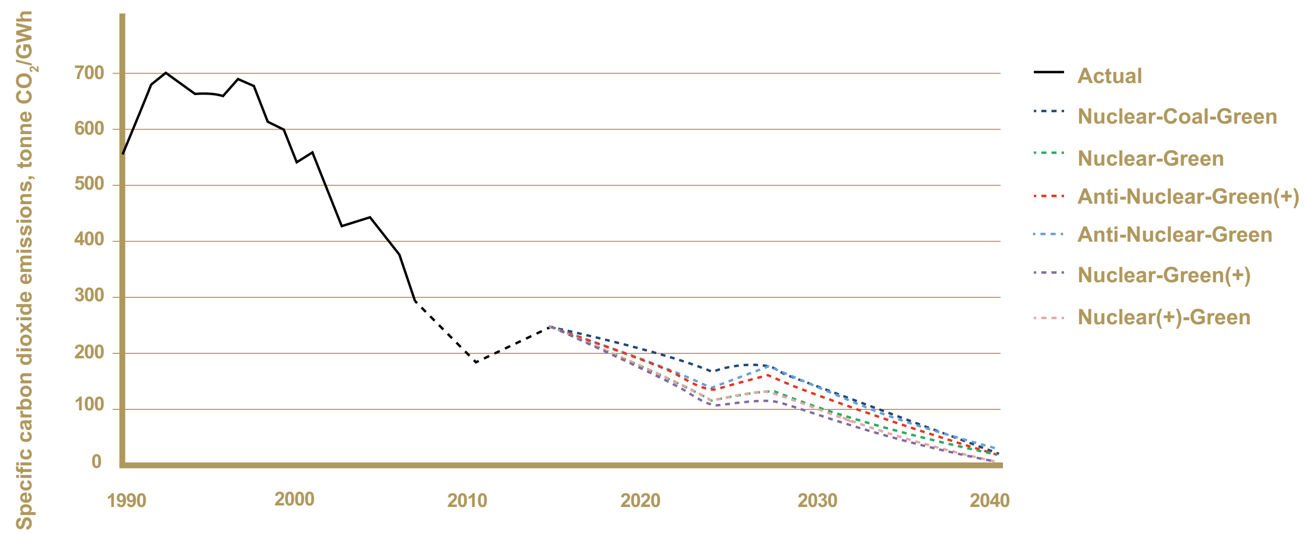

Figure 34 – GHG emissions of power plants with CCS
The absence of the Paks Nuclear Power Plant in terms of decarbonisation can theoretically be made up for by the use of CCS
Source: REKK

etc.) have the same negative effect on biomass-based green energy production as on conventional plant cultivation. It is extremely difficult to predict how this will affect the Hungarian renewable energy potential as a whole and the country's compliance with its international emissions reduction commitments. Obviously, this statement holds true unless an innovation 'explosion' occurs in the energy industry, which may completely overwrite the scenarios based on current trends.

Summing up Hungary's 2050 energy landscape in a simplified manner, the Hungarian energy economy will revolve around nuclear energy-based electricity generation, CCS, natural gas and renewable energy-based heat energy generation. As a multiplicator effect, this would involve an extensive electrification in transport and the rapid increase in the use of hydrogen-powered vehicles as a zero-carbon alternative. In the event the economy-destabilising price turbulences of natural gas become general, the increase of coal import and the utilisation of coal through CCS/clean coal technologies should again be given prominence. The same way, the exploitation of the strategic Hungarian coal and lignite resources is also a reality. This is, by the way, one of the most important recommendations of the 'IEA Review of the Energy Policy of Hungary 2010 – Preliminary Findings and Recommendations' study. The domestic coal resources represent 1.6 billion tons of black coal and 9 billion tons of brown coal and lignite, an amount sufficient for 200 years even at a rate of extraction of 50 million tons of coal/lignite a year. The building up of strategic reserves is an economic and security policy issue. Responsibly thinking countries will define their fuel resources as strategic reserves.

Surprising as it may sound, waste will become the most important industrial raw material and strategic energy resource of the 21st century. Unfortunately, in Hungary the dumping of municipal wastes without utilisation is still the most widely used waste management method. This represents the lowest level in the technological hierarchy of waste disposal, as opposed to preventing the generation of waste, recycling and the energy utilisation of waste. Since municipal organic waste qualifies as biomass, its energy utilisation is added to the share of renewable energy sources. Similarly to many other countries, where it accounts for up to 15 to 20 percent of biomass-to-energy utilisation, it could increase the share of renewables also in Hungary. In highly industrialised countries worldwide, the energy utilisation, in incineration plants, of burnable communal wastes, in strict adherence to technological discipline and the strict environmental standards, is considered a resolved issue. The utilisation of up to 60 percent of such wastes would be feasible in that manner even at the current technical/technological level. Hungary must also move into this direction, as deposition without recovery is not sustainable, occupies an increasing area of valuable arable land and endangers drinking water supplies and natural biodiversity.

10 ABBREVIATIONS

ACER	Agency for the Cooperation of Energy Regulators
AGRI	Romanian-Hungarian initiative for the maritime import of LNG from Azerbaijan and Armenia
BAT	Best Available Technology
BAU model	Business As Usual scenario
CCS	Carbon Capture and Storage
CHP	Combined Heat and Power, low capacity but high efficiency cogeneration power plants
DECC	The UK model of a transparent system of institutions and legislation, developed by the Department of Energy and Climate Change
E85	A fuel product under customs tariff no. 3824 90 99, with a bioethanol content of 70 to 85 percent, manufactured exclusively of agricultural raw materials produced within the Community
ESCO	Energy Service Company
ESMAP	Energy Sector Management Assistance Energy Sector Management Assistance, a program monitoring the transparency of the system of institutions and legislation in the energy sector
ETS	Emission Trading System
EUROSTAT	The online databank of the Statistical Office of the European Union
EA-16	The 16 states of the euro zone within the EU and the mean data concerning these states
EU-27	All 27 states of the European Union and the mean data concerning these states
FERC model	The US model of a transparent system of institutions and legislation, developed by the Federal Energy Regulatory Commission
GDP	Gross Domestic Product
LNG	Liquified Natural Gas
LPG	Liquefied petroleum gas
NEA	The Nuclear Energy Agency of the OECD
NREAP	National Renewable Energy Action Plan
NOVEM model	The Dutch model of a transparent system of institutions and legislation
OECD	Organisation for Economic Co-operation and Development
PUC model	The US model of a transparent system of institutions and legislation, developed by the Public Utility Commission
SWOT analysis	A graphic summary of internal **S**trengths and **W**eaknesses, essential external **O**pportunities and **T**hreats
TPS	Total Primary Energy Supply
GHG	Greenhouse gas
NSP	New Széchenyi Plan
V4	The Visegrád Group (Czech Republic, Poland, Hungary and Slovakia)
V4+	Any formation in which the V4 are joined by other countries

MÉRTÉKEGYSÉGEK

CO_{2eq}	carbon dioxide equivalent (CDE), the amount of carbon dioxide generating an effect equivalent to the increase of greenhouse effect generated by certain greenhouse gases
J	jjoule, the SI unit of measurement of energy 1 GJ = 0.2778 MWh = 0.0239 tons of oil equivalent
ppm	part per million
toe	tonne of oil equivalent standard, a unit of measurement based on the thermal value of a tonne of crude oil, 1 toe = 41.868 GJ
W	watt, the derived unit of power in the International System of Units (SI), 1 W = 1 J/s
Wh	watt hour, a widely used non-SI unit of measurement of energy, 1 GWh = 3 600 GJ = 85.9845 toe
tonnakilométer	The unit of measure derived from the product of freight tonnes and the number of trans port kilometres. Considering the large numbers, a thousand tonne-kilometres are used as a unit.

SI prefixes of the units of measurement:

k	kilo	$= x10^{3}$
M	mega	$= x10^{6}$
G	giga	$= x10^{9}$
T	tera	$= x10^{12}$
P	peta	$= x10^{15}$

NATIONAL ENERGY STRATEGY

2030

11 Economic Feasibility Study

CONTENTS

This summary is based on the 'Economic Impact Analysis of the National Energy Strategy 2030',
drawn up by the Regional Energy Research Centre'

July 2011

Ministry of
National Development

INTRODUCTION

The purpose of this Annex is to summarise the most important findings of the economic impact analysis concerning certain priorities of the National Energy Strategy 2030. Facilitating the exposition of the economic relationships linked to the key issues of the government measures related to the long-term assurance of secure, competitive and sustainable energy services, the impact analysis also pays attention to identifying the economy-stimulating potentials related to the industry. The analysis examines the three major sub-markets (electricity, heat and natural gas markets) of the Hungarian energy industry in an integrated manner.

It must be pointed out that the current basic principle of the operation of the sector, i.e. controlled, free-market competition of mostly private investors, is the right organising principle, in which no significant change is expected until 2050. In some areas, however, government intervention beyond the normal market surveillance duties may have a beneficial effect, as it may further the achievement of desirable objectives that otherwise would probably not be attained due to the deficiencies of the markets. A special example may be European climate policy, targeting a drastic (nearly 100-percent) reduction of the carbon dioxide emissions of the electricity sector, giving an unprecedented challenge to energy market operators and the governments concerned.

The analysis focuses on the following areas, requiring priority action by the government:

- the issue of the utilisation of nuclear energy;
- the issue of encouraging electricity and heat energy generation based on renewable energy sources;
- ensuring the availability of the production capacities required for the safe operation of the grid;
- the problem of the diversification of the import sources of natural gas; and
- the improvement of the efficiency of residential and community energy utilisation, primarily in the field of improving the energy performance of buildings.

The following sections provide a summary of the most important results of the impact analysis.

11.1 ELECTRICITY SECTOR

1. The results below pertain to the 1.5-percent annual increment of the electricity demand, plus additional effects (electrification, energy efficiency), presented under the 'Joint effort' scenario. The economic impact analysis also includes the modelling results drawn up for the other demand scenarios.

2. The probable effects of six electricity production scenarios, different in terms of the size of new nuclear and coal-based base-load capacities and the share of renewable electricity production, have been analysed on the basis of methodologically consistent energy market models. The essential characteristics of the scenarios and their most important expected impacts are shown as the values of the two tables below (Tables 1 and 2).

a) Nuclear-Green: The construction of new nuclear units at the Paks site and the extension of the renewable energy utilisation path set out in Hungary's NREAP

b) Anti-Nuclear-Green: No new units are built at the Paks site and the renewable energy utilisation path set out in the NREAP is extended

c) Nuclear-Green(+): The construction of new nuclear units at the Paks site and a more ambitious renewable energy utilisation path than the one set out in the NREAP

Name of scenario	Assumptions up to 2050: New baseload power plants – Nuclear	Assumptions up to 2050: New baseload power plants – Coal	Assumptions up to 2050: Share of renewable electricity – 2030	Assumptions up to 2050: Share of renewable electricity – 2050
Nuclear-Green	2000 MW	0 MW	15%	20%
Anti-Nuclear-Green	0 MW	0 MW	15%	20%
Nuclear-Green(+)	2000 MW	0 MW	20%	35%
Nuclear(+)-Green	4000 MW	0 MW	15%	20%
Nuclear-Coal-Green	2000 MW	440 MW	15%	20%
Anti-Nuclear-Green(+)	0 MW	0 MW	20%	35%

Table 1: The scenarios concerning the basic characteristics of the power plant mix

d) Nuclear(+)-Green: The construction of new nuclear units at the Paks site and also, after 2030, at a new site, plus the extension of the renewable energy utilisation path set out in the NREAP

e) Nuclear-Coal-Green: The construction of new nuclear units at the Paks site, the extension of the renewable energy utilisation path set out in the NREAP and the construction of a new coal power plan

f) Anti-Nuclear-Green(+): No new units are built at the Paks site and a more ambitious renewable energy utilisation path than the one set out in the NREAP is implemented

3. The two genuine 'decarbonisation' scenarios (no. 3 and 4 in the above tables), i.e. the scenarios, i.e. the ones including new nuclear capacities of 4,000 MW or powerful renewable electricity generation in addition to the Paks expansion and CCS for gas power plants, represent the most capital-intensive alternatives. While their estimated total investment requirement is around HUF 9,000 billion, the related carbon dioxide emissions in 2050 amount to a mere 2 million tons/year (one-fifth of the 2010 amount). The nearly equal capital requirement and environmental performance of the two scenarios poses a genuine energy policy dilemma, notably that the (second) 2,000 MW nuclear capacity expansion and the renewable electricity capacity expansion at a more ambitious rate than the current NREAP are realistic alternatives of each other.

4. A further component in the issue is that, assuming an efficient support system, the support requirement of renewable power generation will not increase at an explosive rate despite the significant increase of the share of renewables. This is because the support needs of the generation of a unit of renewable power will steadily decline during the forthcoming decades due to the continu-

Name of scenario	Total investment required between 2010 and 2050, without and with CCS* (HUF billion)	Carbon dioxide emissions without CCS in 2030/2050 and with CCS in 2050 (mt)	Wholesale electricity price and net import in 2030 (€/MWh, TWh)	Average subsidy requirement and price-increasing effect of renewables between 2020 and 2030 (HUF billion/year, HUF/kWh)
Nuclear-Green	6548 / 7465	8,4 / 15,3 / 3,1	90 / -5,8	59 / 1,2
Anti-Nuclear-Green	4923 / 6030	10,7 / 19,9 / 4,0	97 / 2,5	54 / 1,1
Nuclear-Green(+)	8111 / 8932	7,7 / 11,5 / 2,3	89 / -6,7	70 / 1,4
Nuclear(+)-Green	8151 / 8898	8,4 / 10,7 / 2,1	90 / -5,8	59 / 1,2
Nuclear-Coal-Green	6749 / 7773	11,0 / 17,1/ 3,4	89 / -7,7	60 / 1,2
Anti-Nuclear-Green(+)	6520 / 7550	10,0 / 16,1 / 3,2	95 / 1,8	64 / 1,2

Table 2: Summary of the results in the electricity sector, for the 1.5-percent annual increment of the electricity demand, plus additional
*CCS: Carbon Capture and Storage
red – worst scenario, green – best scenario from the aspect concerned

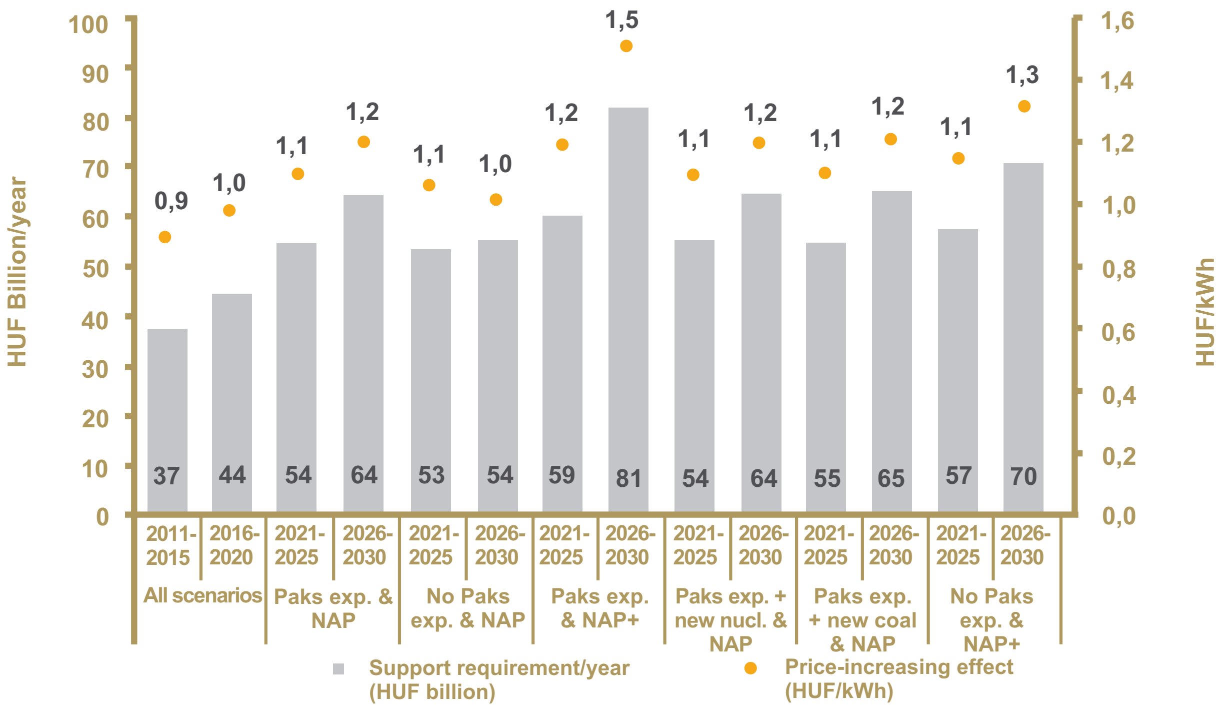

Figure 1: Support requirement of renewable power generation at 2009 price

ous increase of the market price of electric power owing to the increasing petroleum, gas and coal prices. In none of the scenarios does the annual support requirement exceed HUF 70 billion (at current prices) in any year,

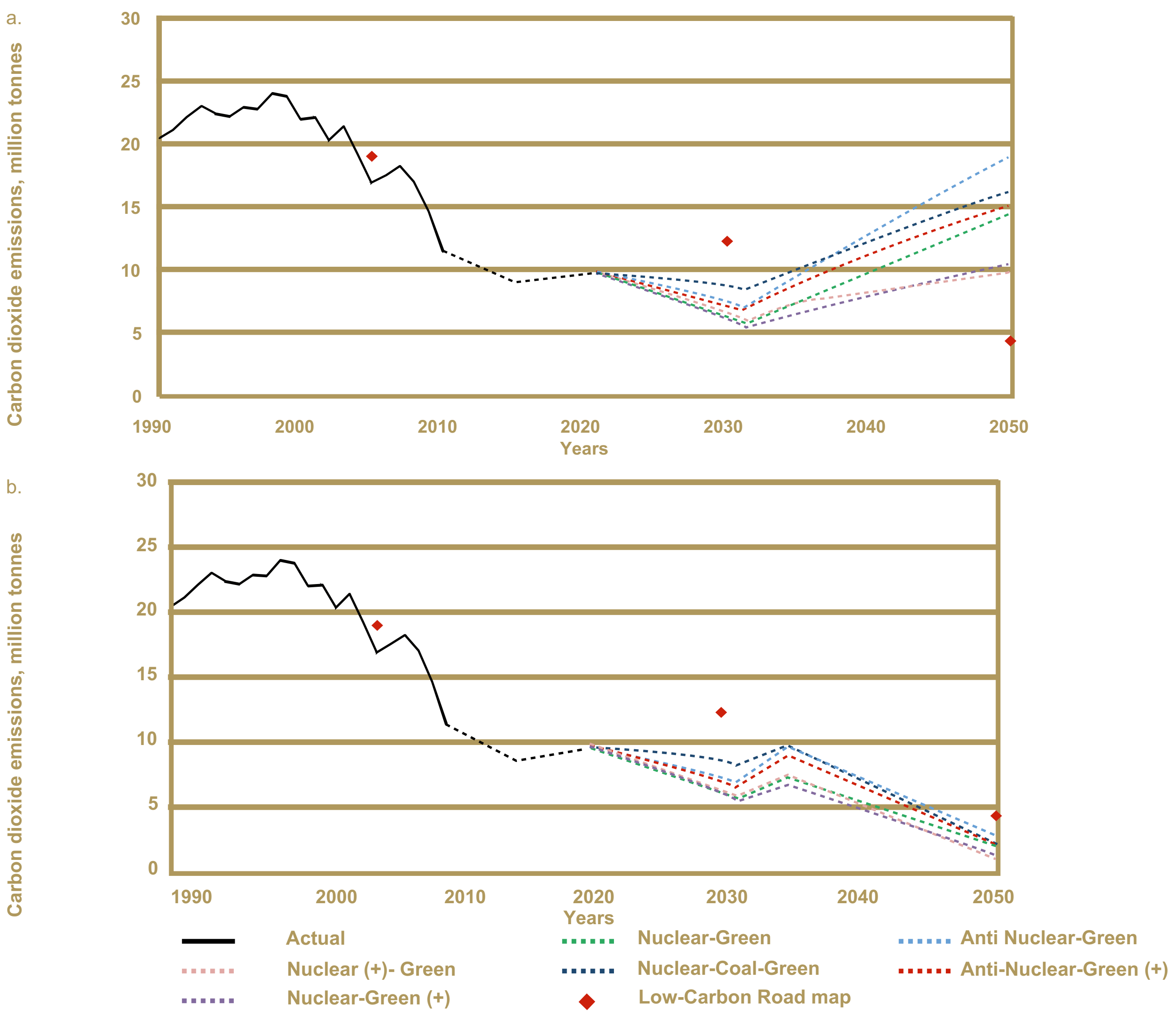

Figure 2: The carbon dioxide emission of power and combined thermal energy generation without CCS (a.) and with CSS (b.)

an amount close to the current amount of support. The support requirement per kWh remains below HUF 1.5 (Figure 1).

5. The alternative including the scenario with minimum renewables and free of new nuclear projects and CCS represents the other extreme. The latter scenario costs half of the former and involves almost ten times as much carbon dioxide emissions.

billion), which would bring the European decarbonisation scenario within reach (Figure 2).

7. On a forty-year average, the scenarios require roughly 3 to 5 percent of the (current) national economy investments in power generation.

8. Gas-based power generation will remain of crucial importance in Hungary during both the 2030 and 2050 timeframes. On the basis of built-in capacity, natural gas

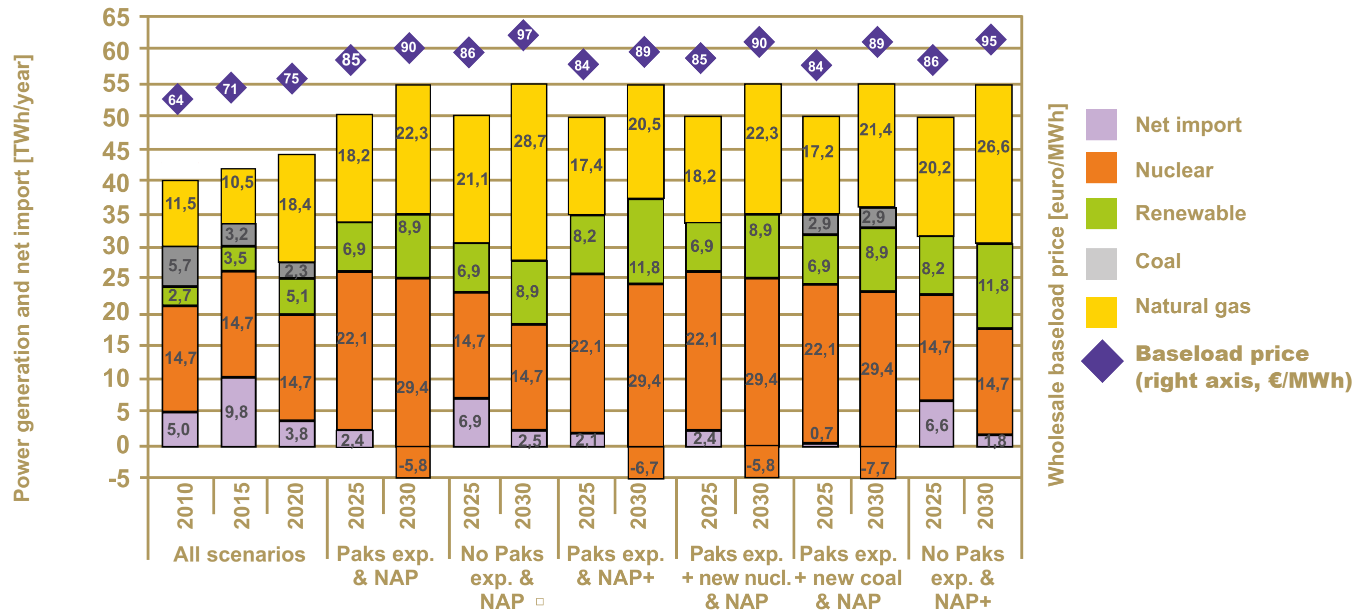

Figure 3: Modelling results at gas prices indexed to Western spot prices

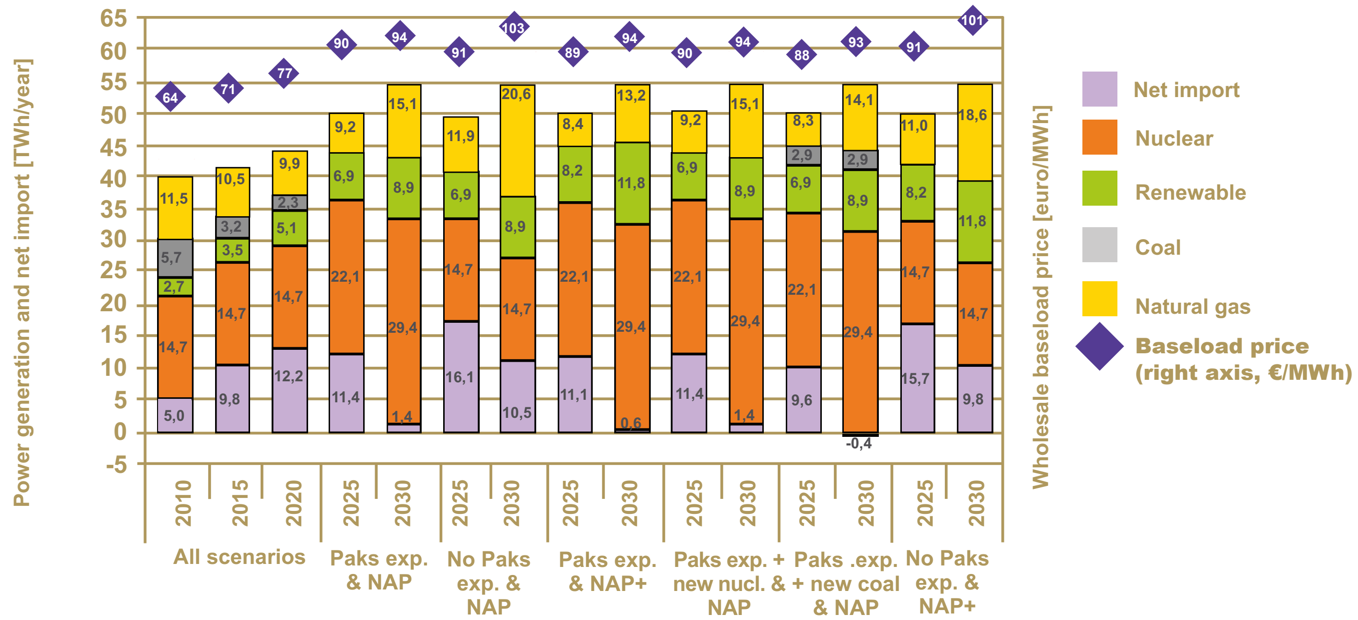

Figure 4: Modelling results at oil-indexed gas prices

6. CCS technology appears to be a watershed in terms of achieving a genuinely low level of carbon dioxide emissions. In the event the use of this technology becomes viable in the post-2030 period, emissions may be reduced by 10 to 15 million tons at a moderate cost (~HUF 1,000

power plants represent the highest share during every timeframe and in every scenario. This is partly based on the assumption that even if the integrated internal electricity market of the EU is established, the national energy policy will keep striving to maintain the country's capacity for self-sufficiency in terms of electric power supply, i.e. that Hungary should maintain a back-up power-generation capacity of 15 percent over the peak consumption demand.

9. Another important message of the analysis is that the future and success of gas-based power generation primarily depend on whether the power plants will be able to replace the currently typical oil-indexed gas with market-priced fuel. That could dramatically improve the regional competitive position of gas-based plants (Figure 3). The calculations with the regional electricity market model have shown that Hungarian gas prices in excess of the Western European level would, on the contrary, result in a significant setback of domestic gas-fuelled power generation and a substantial import of electricity (Figure 4).

10. It can thus be concluded that Hungary's prospective net electricity import (export) position will, to a significant extent, depend on the evolution of the relationship between Hungarian and international natural gas prices and thus on the competitiveness of natural gas-based power stations.

11. The transition to spot market gas prices after 2015 will essentially double the expected gas demand of the electricity sector. Incidentally, depending on the evolution of gas prices and the power station scenarios, current estimates of the gas demand of the domestic electricity sector in 2030 vary in the rather wide range of 4.0 to 5.6 billion m^3/year, compared to the current 3 billion m^3/year (Figure 5).

12. Over the 2030 timeframe, the scenarios basically do not differ in terms of wholesale prices. The general upward (real) price trend can be explained by the increasing gas and coal prices in connection with the increase of the price of oil. Between 2020 and 2025, each scenario includes a sudden price surge due primarily to the price increase of the carbon dioxide quota from €16/t to €30/t (as a result of the tightening European climate policy). At the same time, under most scenarios, market-based electricity prices are typically €6-8/MWh lower, provided that market-priced gas is available.

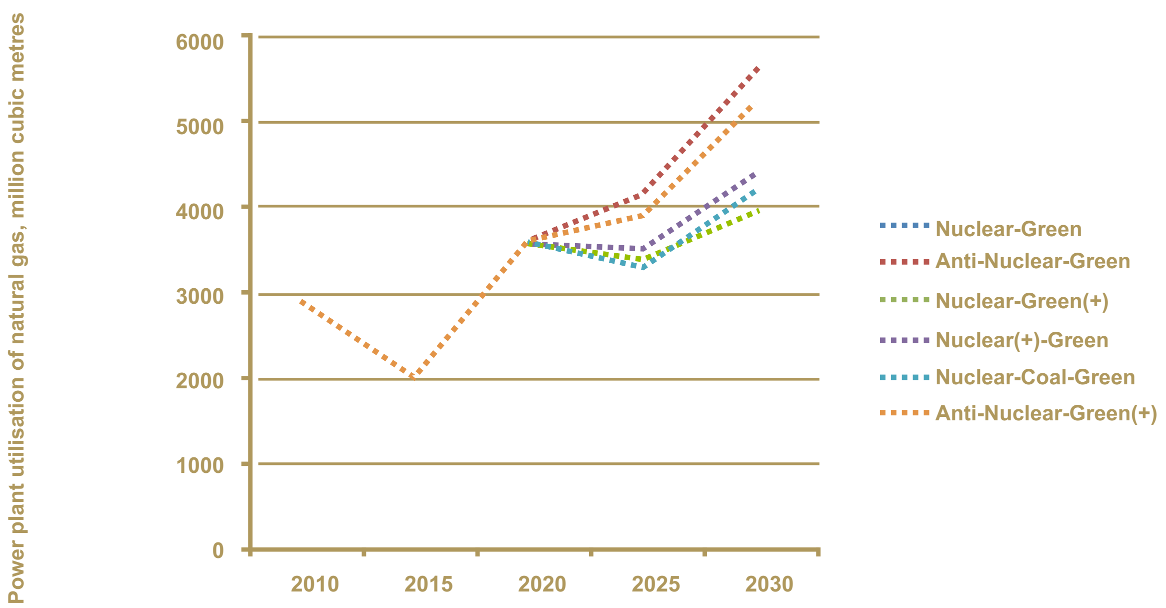

Figure 5 – The natural gas consumption of power plants at market gas prices

11.2 HEAT MARKET

1. In Hungary, 40 percent of the total energy consumed goes for heating/cooling purposes. Of that amount, the residential and tertiary sector account for over 60 percent. A major part of heating and heat generation is currently based on natural gas. Heating and cooling-related expenses account for a substantial part of the overhead costs of the residential and communal sector.

2. By the implementation of a substantial building energy program, the Energy Strategy would reduce the heating energy demand of the residential and communal building stock by 84 PJ, i.e. 30% up to 2030. In connection with the significant reduction of the use of primary energy (mainly natural gas), greenhouse gas emissions would also be reduced and jobs would be created. Unlike in the case of price and tax-type support, the implementation of the program could represent long-lasting assistance in reducing the overhead burden of the population, as the retrofitting of an average-sized prefab home will result in 40-50 percent savings in heating energy.

3. In addition to reducing heating energy consumption, the Energy Strategy would increase the share of renewable energy sources from today's 10 percent to 25 percent within the total heat consumption up to 2030. Obviously, that would further reduce gas consumption and carbon dioxide emission. Another typical trend is the substantial growth of renewable-based energy consumption. By 2030, it will increase to 32 percent within the heating energy consumption of the residential and tertiary sector.

4. The estimate concerning the heating and cooking energy consumption of the residential and tertiary sector up to 2030 has been based on the HUNMIT model[42] without the implementation of energy efficiency programs. This is a BAU scenario (including no energy efficiency programs), calculating with a slight increase of the total heat energy consumption in the targeted consumer group up to 2030.

5. By 2030, even the BAU scenario forecasts a significant reduction of natural gas, primarily as the result of the increasing share of renewable energy sources. Under the BAU scenario, the forecast consumption is slightly over 9 billion cubic metres, which is reduced to 7.4 billion m^3 under the reference scenario.

6. The impact analysis also included the examination of the effects of a more ambitious program (policy scenario), resulting in a potential decline of 111 PJ. Its achievement would reduce the gas consumption of the sector to 5.8 billion cubic metres by 2030 (Figure 6).

7. In addition to energy savings, the building energy program also has the positive effect of reducing carbon dioxide emissions. While under the reference program the annual emission of about 15 million tons in 2010 is

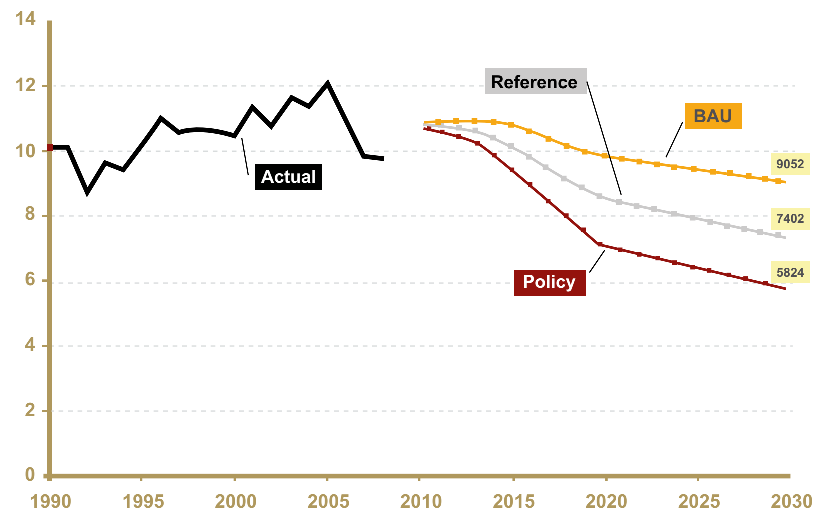

Figure 6: Actual and forecast data of heat and material-type natural gas utilisation under various scenarios, billion cubic metres

[42] The HUNMIT is a model drawn up for Hungary by the Ecofys consultancy firm at the request of the Ministry of the Environment and Water in 2009, containing an estimate of greenhouse gas emissions and the prevention potentials up to 2025 in six sectors: residential; services; industry; transport; energy supply and waste.

reduced to 9 million tons (40 percent decline), it is further reduced by 1 million tons by the more ambitious policy program.

8. Its positive effect on employment could be a third significant benefit of the envisaged building energy program. Ürge-Vorsatz et al. (2010) assessed the employment implications of four building energy programs varying in terms of the 'depth' of the retrofit and the number of homes/building involved. The programs assumed an average retrofit rate of 100-250 thousand homes/year over the forthcoming 20 to 40 years. That is close to the timetable of the programs outlined in the Energy Strategy. In the study, an input-output method is used for the analysis of the direct (employment in the construction industry) and indirect (including the rippling effects over the whole of the economy) employment implications of the programs. Depending on the extent and depth of the programs, an increase of between 43 and 131 thousand jobs were estimated by the study up to 2020.

9. The implementation of the envisaged building energy programs requires a substantial and ongoing support, the amount and scheduling of which are shown in the figure below. As shown, the support requirement under the reference scenario increases from the initial HUF 200 billion/year to a magnitude of HUF 300 billion by 2013 and HUF 400 billion from 2015 (Figure 8). The support requirement under the policy scenario increases at an even steeper rate at the end of the period. The authenticity of the program laid down in the strategy may not be substantiated unless the financing and institutional issues concerning its background are clarified as soon as possible.

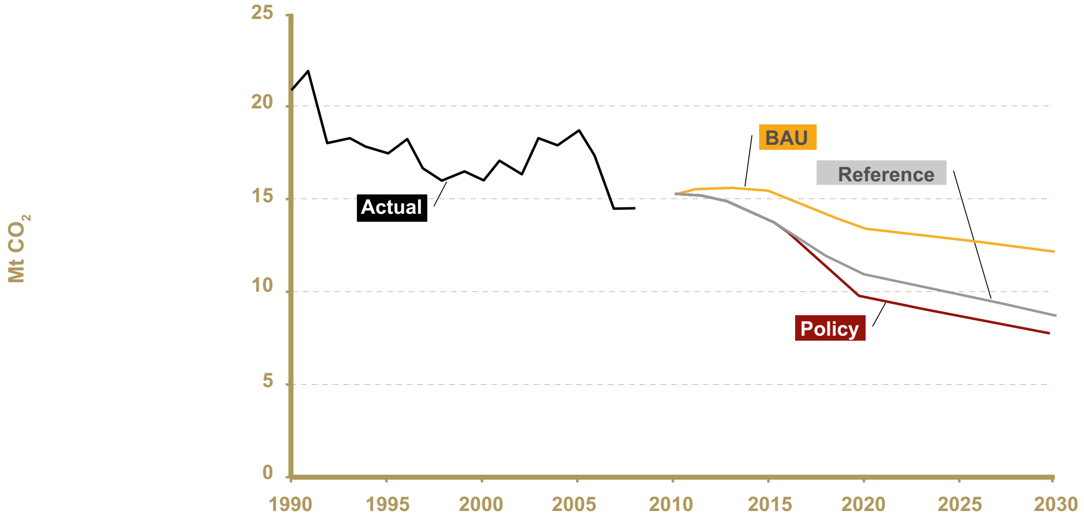

Figure 7: The CO_2 emission of the residential and tertiary sector during 1990-2008 and expected CO_2 emissions under the three scenarios, Mt

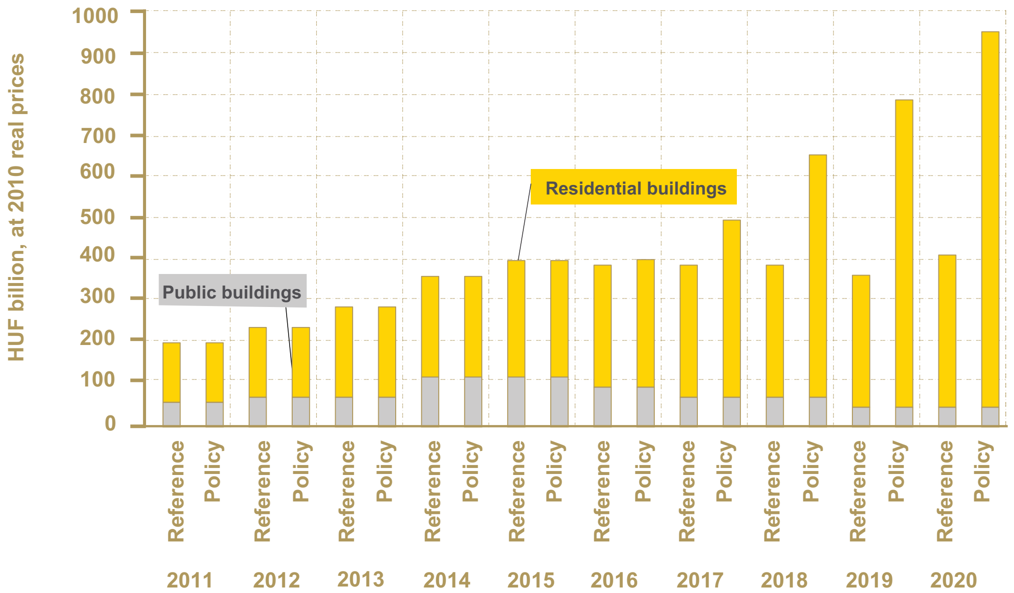

Figure 8: The estimated extent of public financing under the two scenarios, between 2010 and 2020, residential and public buildings

11.3 GAS MARKET

1. Despite Hungary's advanced gas infrastructure, its advantageous geological conditions in terms of the gas industry and its geographical location, the country's natural gas market is in a notoriously vulnerable situation. The volume of extracted gas is declining. Three-quarters of the import, accounting for 80-85 percent of a domestic consumption very high in European comparison, currently arrives from a single source under a long-term supply agreement. Most of the supply comes through Ukraine. Even in the long term, only Russian gas may potentially be imported from that direction. Meanwhile, Hungary is connected to the increasingly competitive main European gas market (Benelux – German – French) by a low-capacity Austro-Hungarian pipeline only, which is also its only access to liquefied natural gas sources.

2. Our unilateral gas import dependence represents a serious supply security risk, whereas the long-term persistence of this situation implies a substantial price risk to Hungarian consumers. Due to the infrastructure and market structure reasons referred to above, Hungary is hardly able to benefit from the tough competition emerging on the European natural gas markets. An even more serious challenge is that the long-term contract currently providing the backbone of the Hungarian supply will soon expire, which leaves open the crucial question of the potential sources and prices of this fundamental primary energy resource for Hungarian consumers after 2015. While this is important in terms of household overhead expenses, as pointed out above, it is also an energy policy issue crucially affecting the future competitiveness of gas-based power generation in Hungary.

3. Consequently, establishing the opportunity for diversified supply is treated as an energy policy priority in the Energy Strategy with regard to the country's future natural gas import, expected to remain substantial.

4. In terms of the future development of the Hungarian gas market, two scenarios have been examined in the impact analysis:

a) BAU. In the event no further improvements of the gas network, also enabling non-Russian (i.e. Western) supplies, are implemented during the timeframe of the Energy Strategy, between 2015 and 2030, the wholesale price of gas will move along an oil-indexed path, similar to the current one in Hungary.

b) POLICY. During the timeframe of the Energy Strategy, the domestic gas transport infrastructure is improved so it enables physical and commercial access to the gas markets of continental Europe (and thus, indirectly, to LNG resources), facilitating the gaining ground of spot market-based European wholesale gas prices, expected to be lower than oil-indexed prices. While cross-border pipelines enabling non-Russian import are capital-intensive investments, they certainly improve the negotiation position of Hungary concerning gas supplies.

5. The improvements in order to strengthen the negotiation position exert a double effect on the consumer price of gas:

a) a part or all of the costs of the improvement are incorporated into the gas supply tariffs established by the authority, thus increasing the end consumer prices;

b) at the same time, the strengthening negotiation position as a result of the improvements will lead to an increasing reduction of the prices of gas products compared to the BAU scenario, i.e. the oil-indexed gas price.

6. As far as the gas market priority of the Energy Strategy, the impact analysis sought answers to the following main questions:

a) What kind of improvements of the gas network are essentially required in order to enable the achievement of a negotiation position putting the Russian supplier into a genuine competitive situation on the Hungarian market?

b) Compared to the currently prevailing oil-indexed import price of gas, what price difference and percentage price advantage would make the implementation of the improvements viable from a social aspect?

c) What can be concluded of the pricing options of a new long-term agreement, using a regional gas market model taking infrastructure potentials into account?

7. In order to answer the above questions, the impact study provides a detailed forecast, based on electricity and heat market analyses, of the potential natural gas demand scenarios up to 2030, the potential evolution of domestic extraction and the net domestic natural gas demand, arising as the difference of the former two. At the same time, based on the ten-year development plan of the gas market system administrator (FGSZ Zrt), it analyses the potentials available in order to increase the non-Russian capacities and the related costs.

8. The potential non-Russian import capacity improvements and the relationship of the expected net import demand with non-Russian import capacities are illustrated in Figures 9 and 10.

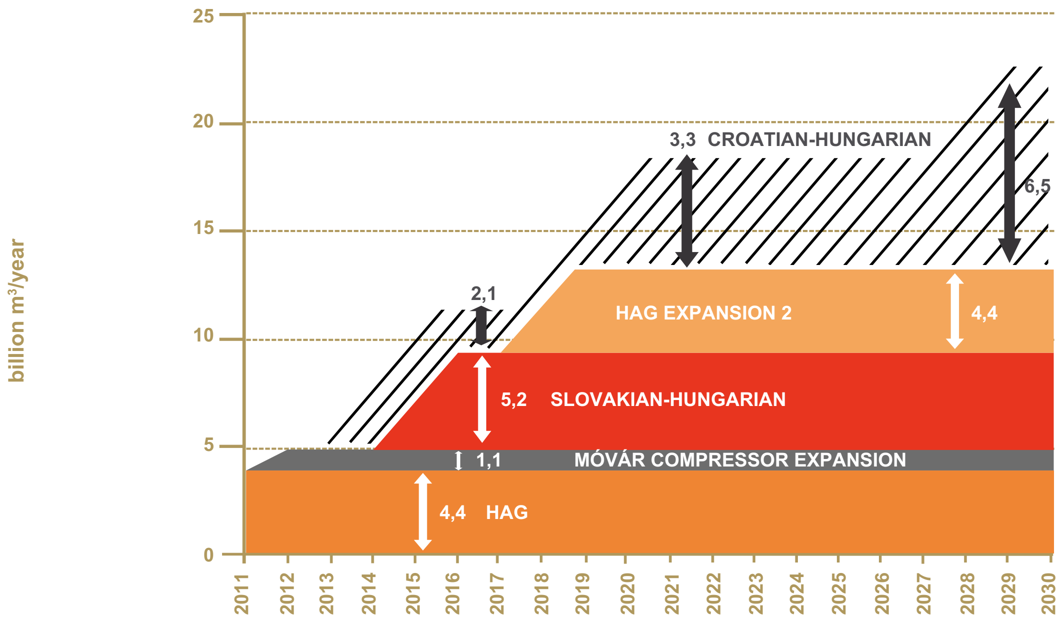

Figure 9: Hungary's gas import capacities from non-Russian sources if the improvements recommended by the FGSZ are implemented, billion m³/year

9. Both the analysis using the regional gas market model of the REKK and our ROI calculations indicate that, at the natural gas import demand expected for the next decade, it is sufficient to implement one of the two options of the Slovakian-Hungarian interconnector and the HAG2 capacity expansion in order to achieve that gas can be purchased at market prices after 2015.

10. During the decade following 2020, the natural gas utilisation of the power plant sector is expected to increase considerably, potentially generating an additional import demand of 3-4 billion m³/year, in particular if domestic extraction declines at the same time. While even under that scenario, the security of supply can be guaranteed by an infrastructure improved by either the Slovakian-Hungarian interconnector or the HAG2, it may become necessary to implement the other major pipeline project in order to maintain competition on the gas market. It seems sufficient to make a decision on that issue in the second half of the 2010s.

11. It is undoubtedly justified to treat the development alternative including the expansion of the Mosonmagyaróvár compressor and the Slovakian-Hungarian pipeline as an energy policy priority. At a real discount rate of 5 percent, that option would be a socially viable project even if a price advantage of app. 1 percent is achieved. Taking into consideration the related internal development requirements, the required price advantage is around 1.5 percent. These values are considerably below the expected difference between our market and oil-indexed price forecasts (10-20 percent to the advantage of market-based pricing).

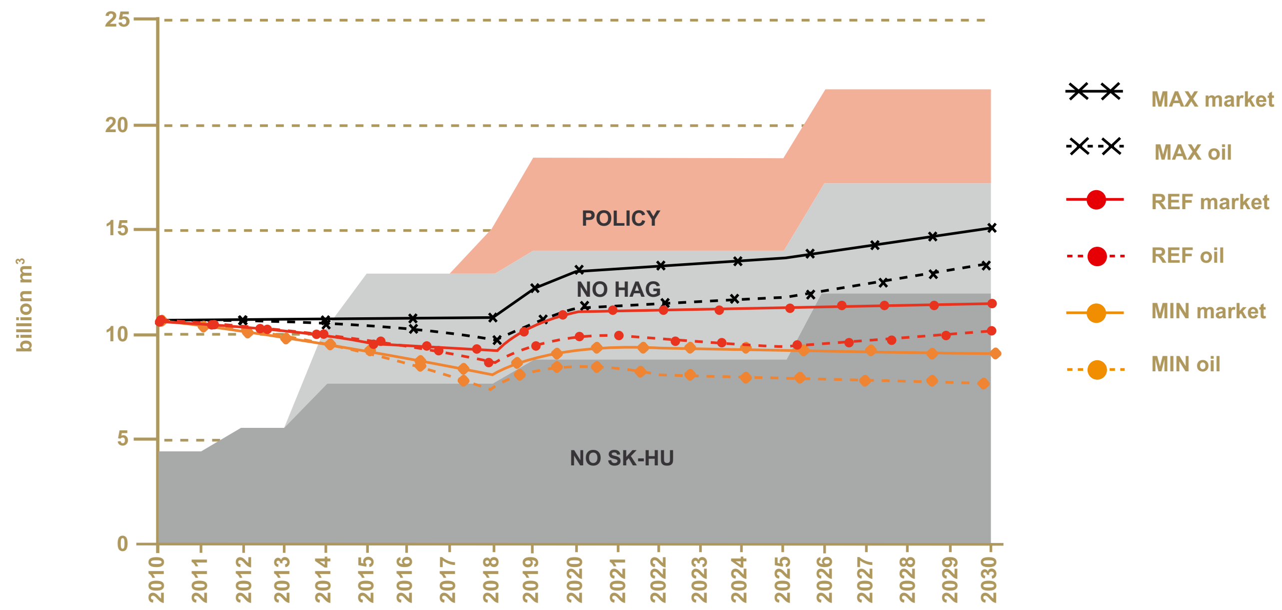

Figure 10: Net gas import demand and Western import capacity scenarios*

12. The development of cross-border capacities at the analysed reduction of the purchase cost may involve further benefits, not quantified in this study, for the stakeholders of the Hungarian economy. Combined with domestic network improvements, the above projects may multiply the transit traffic of the domestic natural gas transmission company and facilitate the regional marketing of the services of the completed and planned underground natural gas storage facilities. As we have pointed out, they would also create the primary condition of the competitiveness of our gas-based power plant fleet, by far the most significant one in the region.

13. The construction of physical capacities is a necessary but not sufficient condition of the gaining ground of market-based gas pricing in Hungary. It is also necessary that the rules of access to networks and in particular to cross-border capacities in Hungary and those countries within the region that play a crucial role in terms of Hungarian supply (in particular Austria, the Czech Republic, Croatia, Germany, Italy and Slovenia) should not prevent the conclusion of agreements on the free and non-discriminatory supply of gas to the Hungarian market or enable the 'withholding', of idle transport capacities for strategic purposes.

*NO SK-HU: construction of the Slovakian-Hungarian interconnector fails; NO HAG: the Slovakian-Hungarian interconnector is completed but the project to double the capacity of the current HAG pipeline fails; POLICY: all of the improvement proposals of the system administrator to increase supply from non-Russian sources are implemented

Ministry of
National Development