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Development and assessment of Mitigation / Adaptation Climate Change policy portfolios for Moldova

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ABBREVIATIONS

Abbreviation	Full name
ANCE	National Agency for Energy Conservation
ANRE	National Agency for Regulation of Energy
BAT	Best Available Technologies
BAU	Busines As Usual
CDM	Clean Development Mechanism
CERs	Certified Emission Reductions
CHP	Combined Heat and Power
CCS	Carbon Capture and Storage
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EE	Energy Efficiency
EEA	European Environmental Agency
EEF	Energy Efficiency Fund
ENPI	European Neighboring Policy Instrument
ERUs	Emission Reduction Units
ESCO	Energy Services Company
EU	European Union
FNC	First National Communication
GHG	Greenhouse Gas
GWP	Global Warming Potential
HPP	Hydro Power Plants
IEA	International Energy Agency
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Chang
MIEPO	Moldovan Investment and Export Promotion Organization
MoE	Ministry of Energy
NC	National Communication
NDS	National Development Strategy
NEEP	National Energy Efficiency Program
NEU	Northern Europe
RES	Renewable Energy Sources
SEM	Southern Europe and Mediterranean
SNC	Second National Communication
TPP	Thermal Power Plant
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

INTRODUCTION

Objectives of the Moldovan climate change policy

Moldova acceded to the Kyoto Protocol on February 13, 2003 (the official date of accession was April 22, 2003). As a non-Annex I Party, the Republic of Moldova has no commitments to reduce GHG emissions under the Kyoto Protocol (2nd NC to UNFCCC, 2009). However, the country submitted a voluntary emission reduction target for the Copenhagen Accord in 2009 that was included in its Appendix II. The country expressed its willingness to undertake mitigation measures leading to no less than a 25% reduction of its total national GHG emissions by 2020 compared to the base year (1990) level[1].

In December 2009 the Energy Community Ministerial Council decided on the accession of Moldova[2]. Now, Moldova is a contracting Party[3] to the Treaty that established in May 2006 the Energy Community of Southeast Europe and EU and has accepted the obligation to implement the Energy Community acquis. Under this framework the country will apply directives related to the use of RES and the promotion of energy efficiency.

For complying with its obligations under these two treaties the climate change policy of the country has to reach the following additional objectives as these were expressed through Strategies and Programs. More specifically according to the:

- "*National Energy Conservation Program for 2003-2010*" (Government Resolution No. 1078 of 05.09.2003 (5th National Communication, 2010)) the country aimed at achieving:
  - energy efficiency improvements at the manufacturing industry enterprises through reduction of energy consumption by 2-3% annually;
  - energy savings of 10 % of the annual energy consumption at the manufacturing industry enterprises.
- "*Energy Strategy of the Republic of Moldova until year 2020*" (Government Resolution No. 958, 21.08.2007, Official Monitor No. 141-145 from 07.09.2007[4]):
  - 6% increase of the share of RES in the country's in the energy balance in 2010 to and 20% in 2020 (p.158);
  - 7-10% reduction by year 2020 to the electricity distribution technical losses (p. 115);
  - the achievement of these targets will lead to an annual reduction of CO_2 emissions of approximately 167-210 thousand tCO_2 equivalent. (5th National Communication, 2010; United Nations, 2009).
- *National Energy Efficiency Program* (*Government Resolution No 833, 10.11.2011, Official Monitor No. 197-202/914 from 18.11.2011)*[5].

With this Program the Government confirmed its intention for the accomplishment of aforementioned and new targets. More specifically:

- 6% increase of the RES share in the total energy mix by 2010 and 20% by 2020;
- 10% at least increase of the biofuels share in the overall fuel share by 2020;
- 25% at least reduction of the Greenhouse Gas (GHG) emissions by 2020 compared to the base year 1990;
- 20% reduction of the total primary energy consumption by 2020 compared to 2009.

[1] http://unfccc.int/files/meetings/cop_15/copenhagen_accord/application/pdf/moldovacphaccord_app2.pdf
[2] http://www.energy-community.org/portal/page/portal/ENC_HOME/ENERGY_COMMUNITY
[3] Law 117-XVIII of 23.12.2009 for an Accession of Republic of Moldova to the Energy Community Treaty (Ministry of Economy of the Republic of Moldova, 2012)
[4] http://acem.zzl.org/energy%20strategy.html
[5] http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=340940

As a member of the Energy Community and for the implementation of Directive 2009/28/EC the respective RES target for year 2020 was calculated initially at 10%[6] (IPA Energy and Water Economics, 2010).

Spectrum of climate change mitigation options for Moldova

The highest share of GHG emissions in 2005 was attributed to the energy sector (65%) followed by the agricultural sector (18%), the waste sector (12%) and the industrial sector (approximately 5%) (Ministry of Environment and Natural Resources, 2009). Since the energy sector has the largest share in the national GHG emissions, Moldova's mitigation options are oriented towards this sector.

The reasons that the energy sector from the transformation part produces the majority of the national GHG emissions are the following. The national energy system includes one large Thermal Power Plant (TPP) located in the Transnistrian Region (Administrative Territorial Units on the Left Bank of Dniester River); three (3) municipal Combined Heat Power Plants (CHP)[7]; Nine (9) CHP plants beside sugar factories; and two (2) Hydroelectric Power Plants (HPP) (United Nations, 2009). Approximately 60-70% of the equipment in the energy sector is obsolete (Ministry of Economy of the Republic of Moldova, 2012). For the time period 2001-2008 the gas losses in pipelines were estimated at an average of 7% (Ministry of Economy of the Republic of Moldova, 2012). The technologies used for electricity generation are not as efficient as the similar world ones (e.g., the nominal efficiency of the local CHPs is twice less than the modern installations) (United Nations, 2009). The majority of these plants were built in the decade of 1950 (United Nations, 2009).

Centralized heating systems operate in 15 cities. These systems were built before the disintegration of the former United Soviet State Republic (USSR). Out of 2084,7 thousand Gcal of total heat that entered the grid in 2011, 35% was produced by Heat Distribution owner and 65% of heat was from CHP-1 and CHP-2[8]. 97,3% of centralized heat consumption is distributed in municipality Chisinau (86,2%) and Balti (11,1%). Since the electric efficiency at the CHPs is under 20% (the efficiency at only CHP-2 is about 30%), efficiency of these technologies is also considered as reduced (United Nations, 2009). Heat distribution losses are approximately at 412 thousand Gcal on average per country, constituted, or 19,8% (ANRE Report, 2011), because of outdated facilities. As CHPs, boiler houses designed for centralized heat supply are depreciated as well, having much lower efficiency than modern ones.

From the demand part the reasons are the following. The structure of electricity consumption in Moldova remains unbalanced since population consumes the largest part (usually 30-40%), followed by industry with about 25-35% (Republic of Moldova, 2010). Other sectors of the national economy (agriculture, transport, constructions, etc.) have insignificant shares of electricity consumption (Republic of Moldova, 2010). More specifically the household consumption demonstrated increased shares of 45,7% in 2010 and 45,1% in 2009, followed by the industrial sector with 22% in 2009 and 24% in 2010 and the sector of commerce and services with 22% and 19% respectively (Energy Balance, 2011). Electricity distribution losses are still high and are equal to 9,89% -13,1% with negative effects for the energy efficiency of the country (ANRE, 2011; Republic of Moldova, 2010).

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[6] Proportion of energy from RES in electricity, heat and transport sectors (IPA Energy and Water Economics, 2010).

[7] These three are: i) CHP-1 from Chişinău with installed capacity of 66 MW, but available one at about 40 MW. ii) CHP-2 from Chişinău with installed capacity of 240 MW, but available one at 210 MW; and iii) CHP North-Bălţi, with an installed capacity of 28.5 MW and an available power of 24 MW (United Nations, 2009).

[8] Simultaneous generation of electricity and heat is organized at CHP-1 with an installed 66 MW electric and 296 MW thermal capacity; CHP-2 with an installed 240 MW electric and 1397 MW thermal capacity and CHP–North in Balti with an installed 24 MW electric and 165 MW thermal capacity (United Nations, 2009).

Because of the utilization of energy-intensive, morally and physically outdated technologies e the energy consumption is intensive in the country, totalling about 3 times the respective indicators reported in developed countries (National Development Plan 2008-2011, 2007). Additionally, the heavy reliance of the economy (up to 96%) on imported energy resources and the up-surging price for those is an additional burden for the production sector of the country (National Development Plan 2008-2011, 2007).

In the transport sector (except air transport), from the total fuel used by the vehicles around 75% correspond to diesel oil, 21% to gasoline and only 4,2% to liquefied gas (Energy Balance, 2011). In 2007, approximately 92% of the total energy consumption in the transport sector was used for road transportation; 5% - for railway transport, 2,4% - for air transportation, and as little as circa 0,02% for navigation.

The majority of the residential and administrative buildings were built during the era of former USSR and due to very low energy price, they were designed for high energy consumption. During the last 10 years efforts were undertaken to diminish energy intensity in this subsector: for around 10% from total of 30,1 mil. m^2 of urban buildings and for 1-2% from 48,8mil. m^2 of rural buildings wall isolation, windows and doors replacement are already carried out by the owner of buildings (A. Gutu, 2011).

The country is a net energy importer with only 3% of demand for primary energy coming from domestic sources (Ministry of Economy of the Republic of Moldova, 2012). Natural gas is the major fuel in Moldova and has approximately a 65% share of the total primary energy supply with Gazprom from Russia as unique source of supply (Ministry of Economy of the Republic of Moldova, 2012). The highest dependency is showed by the energy companies which in 2010 accounted for 42% of overall consumption (Ministry of Economy of the Republic of Moldova, 2012).

The main weaknesses of the energy sector are: i) the lack of indigenous energy resources (97% of national energy needs are imported); ii) the excessive dependence (100%) on natural gas imported from a single supplier; iii) the low level of renewables implemented; iv) the lack of adequate power capacity on the right bank of river Nistru; v) the lack of adequate power transmission lines, energy efficiency is up to three times higher than in West Europe, and poor condition of most energy infrastructure (Energy Strategy up to 2020).

These weaknesses in combination with Moldova's rising profile as a transit country for energy supplies to the Balkan region set three main pillars for its energy policy: energy efficiency, renewable energy and diversification of supplies (EC, 2011). These three main directions are reflected in the "*National Development Strategy of the Republic of Moldova 2012-2020*" which was approved recently[9] by the Parliament (Republic of Moldova, 2010). This Strategy sets seven (7) priorities for the country one of which is energy. More specifically, the development of the energy sector development is to be achieved through: (1) ensuring energy security and (ii) increasing energy efficiency (Republic of Moldova, 2010).

Strengthening energy security will be done through the liberalization of energy market in accordance with the Energy Community Treaty requirements, joining to ENTS-E, development of new gas and electricity interconnections with neighboring countries. In the same time a special attention will be given to the optimization of energy mix, diversification of energy resources used, and the creation of new capacity to generate energy.

Based on the objectives of the Moldavian climate policy and on the needs of the energy sector the most significant mitigation options for the country are the following.

[9] http://gov.md/doc.php?l=ro&idc=447&id=4874

Exploitation of RES

The exploitation of RES is still in an early stage since in 2007, their share in energy consumption was 85 ktoe, just 4% of the total primary energy supply (United Nations, 2009). The RES that can be employed in the Republic of Moldova are biomass, solar, wind, hydro and geothermal energy (UNDP, 2009). The total RES potential for the country estimated at 113,4 PJ (Republic of Moldova, 2007 - Energy Strategy of the Republic of Moldova until year 2020). The theoretical potential for these RES types, excluding geothermal, was estimated at 2,7 Mtoe while their overall technical potential (excluding geothermal) is estimated at 2500 tonnes of oil equivalent (toe) (UNDP, 2009; United Nations, 2009). According to more recent estimations the overall RES potential is 2,7 up to 4,1 Mtoe (Ministry of Economy of the Republic of Moldova, 2012). Biomass, hydro, solar and wind energy are the available national resources for Moldova with the two first having the largest share, while solar and wind energy being inadequately explored (United Nations, 2009).

Hydropower

Despite the large number of rivers in Moldova, the energy potential for hydroelectric generation is relatively low and estimated at 0,3 toe (UNDP, 2009). That is why there are only two significant-size hydroelectric power plants (EBRD, 2010). However, several mini-plants can be constructed with power of 200-400 kW and flux mini power plants with total power of 100 kW on the Dniester, Prut and Raut rivers (UNDP, 2009). The produced energy is expected to be used for small-scale irrigation. Implementation of the planned activities would require 10million Euros investment, leading to annual fuel substitution of 23800 toe and GHGs reduction of 13000 tones (UNDP, 2009).

Under the Energy Strategy 2020, mini hydro stations with a capacity of 1,2 MW are planned to be built on the Reut River, close to the village of Tribujeni, in the Orhei district (United Nations, 2009).

Biomass

Fuel wood, wooden wastes and agricultural residues are burned for heating and cooking needs using modern installations with effective power of not less than 75-80% (UNDP, 2009; United Nations, 2009). The total volume of standing wood mass in the forests of the country is approximately 45 million m^3, on average 124 m^3 per hectare (United Nations, 2009). The structure by age in all forest species is misbalanced, in particular in those of low productivity.

The potential of wood combustion and agricultural and wooden wastes is estimated at 820 thousand toe, respectively 48,4% from the total gross energy resources consumption in 2001 year. For achieving the objectives of the Energy Strategy regarding fuel wood, wooden wastes and agricultural residues resources combustion, it is necessary to increase their consumption at 300 thousand toe.

Biogas is obtained by fermentation from animal and poultry manure. The potential for biogas production in the country is estimated at 3700 thousand m^3. In order to achieve the Energy Strategy's aim concerning Biogas Resources, it is necessary to increase the fermentation installation capacity at 7100 m^3 (United Nations, 2009). The technical reserve for biogas installations is more than 50 MW (Republic of Moldova, 2007 - Energy Strategy of the Republic of Moldova until year 2020).

Biomass energy potential is estimated at 2700 toe, while its technical potential is estimated as more than 370 thousand toe per year or equivalently in total 19,4 PJ (EBRD, 2009; UNDP, 2009; United Nations, 2009). This total includes agricultural wastes (7,5 PJ), fuel wood (4,3 PJ), wood processing wastes (4,7 PJ) and biogas (2,9 PJ). Another 2,1 PJ is the estimated potential for biofuels in the country (Energy Charter Secretariat, 2011; EBRD, 2009).

Bio-fuel obtained from rape seed, corn, sorghum, etc. The potential of bio-fuel in Moldova is unknown (United Nations, 2009). There is estimation that overall costs for woods, biogas and biofuel energy production would be 7,6 million Euros, resulting in 117 thousand toes of annual fuel substituted and a 258 thousand tonne GHGs reduction (UNDP, 2009).

Solar

For Moldova, the theoretical (maximum) sun brightness period is 4450 h/year, but the real value is 2100-2300 h/year, approximately 50% of the maximum theoretical period (United Nations, 2009). The brightest Moldovan period is from April to September, representing more than 75% of the total annual brightness period (United Nations, 2009).

Solar energy potential is estimated at 1200 toe, with the following possible uses: drying agro-products, water heating and electricity production in photovoltaic installations (UNDP, 2009). The energy produced under these uses would substitute for 38,5, 11,5 and 0,5 toe respectively and would reduce GHGs by 38,5, 11,5 and 0,5 thousand tonnes, respectively (UNDP, 2009).

For achieving the aim of the National Energy Strategy the estimation was that through 2010 one million m^2 solar installations for water heating and 80 thousand m^2 solar installations for agricultural products drying were necessary to be installed (United nations, 2009).

The solar potential is around 50,4 PJ (Energy Strategy, 2007). The technical reserve for photovoltaic installations is more than 600MW (National Development Strategy (NDS) for 2008-2011, 2007). Installation is estimated to be approximately 102000 m^2 of solar collectors designed to heat water, about 60000 m^2 for drying agricultural produce, and over 5000 m^2 of photovoltaic systems with the installed power of 300 kW (EBRD, 2009).

Wind

Wind energy potential is estimated at 0,7 toe, while the total technical potential of wind power capacity is approximated at 1000 MW which would produce 11 TWh per year (EBRD, 2010; UNDP, 2009). The technical reserve for wind is 600-1000MW[10].

Wind energy will be used for electricity production at stations with general installed power capacity of 8MW (UNDP, 2009). It is estimated that for such an investment the amount of 5,5 million Euros is required, but it would result in a substitution of 5 toe of fossil fuel energy and a reduction of GHGs emissions of 16900 tonnes (UNDP, 2009).

In addition to the poor measurement there is another obstacle to the use of the wind energy, namely the widespread belief that the country wind resources are poor (United Nations, 2009).

Geothermal

The geothermal energy resource potential is estimated to be poor. A few wells with the temperature between 30°C and 50°C were discovered in the southeast part of the country, near the town of Cahul, and in the west part of the country, near the town of Ungheni. However, no wells with high temperature thermal water are available yet in the Republic of Moldova (United Nations, 2009).

Energy efficiency

Substantial increase in the costs of energy resources is attributed to the very low energy efficiency of the country which is almost three times lower than in European countries (Republic of Moldova, 2010). The need for energy efficiency actions is imposed by the high

[10] I. Bostan and others. Systems for conversion of renewable energies. TEHNICA-INFO, Chisinau, 2007.

energy consumption which leads to increased energy intensity, increasing energy prices, morally and physically outdated technology and equipment, and lack of knowledge and skills in the area of energy efficiency and use of renewable energy resources (Republic of Moldova, 2010). It is estimated that a well-planned and concerted implementation of an energy efficiency program in Moldova could reduce the financial impact of the energy sector on the GDP by 1,6-1,7% per year, starting with 2009 (United Nations, 2009).

Energy efficiency is one of the priorities for the national economy and for the energy sector and has been named a key objective under the EU-Moldova ENP Action Plan (Objective 66).

The housing stock accounts in total 78,9 million m^2, the building being built 20-60 years ago and are distinguished by low thermal characteristics. The potential savings of old buildings is estimated between 30 and 50%. The construction sector is responsible for achieving energy savings of around 10-12% in the national target of 20% by 2020 (Government of Moldova, 2012; NEEP, 2011).

The National Energy Efficiency Program 2011-2020[11] and the National Development Plan 2008-2011 included the following measures per sector:

Energy sector

- The total efficiency of the thermal power plants of a new combined cycle should be less than 80% while their 45-50%;
- Reduction of losses in the electricity distribution networks from 13% in 2011 to 10,7% in 2020. This corresponds to 0,52% - 0,82% annual reduction of losses (National Energy Efficiency Program 2011-2020;
- Priority will be given to the production of electricity in cogeneration mode, recovery potential of renewable energy sources and use the existing heat supply;
- Reconstruction and modernization of electric power transport and distribution, to ensure reduction of losses, non-interrupted provision of EDN-s and final consumers with electric energy (National Development Plan 2008-2011);
- Increasing and fully using the existent natural gas transiting capacity;
- Attraction of investments for implementation of energy conservation technologies;
- Modernization of thermal power transport and distribution infrastructure;
- The distribution electricity losses should be diminished from 13% in 2011 to 7-10% in 2020, equivalent to 0,52%-0,82%/year decreasing (NEEP, 2011) [12];
- The distribution heat losses is planned to reduce from 19,8% (412 th Gcal) (ANRE Report, 2011) to 10-12%.

Reducing losses of heat supply networks remains a priority for the energy sector and complies with EU policies including the Green Paper of 2006. A key issue in this context is energy efficiency regulation, including installation of energy efficient equipment and optimization of heat demand (Republic of Moldova, 2012).

Residential sector

- By 2020 100% of gas consumers should be equipped with meters;
- energy certification of buildings;
- increase energy buildings "nearly zero";
- minimum energy performance requirements for buildings will be introduced;

[11] National Energy Efficiency Program (No 833 from 10.11.2011, Official Monitor No. 197-202/914 from 18.11.2011, http://lex.justice.md/)
[12] http://termocom.md/termo/?page_id=202

- promotion of methodology for energy performance calculation of buildings (NEEP, 2011);
- Energy reduction in building 10% until 2020[13].

Residential sector

- gas metering at 100% by 2020;
- energy certification of buildings;
- increase energy buildings "nearly zero";
- minimum energy performance requirements for buildings will be introduced;
- promotion of methodology for energy performance calculation of buildings (NEEP, 2011).

Public sector

- training managers to monitor energy consumption in the public sector;
- development by local authorities of their energy efficiency plans every three years;
- develop a national program for the development of heat distribution networks, which will be implemented by all distribution companies, regardless of ownership, as set out in the *Energy Strategy of the Republic of Moldova until 2020*;
- lay down rules concerning energy and environmental performance of energy-related products used by final consumers;
- preparation and approval of the Law on Heat and secondary normative framework for its implementation;
- continuation and completion by 2016, the installation of heat metering equipment for 100% of buildings in Moldova.

Manufacturing Industries

- promotion of the voluntary agreements in order to achieve energy savings in industrial sector. According to the estimations made, the agreements allow to save from 10 to 20% of energy. A separate Industry Energy Efficiency Program will be developed as well;
- normative framework on energy performance of buildings will be put in practice;
- public building rehabilitation at 10% until 2020[14] .

Transport

- replacement of diesel oil and gasoline by liquefied gas.

Fuel switch

- diesel oil and gasoline replacement by liquefied gas in road for the transport sector (NEEP, 2011);
- in the residential sector fossil fuel used for schools and kindergartens heating should be replaced by biomass (agriculture waste) (NEEP, 2011).

Mitigation through CDM

Because of high energy intensity, the country has a lot of opportunities for development and promotion of CDM projects, mainly in:

[13] http://gov.md/doc.php?l=ro&idc=447&id=4874
[14] http://gov.md/doc.php?l=ro&idc=447&id=4874

- Electricity losses reduction. At the moment transport and distribution losses are at the level of 15% (ANRE, 2011);
- High efficient lamps implementation. Because of the high price of such lamps they are not used;
- Low CHP capacity;
- Abolished local CHP refurbishment. All existing local CHP are totally depreciated and have very low energy efficiency;
- Electricity produced by renewable energy sources (mainly: wind, solar, biogas);
- Landfills waste treatment in biogas with further electricity production. No landfill biogas collection facility have been installed up to now, except in Tintareni (near to Chisinau), but the last project has not finished yet.

Spectrum of adaptation needs in Moldova

A. Energy sector

The Moldovan energy distribution infrastructure is possible to be more vulnerable to climate change impacts. More specifically:

- More frequent and more violent extreme weather events such as storms or lightning strikes could damage supply grids and present a threat to electricity transmission and distribution (UNDP, 2009);
- Less available water resources due to reduction in precipitation and to total renewable freshwater resources may become the main obstacle to enhancing local hydro- and cogeneration power production (UNDP, 2009).

Proposals for the adaptation needs of this sector focus on (UNDP, 2009):

Changing consumer behaviour. Energy savings in lighting and equipment in households, industry and in all sectors of the national economy through technological modernisation are necessary. A public awareness campaign and relevant tariff incentives (higher tariff s for high energy use) may be helpful (UNDP, 2009).

B. Agriculture sector

Agriculture is the dominant sector of employment in Moldova. Moldova's soil is the main natural asset of the country, with 75% of its land area being lands used in agriculture (National Development Programme 2008-2011, 2007). The total land area of the Republic of Moldova is 3,385 million hectares, out of which 2,506 million hectares (74%) are agricultural land (UNDP, 2009).

During the last years the sector faced problems in implementing the land reform and use of soil, the avoidance of using advanced technologies, due to farmers' limited knowledge about the best practices used in the sector and the limited access to chemical and biological fertilizers (National Development Programme 2008-2011, 2007). The soil erosion is main factor contributing to soil degradation, exerting a negative impact on aquatic resources (National Development Programme 2008-2011, 2007)

During the past two decades, this sector faced droughts, soil erosion and wind, thunder storms and heavy rain falls, hail, spring frosts and floods (UNDP, 2009). Climate change impacts will possibly affect negatively: i) wheat production, which is important in providing food security and ii) the vineyards which are economically very important (UNDP, 2009). These trends will increase the number of rural families into poverty and will further encourage the depopulation of rural areas unless alternative economic occupations are provided (UNDP, 2009).

Following privatization reforms undertaken during the past decade, some 85% of Moldovan households today own agricultural land. The majority of the farms (400,000) are small with an average landholding size of only 1,6 to 1,8 hectares. Together they represent about 45% of the utilized land and an overall share of some 72% of the total agricultural produce.[15] These small farms in the central hot semi-humid and south hot-arid zones are the most vulnerable to the types of extreme climate conditions expected to become more severe with climate change (UNDP, 2009). Provision of irrigation may increase yields by 1,5 to 2 or more times as compared with yields without irrigation (UNDP, 2009).

Five risks are considered to be high priority for agriculture[16]:

- Increased risk of drought and water scarcity;
- Increased irrigation requirements;
- Soil erosion, salinization, desertification;
- Increased risk of agricultural pests, diseases, weeds; and
- Wheat and maize yield decrease.

Adaptation needs for this sector focus on ensuring sustainable growth of the agriculture sector and food processing industry, and a consequent improvement in the quality of life in rural areas by increasing the productivity and competitiveness of the sector.

C. Forestry sector

According to the Sustainable Development Strategy for the Forestry Sector, the country intends to plant new forests of 73000 ha for the period 2003-2020 (Sustainable Development Strategy for the Forestry Sector, 2001[17]).

The country intends to increase afforestation from 10,3% in 2002 up to 12,1% in 2010 and 13,2% in 2015 (National Development Plan 2008-2011, 2007). The direct contribution of the forestry sector to the sustainable development of the Republic of Moldova will be achieved through two basic strategic directions: restoration and bio-eco-protective potential of forests and areas with forest expansion.

Specific objectives to achieve these strategic directions clearly account for climate risk: (i) mitigation of the destructive effect of temperature changes, droughts and other negative climatic factors; (ii) reducing soil degradation by erosion, which is affecting over 80% of agricultural lands, impacting the loss of 40-60% of soil fertility; (iii) reducing and stopping the landslide; (iv) improving the quality of aquatic resources; (v) reducing the greenhouse gases emissions through carbon removals; (vi) conservation of biological diversity, as forest vegetation provides refuge and habitat for various species of wild plants and animals that are endangered as a result of anthropogenic impact; (vii) increasing resource potential and the volume of wood products accessories[22] (2nd NC, 2010).

Adaptation needs for this sector include:

- natural regeneration of forests, assisting the natural regeneration of forests, as well as planting new forests[18];
- Involves the afforestation of the degraded agricultural lands, the reconstruction of the forest protection belts along the roads and railways, the reconstruction of existing and plantation of new forest belts to protect the agricultural lands, ponds and water basins[19].

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[15] Suter, Rene (2008). "Relief and Technical Assistance Response to the Drought in Moldova". Programme Review Mission Report, UNDP/BCPR.

[16] National Climate Adaptation Strategy, 2011. Draft

[17] Parliament Resolution No. 350-XV of. 12.07.2001, http://www.fao.org/docrep/014/k9589e/k9589e12.pdf

[18] The State Program for Regeneration and Afforestation of the Lands of the Forestry Fund for 2003-2020 periods. (Government Decision No. 737 from 17.06.2003, http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=335064

D. Water resources

Moldova experienced a catastrophic drought in 2007 and devastating floods in 2008 (UNDP, 2009). The Republic of Moldova withdraws water for economic use from both surface and underground sources, but in 2009 the volume of water withdrawn from surface sources exceeded the volume from underground sources (mainly contained in confined aquifers); the latter have a share that varied in the past decade between 13% and 18% (UNDP, 2009). The country has two major river basins: Dniester (the largest) and Prut (the second largest) river basins. Their stream flow amounts to 98% of total surface water resources in Moldova. There are also numerous smaller rivers out of which only nine have a length of about or exceeding 100 km (UNDP, 2009).

Currently 65 to 70% of total water is used in industrial heating and cooling and hydro-energy production. However, water quantity in Moldova is quite sensitive to climate change effects. Thus, water scarcity will start adversely affecting national development goals by 2020 if only surface water is taken into account.[20].

Sub-surface waters are the main source of potable water supply in the Republic of Moldova, for 100% of rural population and 30% of the urban population, or 65% of the total population of the country. The remaining 35% of the population use surface waters as a source of potable water, including 32% from the Dniester River, 2,8% from the Pruth River and 0,2% from other surface waters. Internal surface water resources account for 1,2 km3/year. The entire river network consists of about 3600 water streams totalling about 16000 km in length. (UNDP, 2009).

44% of the population in the country does not have access to safe drinking water sources. At present all towns and municipalities and over 65% of rural settlements have centralized drinking water supply systems (SNC, 2009).

Only 50% of this type of systems is in satisfactory technical condition. The rest needs capital repairs or rather reconstruction. The possibility to use water resources for irrigation depends on their condition and quality. The waters of the Dniester and Pruth rivers are of suitable quality to be used for such purposes. As a rule, the waters of inland rivers and reservoirs are polluted, its mineralization exceeds 1 ram/liter and it can be used for technological purposes only. Of the sub-surface water reserves only 50% comply with water quality requirements (SNC, 2009). So, for irrigation purposes the waters of Transborder Rivers can be used, in the first place. The waters of the inland rivers and lakes can be used for irrigation only after improving the quality of the water to exclude salinization and alkalinization of soils. Wide use of water resources for irrigation purposes is limited due to a high weariness degree of the irrigation systems and their scarcity[21].

Total water consumption in the past decade represents slightly more than 20% per cent of the water use in the past (UNDP, 2010). The decline is more evident in the cases of agricultural water use (especially for irrigation) and water consumption for production needs (mainly industrial) (UNDP, 2010). According to the estimates, the structure of water use haschanged as well. Currently, about 65 to 70% of total water is used in industrial heating and cooling and hydro-energy production, 15 to 20% for drinking and domestic purposes and 5 to 8% for irrigation (Republic of Moldova, 2012). Compared to average figures for 1980s, the share of household consumption has doubled in the structure of water use, while the same figure for irrigation has fallen to a third of the earlier level.

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[19] The Program on Use of New Areas and Soil Fertility Enhancement for 2003-2010 (2003). (Governmental Decision No. 636 from 26.05.2003, Monitorul Oficial No. 99-103 dated 06.06.2003) http://www.google.ru/url?sa=t&rct=j&q=decizia%20guvernului%20nr.%20636%20dated%2026.05.2003&source=web&cd=3&cad=rja&ved=0CDEQFjAC&url=http%3A%2F%2Fwww.agravista.md%2Fcgi%2Fjump.cgi%3FDB%3DFisier%26view%3DFile%26ID%3D8939&ei=xEg_UKexG5DBtAalqoAo&usg=AFQjCNGjyCtoFCASDm3LT7ppmnDB8EL-MQ

[20] National Climate Adaptation Strategy, 2011. Draft, http://clima.md/lib.php?l=ro&idc=237&

[21] Second National Communication, 2009

Adaptation needs for this sector include:

- Dams and reservoirs represent the main option for adapting to climate change in the water sector since the country is deficient in natural lakes and with abundant intermittent streams (UNDP, 2010);
- rehabilitation, technical renewal, and development of municipal water supply and sewerage systems towards meeting the targets of the Millennium Development Goals by 2015;
- Implementation of plans for ensuring safety of drinking water and compliance of drinking water quality with requirements, imposed by the EU Directive 98/83[22].

Because of heavy rains, especially in the north-eastern part of the Carpathians, Romania, Ukraine and the Republic of In the Republic of Moldova, the biggest flash floods occurred on the main Dniester and Prut rivers, as well as, locally, on several small inner rivers. The Dniester River flash flood caused the most significant damage. The total losses due to the floods in 2008 in the regions adjacent to the Dniester are estimated at 300 million USD.

[22] Program of Water Supply and Sewerage in Communities of the Republic of Moldova until 2015 (Government Decision No. 1406 of December 30, 2005, Decree No. 662 of June 13, 2007)

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BUSINESS – AS – USUAL SCENARIO (2000 – 2050)

BAU scenario description

General comments

Moldova made no or only limited progress towards the effective implementation of key priorities, that were defined under the EU-Moldova Action Plan. These included market and regulatory issues, the fight against corruption, drugs and trafficking in human beings, or reforms in sectors such as energy and the environment (EC, External Relations Directorate – General, 2011). Inadequate allocation of resources, delays in adopting secondary legislation or insufficient political backing constituted lasting impediments to the implementation of internal reforms (EC, 2011).

The main observations for this policy portfolio are the following:

- Investments in RES facilities are made mainly in biomass and solar for heating production based on foreign assistance[23] (SNC, 2009). Hydropower and one small (100kW) power plant on biogas are the only RES utilized for electricity generation and registered in the Official Moldova Energy Balance (Moldelectrica, 2011; ANRE, 2011). Only two relatively big hydropower plants are operating in the Republic of Moldova (Dubasari HPP of 48MW (controlled by Transnistria secessionist authority) and Costesti HPP of 16MW) (Moldelectrica, 2011);
- Despite the published "Methodology on renewable tariff calculation"[24], RES were not promoted. Individual solar thermal building systems and small solar photovoltaic roof maintained units[25] were the only projects established (MoSEFF, 2011).

Although there is a high proportion of vulnerable poor[26] that will suffer more due to the impacts of climate change, the country lacks of adaptation climate change policy (EC, External Relations Directorate – General, 2011).

The BAU scenario is only a mitigation policy portfolio.

Policy Portfolio for this scenario

Laws for RES

Electricity Law (No. 124-XVIII, Dated: 23.12.2009)

This Law transposed Directive 2003/54/EC concerning common rules for the internal market in electricity and repealing Directive 96/92/EC (Ministry of Economy of the Republic of Moldova, 2012). Only the distribution company has rights to build, operate distribution network within the authorized territory. The Government approves the constructions of interconnections with other power systems; sets up the conditions for electricity import and export; issues permission for construction of power plants, on bid basis, with capacity over 20 MW (Ministry of Economy of the Republic of Moldova, 2012). Any third party, including RES has access to the transport and distribution grid based on the published fees. The license for electricity production is issued for power plants of 5MW and more if this power is used for public purposes. This provision is extended for RES as well.

[23] http://www.undp.md/presscentre/2012/Biomass_23July/index_rom.shtml

[24] Methodology for the determination, approval and application of tariffs for the electricity generated from renewable sources and for bio-fuel. Official Monitor No 45-46 from 27.02.09

[25] http://ieasm.webart.md/data/m71_2_170.pdf

[26] With a GDP per capita of 1000€ per annum, about 30 % of the population of Moldova ('the poorest country in Europe') live in absolute poverty and 4,5 % live in extreme poverty (EC, External Relations Directorate – General, 2011). That is why social spending thus remains a major component of public expenditure.

Law on Renewable Energy Resources (Parliament Resolution No. 160-XVI, 12.07.2007)[27]

It sets the rules about the Tariffs for RES: (1) Charges shall be set for RES and approved on an annual basis, depending on the type and capacity of the production facilities, production volumes, expected delivery period and delivery of renewable energy; (2) when applicable for the definition of the tariffs prices on the international market will be taken into account.

It establishes also the Energy Efficiency Fund (EEF) as an independent legal and autonomous financially entity. It main activities are: management of financial resources in order to promote the financing of activities for energy efficiency and RES in accordance with the strategies and programs drawn up by the Government. The EEF launched activity in 2012[28].

It defines the tasks of the National Agency for Regulation of Energy (ANRE): a) publishes the rates for each type of renewable energy and fuel, calculated by the manufacturer on the basis of the methodology that is approved by ANRE, so as to ensure the payoff of the investments that are carried out, possibly in the construction, extension or modernization of installations, connection lines, transmission and distribution of energy and fuel, within a period of up to 15 years. All these provided that the prescribed rate of return does not exceed in double the corresponding rate in the traditional energy sector. Approving tariffs will take account of the prices of comparable products on the international market; b) develops, as appropriate, the necessary acts regulating relations between participants in the renewable energy market; c) drafts contracts for the sale of renewable energy and fuel, providing and non-discriminatory access to producers of renewable energy and fuel at thermal and electrical networks, centralized networks and fuel distribution installations; d) issues the licence for producing renewable fuel.

Methodology for the Determination, Approval and Application of Tariffs for the Electricity Generated from Renewable Electric Energy and Biofuel (ANRE's Decision No. 321 from 22.01.2009, Official Monitor No. 45-46 of 27 February 2009) [29]

The Methodology ensures the recovering of all needed and proved costs plus a return on investments that were made, much higher than that applied by the traditional national electricity distribution companies. ANRE will approve the tariffs either by taking into consideration international market prices or the calculations according to the Methodology. ANRE can approve average tariffs for production of renewable electric energy and biofuel for a long term period.

Regulation on the Guarantees for Origin of Electricity Generated from Renewable Electric Energy and Biofuel (ANRE's Decision No. 330 from 03.04.2009, Official Monitor No. 99-100 of 5 June 2009).

The Regulation is based on art. 550 of Law on Renewable Energy. The Guarantee Of Origin (GOO) specifies the RES from which electricity was produced, location of production, date of issue, type of renewable, power generation installed capacity, quantity of electricity produced and allows the manufacturer to demonstrate the origin of renewable electricity produced. It is issued for RES of capacity higher than 10 kW. In the case of waste incineration installation network operator grants guarantee of origin based on the amount of electricity produced.

[27] http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=324901.
[28] Energy Efficiency Fund. GD No 401 from 12.06.12, Official Monitor No 126-129 from 22.06.12
[29] Methodology for the determination, approval and application of tariffs for the electricity generated from renewable sources and for bio-fuel. Official Monitor No 45-46 from 27.02.09

Laws for Energy Efficiency

Law on Energy Efficiency (No. 142, 02.07.2010)[30].

The Law introduces economic agents, which will implement measures and projects on improving energy efficiency may use loans or investment guarantees from the Energy Efficiency Fund's resources, in accordance with the Law on Renewable Energy No.1060 from July 12, 2007 and Regulation on Energy Efficiency Fund, published in 2012.

In order to implement important energy efficiency programs and projects financial sources can be allocated from the state budget. Energy efficiency improvement measures can be financed by third parties based on a written agreement in compliance with the Law on Public-Private Partnership No. 179-XVI from July 10, 2008[31] and ESCO. Energy companies and third parties involved in financing energy efficiency projects are eligible for tax incentives in accordance with provisions from the Tax Code. In order to identify and quantify costs for effective energy savings opportunities, and report the findings a system of Energy certificates should be implemented.

According to the previous Law on Energy Efficiency –published in July 2008 - the MoE has the following responsibilities: i) is in charge of insuring public information on Energy Efficiency (Art.5f); ii) involves civil society in the decision making process (Art.5h), while the EEA insures the dissemination of information about energy efficiency and the use of renewable energy sources (Art.9q) iii) it organizes seminars, conferences and exhibitions for promoting energy efficiency and the use of renewable energy sources (Art.9.r).

Also, according to current institutional rules (Annex to the Rule on the Organization and Functioning of EEA, no. 1173/21 December 2010, Section 2, paragraph 4e), the EEA is in charge of disseminating information on energy efficiency, including mechanisms for energy efficiency, financial and legal framework, and the dissemination of information regarding the use of RES (Government of Moldova, 2012)

Laws for emission trading

Clean Development Mechanism

The Clean Development Mechanism is regulated by:

- Parliament Decree on "*Ratification of UNFCCC*" (No. 404-XIII from 16.03.95, Official Monitor No. 23 from 27.04.1995)
- Law on "The Republic of Moldova's accession to the Kyoto Protocol and for the CDM implementation" (No 29-XV of 13.02.2003, Official Monitor No 48 of March 18, 2003). The Carbon Financing Office[32] was established to strengthen the institutional capacity for the implementation of this Law. The objectives of the Carbon Financing Office include the development, monitoring and implementation of new CDM projects. (United Nations, 2009)
- Government Decree on "*Establishment of the National Commission for the implementation of the UNFCCC and the mechanisms and provisions of the Kyoto Protocol"* (No. 1574, from 01.01.2004, Official Monitor No. 6-12 from 2004[33]). This decision established the "National Commission for the enforcement and implementation of provisions of the UNFCCC and the mechanisms and provisions of the Kyoto Protocol"

[30] http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=343683
[31] Official Monitor No. 165-166 from 02.09.2008
http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=328990
[32] Law No. 899 from 25.08.2005, Official Monitor Nr. 117-118 from 02.09.2005,
http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=305384
[33] http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=299618

aiming to the coordination of activities under the Clean Development Mechanism at a national level (UNDP, 2009).

Policy instruments for the transport sector

At the moment only one efficient measure: imported second hand cars and micro-bus cannot exceed an age more than 7 years and 10 years for truck and bus[34].

The share of biofuel consumption is expected to reach the level of 4% for the transport sector in 2015 and of 10% in 2020 (NDS Moldova 2020).

Main characteristics of this policy portfolio

Although the country has as priorities the penetration of RES and the increase of energy efficiency the current policy portfolio has the following weaknesses (United Nations, 2009):

- The legislation that concerns energy efficiency is more declaratory than operational. There are no quantitative objectives and specific actions per sector (United Nations, 2009). A basic regulatory and institutional framework has been put in place, but additional secondary legislation, specifically Energy Service Regulations, national and local EE Programs and Plans, National RE Action Plans, energy auditing regulations, etc. need to be developed to ensure its actual implementation (Republic of Moldova, 2012).
- The inefficient legislation to support the structure of the Agency for Energy Efficiency and Renewable Energy Sources (former National Agency for Energy Conservation (ANCE)) under the Ministry of Economy and Trade and lack of financial and human resources for its operation. (United Nations, 2009);
- There are discrepancies and contradictions between laws (United Nations, 2009);
- The lack of mechanisms and underpinning legislative framework are the main obstacles in implementation; (United Nations, 2009);
- The lack of legal authority of the housing associations to assist in the implementation of energy efficiency improvements in multistory buildings of the residential sector. (United Nations, 2009);
- The lack of incentives to local governments and public institutions to save energy is considered by mayors, principles, directors of public institutions as a significant obstacle in implementing energy efficiency projects in these institutions. (United Nations, 2009);
- The high share of private ownership, the associations cannot oblige the individual owners or tenants to participate in the funding of energy efficiency measures. The privatization of apartments has left the apartment owners without any obligation regarding common facilities such as heat supply, maintenance of the building shell, etc. (United Nations, 2009);
- Regarding the Electricity Law, the incentives for investment are very low, while there is no competitive framework for energy pricing (Ministry of Economy of the Republic of Moldova, 2012);
- In the field of RES and biofuels, the existing legislation partially transposes the requirements of Directive 2001/77/EC, while the Biofuel Directive 2003/30/EC needs to be further reflected in the Law on Renewable Energy (Republic of Moldova, 2012);
- Both the RES and biofuels sectors are in early stage and effective support schemes need to be enacted in order to stimulate their growth (Republic of Moldova, 2012);

[34] http://www.webtaxi.md/ro/devamarea-auto-moldova. Law on Custom Code no 154 from 21.07.2005. http://lex.justice.md/

- Transposition of new Directive 2009/28/EC on promotion of the use of energy from RES is required. This is subject to transposition in 2012, as pre-conditioned by the Energy Budget Support offered by EU Delegation within 2011-2014;
- Moreover, energy labelling, eco-design and energy performance of buildings have not been adopted yet but are recommendable as to comply with acquis communautaire. (Republic of Moldova, 2012);
- There are proposals for replacing the existing Methodology for RES tariffs calculations[35] by feed-in- incentives (V. Parlicov, 2012[36]) and subsidy programs[37];
- Moldova's CDM generates about 200,000 CERs per year[38]. The Ministry of Economy and the UNDP in Moldova have initiated the feasibility study on introducing an Emissions Trading System in Moldova[39];
- The current Law for Renewable does not set properly the targets according Directive 2001/77/EC; does not stipulate guaranteed or priority access to the network and it does not indicate how the costs of renewable energy projects will be borne by all energy customers (Ministry of Economy of the Republic of Moldova, 2012).
- Infrastructure and energy performed poorly in finance and operation (BSTDB, 2011). Significant reforms of the power sector took place, but the inter-company energy sector debts were not faced properly and still need to be restructured (BSTDB, 2011);
- The target about the forest area (expressed in the National Development Plan 2007-2009 and in the Millennium Development Goals of Moldova) will not be achieved (Republic of Moldova, 2012).

The following results are attributed as outcomes in 2010 of this policy portfolio and compared to year 2001:

- Electricity consumption increased by 951 GWh (Moldova 2020, 2012);
- Total energy of the household sector increased by 27%;
- Natural gas share increased from 30,9% (in 2001) to 37,5% (in 2010), but electricity share decreased from 26,6% to 14,5%. Centralized heating was reduced from 19,5% to 14,7% The energy consumption of industry was reduced by 38% in 2010 compared to 2001. Significant energy consumption was marked in transport sector, it increased by 99%[40].

It is also worth mentioning that the national energy policy focuses more on the industrial (21% of the total final energy consumption in Moldova) instead of the residential sector (40% of the final energy consumption). It also lacks of realistic action planning and program implementation (United Nations, 2009). The existing normative-legislative framework must be extended, especially concerning: (i) imposing energy and environment efficiency requirements (standards); (ii) elaboration of national programs and strategy for energy efficiency, first, in the housing and public sector (United Nations, 2009). Structural reforms implemented in previous years resulted in improved financial situation of the sector and partial rehabilitation of energy infrastructure (National Development Plan 2008-2011, 2007).

[35] Methodology for the determination, approval and application of tariffs for the electricity generated from renewable sources and for bio-fuel. Official Monitor no 45-46 from 27.02.09. http://lex.justice.md/
[36] http://www.cnr-cme.ro/foren2012/PPT/WF%202/
[37] Energy Efficiency Fund. GD no 401 from 12.06.12, Official Monitor no 126-129 from 22.06.12
[38] http://www.google.md/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=2&cad=rja&sqi=2&ved=0CEMQFjAB&url=http%3A%2F%2Fwww.get-moldau.de%2Fdownload%2Fpolicybriefings%2F2011%2FGET_Moldova_PB-09-2011_en.pdf%3FPHPSESSID%3D7b37dba6fb1101d4c5aaeb72850be396&ei=V-IwUMmZF4yRswbRvIGAAw&usg=AFQjCNFWzjNrOplxDafq-RQ2SXHES8lSbw&sig2=Bk1fUB1iR0c0MW0WsYx8Sw
[39] http://www.bgpengineers.nl/news
[40] www.statistica.md

Key assumptions

The key assumptions used for the development of scenarios are similar to those used in previously published studies and papers for the Republic of Moldova (FNC, 2000; SNC, 2009). The categories of the key parameters are common for all scenarios and are divided as follows:

Demographics

According to the "*2010 World Population Prospects*" of the United Nations[41] the population of 49 countries is expected to decrease for the period 2011-2050, while 44 of them are expected to continue decreasing for the period 2050-2100. Among these countries are: Bulgaria, Moldova, Romania, Russia, Serbia and Ukraine. The UN's medium variant population projections up to the year 2050 are used for the BAU scenario.

Table 1: United Nations projections for the Moldavian population (UN, 2010).

	Average annual rate of change (%)							
Variant	2005-2010	2010-2015	2015-2020	2020-2025	2030-2035	2040-2045	2045-2050	2050-2055
Medium	-1,06	-0,68	-0,56	-0,58	-0,79	-0,84	-0,84	-0,69

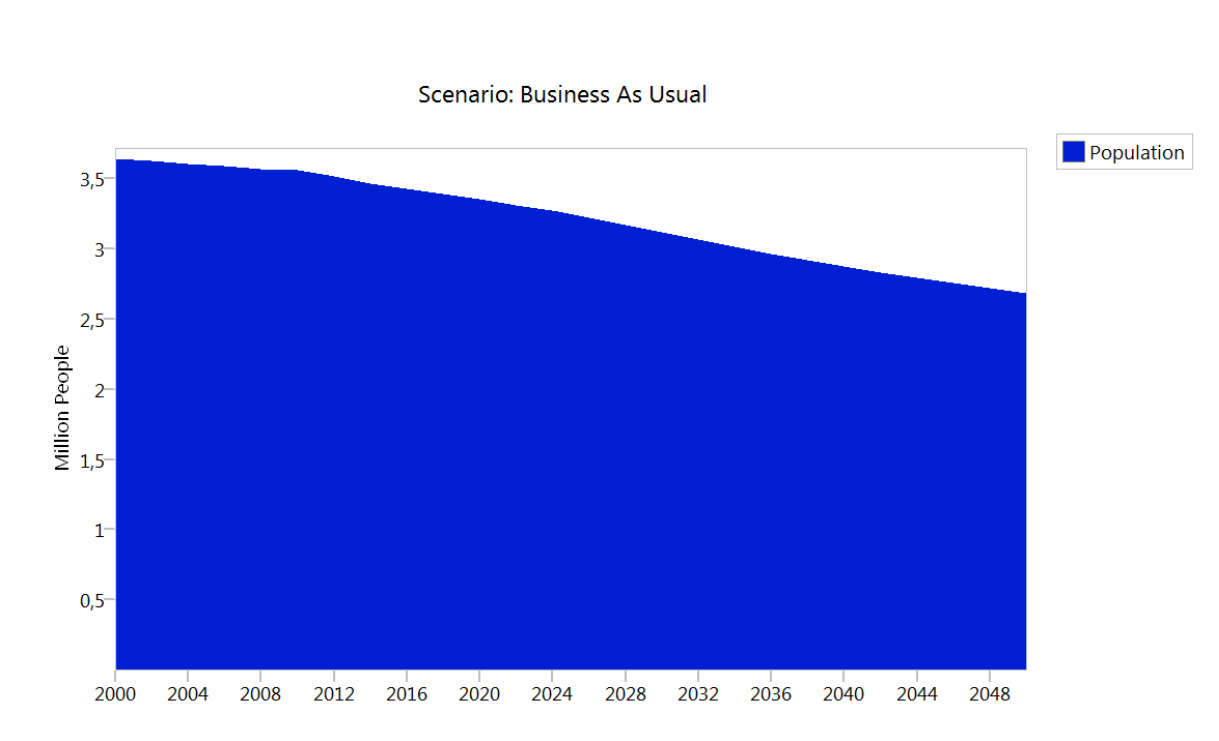

Figure 1: Demographics: Population.

Economy

Gross Domestic Product

GDP is characterized as a key driver of energy demand in all regions. It is assumed to grow worldwide by 3,2% per year on average over the period 2008-2035. In general, the non-OECD countries continue to grow fastest (World Energy Outlook 2010, IEA).

[41] http://esa.un.org/wpp/unpp/p2k0data.asp

The International Monetary Fund (IMF) which provides GDP estimates for the country up to 2016.

Table 2: Projections for the Moldavian GDP (IMF, 2011).

Year	**2011**	**2012**	**2013**	**2016**
Annual percent change of GDP (%)	4,5	4,8	5,0	4,5

These projections are close to those provided by the Black Sea Trade and Development Bank in 2011 for real GDP. More specifically: 4,5% in 2011, 5,0% for 2012 and 2013 and 4,5% for 2014 (BSTDB, 2011).

Recent projections from EBRD and World Bank contained lower values. EBRD refers to 6,4% increase in 2011, 2,5% in 2012 and 3,5% in 2013. This trend is justified by weakened external demand and unfavourable weather conditions (EBRD, 2012; UN, 2011). However, short-term growth prospects are uncertain and depend on the evolution of remittances[42], exports and investment sentiment (EBRD, 2012). According to the projections from World Bank, 2011 presents 6,4% increase that will be followed by 1% in 2012, in line with worsening external conditions, before returning to a 4 –5% growth rate by 2014–15 (World Bank, 2012).

In the "*Moldova 2020, National Development Strategy: 7 Solutions for Economic Growth and Poverty Reduction*" that was published in 2011, the economic growth forecast for the time period 2012-2020 is based on the average rates of economic growth during the decade 2000-2010. The base case scenario of this document estimates an average annual GDP growth of 4,7% during 2012-2020 (NDS, 2012-2020, 2011).

For the *BAU scenario* the GDP growth rate follows the projections of table 2 and remains constant until year 2050 based on the projections of this table.

Sectors

Due to the global economic crisis in 2009 industrial production declined by 21%, agricultural output declined by 10%, investment halved and private consumption fell by 8% (BSTDB, 2011; European Commission, 2010). At the end of year 2010, the largest share of employment was attributed to the state services (public administration, health, education, etc) (24% of total employment), followed by agriculture (22%), trade and catering (20%), industry (13%), transport and communications (6%), and construction (5%) (BSTDB, 2011). In 2011 there were positive signs for the Moldovan economy since the industrial production increased by 7,4%, agriculture by 4,6% and transportation by 16,8% (PWC and MIEPO, 2012).

For the BAU scenario the annual growth rate for the manufacturing-industry sector is 2,5%.

Agriculture

It is one of the largest national sectors with significant contribution to the economy (World Bank, 2012). In 2010 its share to GDP was 12%, while considering its combined share to GDP along with the food processing industry it climes up to 17% (UN, 2011). Its importance is validated by the dominate share of agro-food exports, which are 45–50% of total exports (World Bank, 2012). Half of the production is being exported (UN, 2011). The export-oriented agro-processing industry supports this share since it produces most of the agro-food exports and adds approximately 7–8% to the GDP (World Bank, 2012). Agriculture production is expected to have a high growth potential since it was 8% in 2010, but it is vulnerable to climatic risks (UN, 2011).

For the BAU scenario the annual growth rate for this sector is 1,5%.

[42] Remittances have proved to be a powerful anchor for the Moldovan economy by contributing to 36,2% of GDP in 2007 and above 2 billion USD for salaries earned from abroad for 2008 (Energy Charter Secretariat, 2011).

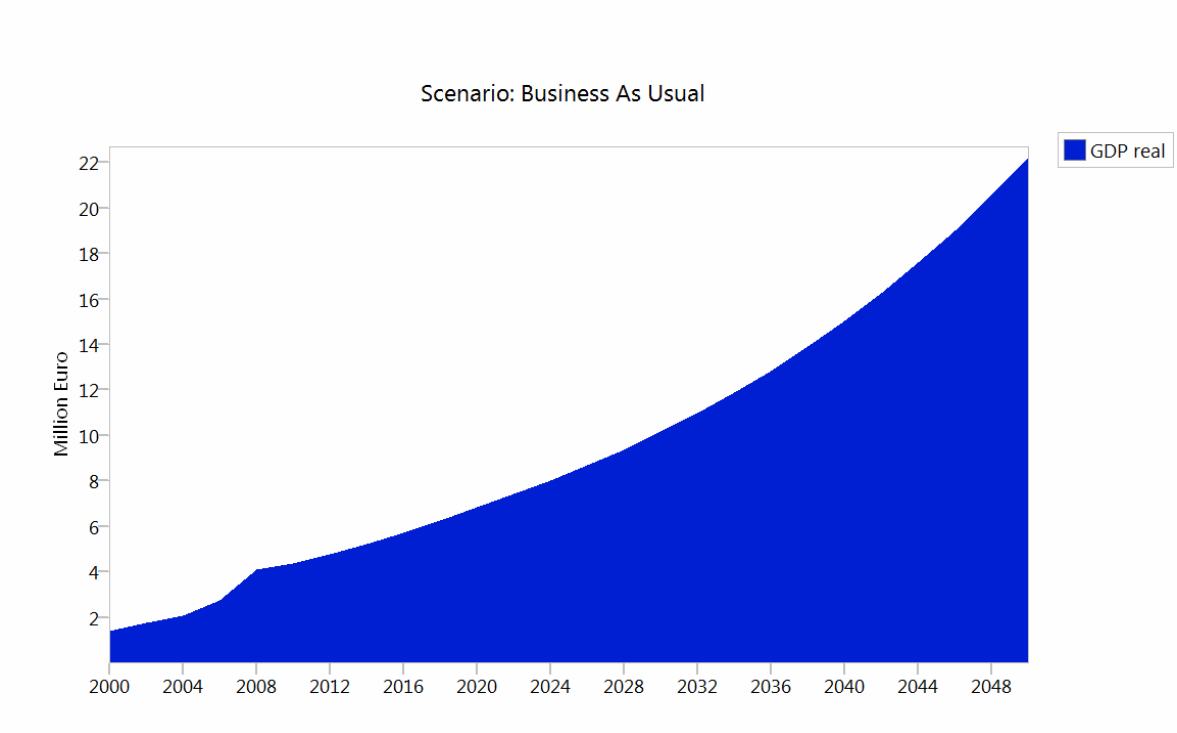

Figure 2: Economy: GDP real.

GDP per capita

Projections of this key driver are based on those of GDP and population. LEAP calculates them automatically based on the projections of the other two key drivers as they are defined for each scenario.

GDP distribution per sector

The GDP distribution per sector was based on the historical data. This distribution was assumed the same for the BAU scenario.

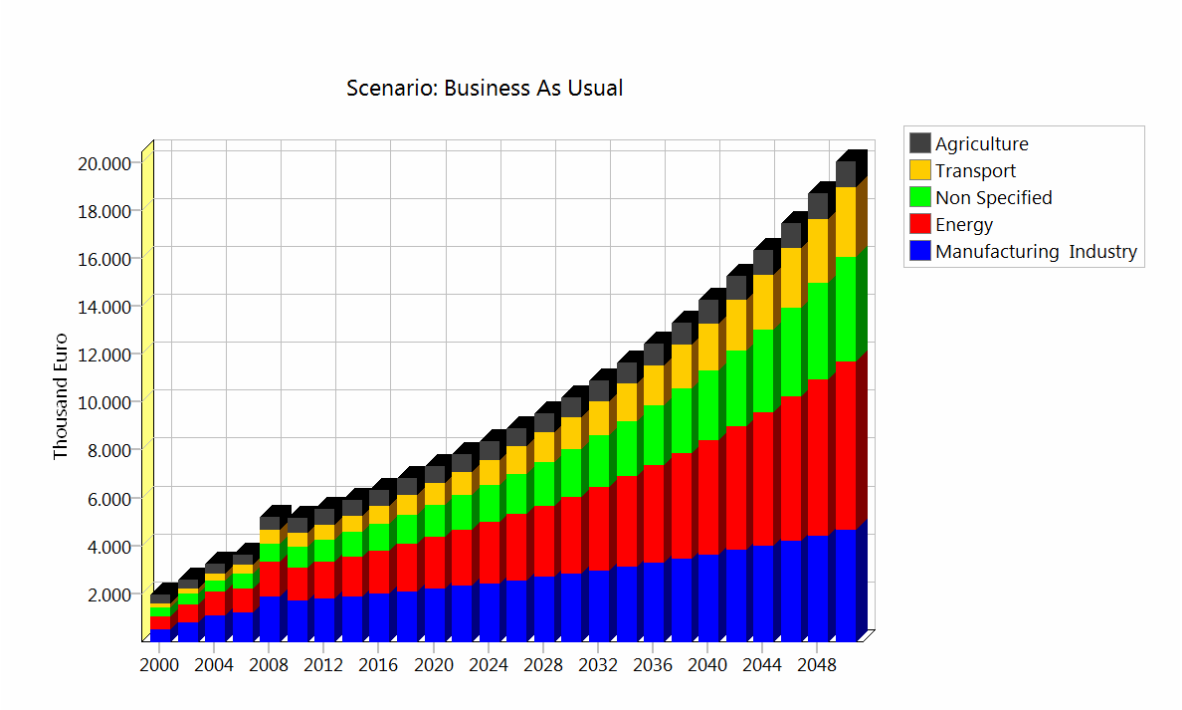

Figure 3: GDP distribution per sector.

Average annual household income

There is an increase during the decade 2000-2010, while the last two years there is a slight decrease. The growth rate of this variable is assumed to follow its historical growth due to the strong contribution of remittances.

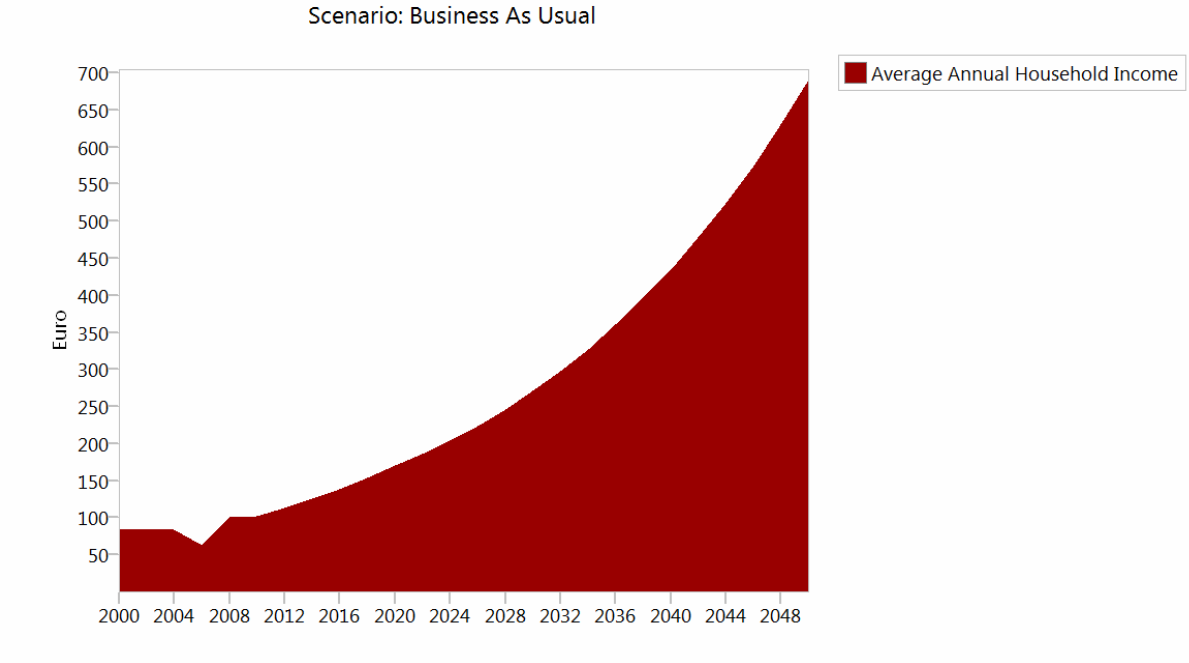

Figure 4: Average annual household income.

Gini coefficient

The data on the Gini coefficient will be used for assessment of policy portfolios in AMS method.

Climate Statistics

Precipitation

Precipitation mainly occurs in the form of rainfall, whereas snow accounts only of 10% of the total precipitation (UNECE, 2009). Between 1950 and 2001 the level of precipitation in Moldova hardly changed. Only an insignificant reduction of 0,003% per year was registered (ENVSEC, Zoi environment network, 2012). However, high variability within and between different years was noted (ENVSEC, Zoi environment network, 2012).

An expected annual decrease of precipitation will occur, against a temperature increase (UNDP, 2009). Moderate increases in precipitation are expected in winter and spring, while summer and autumn precipitation trends are mainly negative (20-30% decrease by the 2080s) (Ministry of Environment of the Republic of Moldova, 2011).

For the BAU scenario the insignificant reduction is assumed to continue. The annual growth rate for this scenario is -0,003%.

Temperature

In Moldova the average annual air temperature for the decade 1997-2007, increased by 0,6°C compared to that for the time period 1985-1996 (ENVSEC, Zoi environment network, 2012).

The annual air temperature of the country is expected to increase according to emission scenarios developed for the General Circulation Model (GCM) (UNDP, 2009). The increase is estimated on average to be at 1,7 to 2,0°C in the near term (approximately by 2040), and by the end of this century at 4,1 to 5,4 °C (Ministry of Environment of the Republic of Moldova, 2011; UNDP, 2009; SNC, 2009). Depending on the GCM experiment, these values vary from 1°C to 6 °C and are in the range of temperature change estimations for Europe (UNDP Moldova, 2012; UNDP, 2009).

For the BAU scenario the assumption is that the temperature will increase by 2,2^{o}C up to 2050.

Extreme events

Extreme weather events will probably become more frequent in the future. Projections for Moldova suggest that absolute maximum temperatures under the baseline climate (34-35°C) that were considered as extreme rare events will possibly become mean maximum summer temperatures (Ministry of Environment of the Republic of Moldova, 2011).

Flash floods

During the past 70 years, 10 major floods of rivers within the Republic of Moldova (Dniester and Prut) were reported, and three of those occurred in the last decade (2006, 2008 and 2010). Large floods on smaller rivers in the country are also quite common (Ministry of Environment of the Republic of Moldova, 2011).

Particularly, the floods during the summer of 2010 were estimated of causing damage and losses of 537 million MDL in total (0,7% of the GDP), or 42 million USD (Republic of Moldova, 2012). Mainly the infrastructure sector (66% of total damages), and the productive sector (25% of the total damages) sustained losses (Republic of Moldova, 2012).

For the time period 1992-2005 the frequency of events during which heavy rains resulted in frequent floods was on average 1,2 per year (UNDP Moldova, 2012).

For BAU the frequency of flash floods is expected to continue its growth rate according to historical data.

Heat waves

The frequency of heat waves increased during the decade 2000-2010 (Ministry of Environment of the Republic of Moldova, 2011). The number of days with temperatures above 30°C or 35°C has also grown over the last decade (ENVSEC, Zoi environment network, 2012).

The frequency of droughts is also increasing, with significant impacts on lives and livelihoods. During the time interval 1990–2011, 10 years (1990, 1992, 1994, 1996, 1999, 2000, 2001, 2003, 2007 and 2011) were specifically marked by droughts of different intensity. All cases led to a significant reduction in crop yields. For the years 1990, 1992 and 2003, the droughts continued during the entire vegetation period (April-September), while for other years the droughts occurred in summer (Ministry of Environment of the Republic of Moldova, 2011). The catastrophic drought of 2007 covered 80% of the country and caused economic damage valued at 1 billion USD (ENVSEC, Zoi environment network, 2012; UNECE, 2009).

Since no other information is available the assumption for the BAU scenario is that the frequency of heat waves will be 20 in 2050.

Frost days

The number of frost days is projected to reduce greatly, leading to the increase of the length of the growing period across the whole country. This reduction in frost days will provide opportunities for crop distribution changes and longer-season varieties, if these are exploited (World Bank, 2010).

No other information is available. For the BAU scenario it is assumed that frost days are reduced following the in absolute terms the growth rate of heat waves. In 2050 their number will be 6.

Policies and Measures

Feed – in – tariff system

The Moldovan National Agency for energy Regulation adopted Decision No 389 of 11.11.2010 on tariffs for electricity produced from RES. For the BAU scenario feed-in-tariffs follow the international trends of the costs for the respective RES technologies.

Subsidies

All necessary information is presented in the policy portfolio of this scenario.

Land management

All necessary information is presented in the policy portfolio of this scenario.

Surface of arable land

No available information.

Surface of forest land

As aforementioned forestry sector is an important sector for Moldova economy. There is also an objective to increase its surface until 485,3 thousand ha by 2030 (33,8%) (Moldova

SNC, 2009). Based on the information presented in the session about the adaptation needs of the country, the surface of forest land is assumed to increase annually by 1%.

Global trends

Crude oil price

Projections for the crude oil prices regarding the Reference scenario of the IEA, World Energy Outlook 2010 will be used.

Coal price

For the coal prices the following forecasts are encountered in the relevant literature: Coal prices increase from 65$ per tonne in 2006 to 120$ in 2015, then fall to 85$ in 2030, compared with 110$ in 2030 in the Reference Scenario — a reduction of 23%.

Natural gas price

Natural gas will remain an important fuel in all sectors in 2050. Analysts are now expecting prices in the 3,75-4,75 $/Million BTU range for 2013-2014 and 6,77 $/Million BTU in 2030 (Henry Hub, 2012).

EUA price

Projections about the EUA price will be used based on the relevant literature.

ERU price

The average CER price was 18€/tCO_2 based on the first 11 months of 2008 (Rotfub W. et al., 2009). The same growth rates that are adopted for the EUA price will be used for the CER price also.

Adaptation

Water Use

Water availability is expected to be reduced due to climate change, while irrigation withdrawals are expected to increase in Eastern Europe river basins (DG Environment, 2007). Under mid-range assumptions on temperature and precipitation changes, water availability is expected to decline in Eastern Europe (by 10% or more in some river basins by 2030) (DG Environment, 2007).

Moldova's available ground water capacity was approximately 3465 thousand m^3 per day as at 01.01.2007. This amount includes the approved ground water sources with total capacity of 2198,5 thousand m^3 per day (UNECE, 2009).

Water use for irrigation

In the mid of the decade of 1990, within 5–6 years, irrigated areas decreased by more than 80 times, and were 1,7% of the previously irrigated area (Sirodev G. I., 2010). Recent and actual economic conditions along with natural processes on the availability of water for agriculture (including natural humidity and artificial watering), led to the reduction of the productivity of main crops – wheat and corn – over the last years by almost 5% (Sirodev G. I., 2010). The use of water for irrigation purposes has been decreasing by 9% per year, while the volume of water used for watering every hectare of irrigated field has been decreasing by 8% per year (Sirodev G. I., 2010).

For the BAU scenario the assumption is that the growth rate for this type of water use follows the historical growth.

Energy Demand

Households

In 1997, the residential sector accounted for 35,4% of all the energy consumed, while in 2007 the share rose to 38% (Republic of Moldova, 2012). Buildings account for about 50% of the thermal energy consumed, 38% of the gas, and 31% of the electric energy (Republic of Moldova, 2012). Simultaneously, the majority of the buildings is not properly heated and cooled (Republic of Moldova, 2012).

Consumption of electric energy represents 14% of the total energy that is consumed in the households' sector (Republic of Moldova, 2012). Households consume in total approximately 40% of the total electric power that is delivered and it is expected to increase (Republic of Moldova, 2012). The main cause of this trend is the growing number of energy-consuming home appliances, especially air-conditioners and refrigerators (Republic of Moldova, 2012).

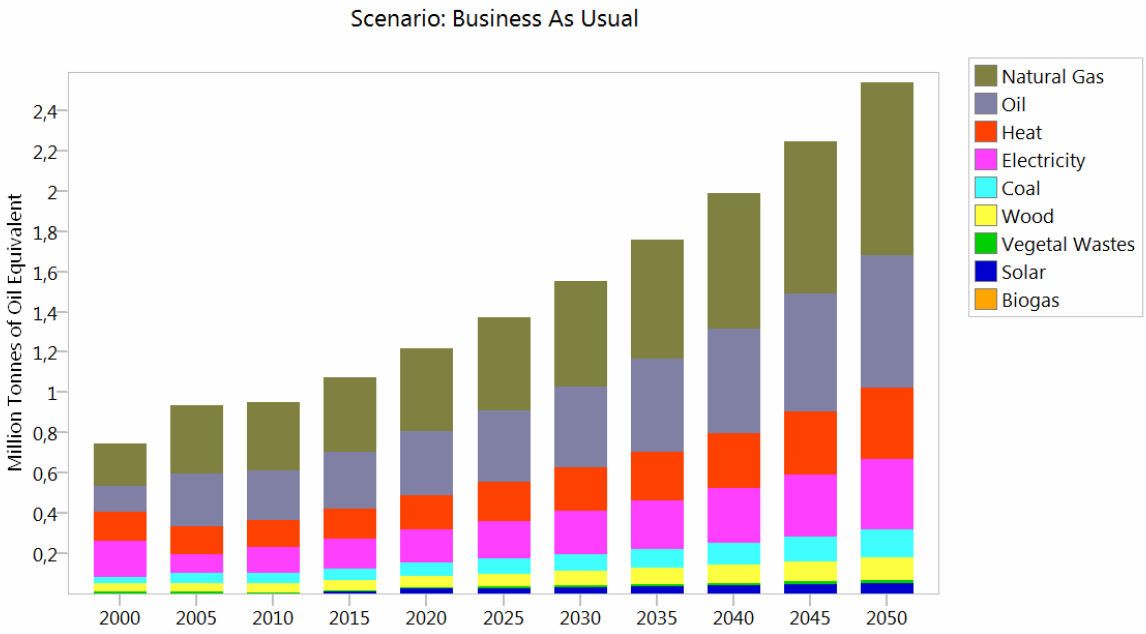

Figure 5: Final Energy Demand in Household Sector, mln toe.

Agriculture

Agriculture has a significant contribution to the national economy, but has a small share in the final consumption of commercial energies (4%) (UNECE, 2009b). The assumption for the growth rate of energy demand in the BAU scenario is that it follows its respective growth rate as described in the session for Economy. Fuel shares are considered to be the same across the years since no policy instrument is applied.

The evolution of the agricultural energy demand is shown in Figure 6.

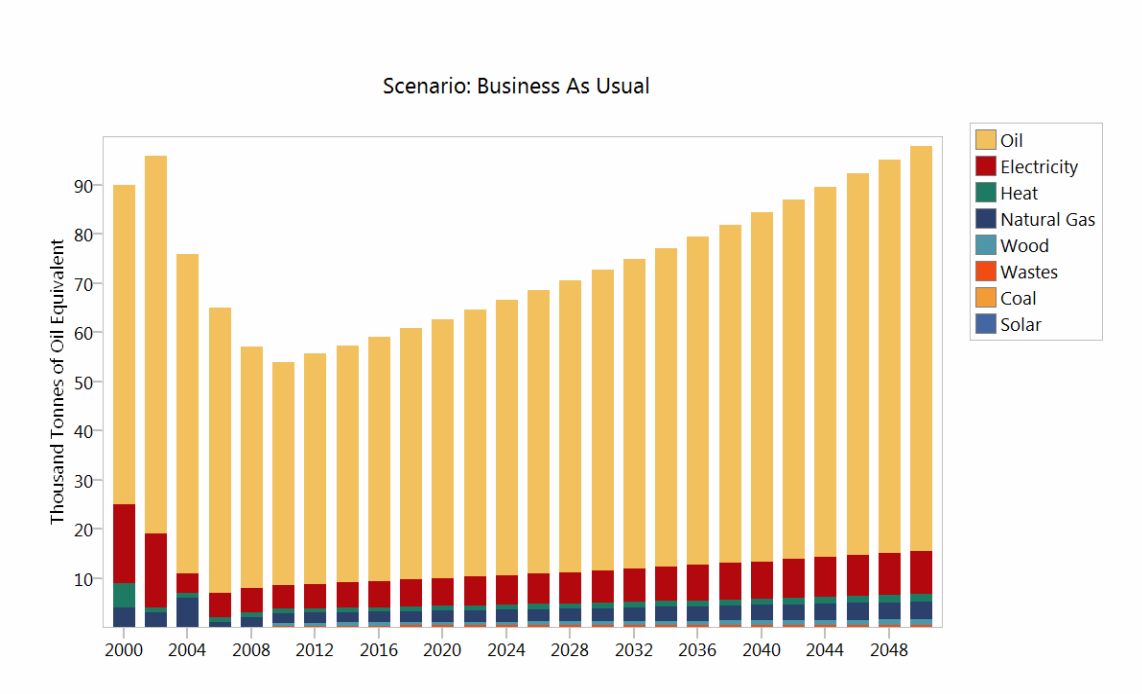

Figure 6: Final Energy Demand in Agriculture Sector, th. toe.

Industry

Due to lack of data for the activity level the industrial energy demand was divided in two sectors: Industry and Construction, so as to facilitate the calculations in the model.

Assumptions for BAU: growth rate of activity level and growth rate of energy demand equal to its respective growth rate described in the session of Economy. Fuel shares are considered steady since no policy instrument is applied.

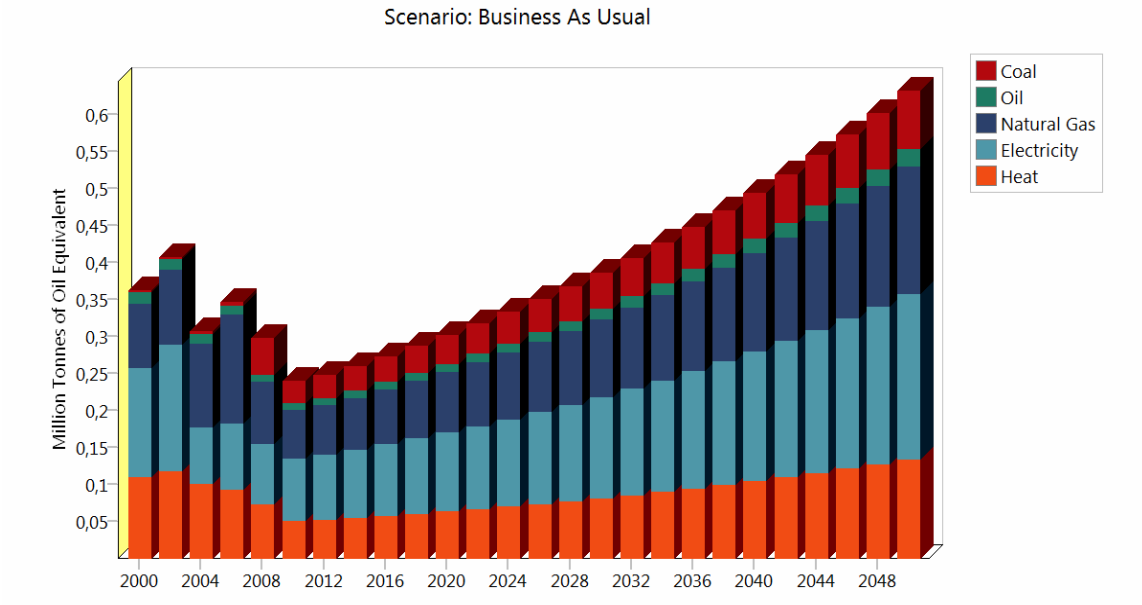

Figure 7: Final Energy Demand in Industrial Sector, mln toe.

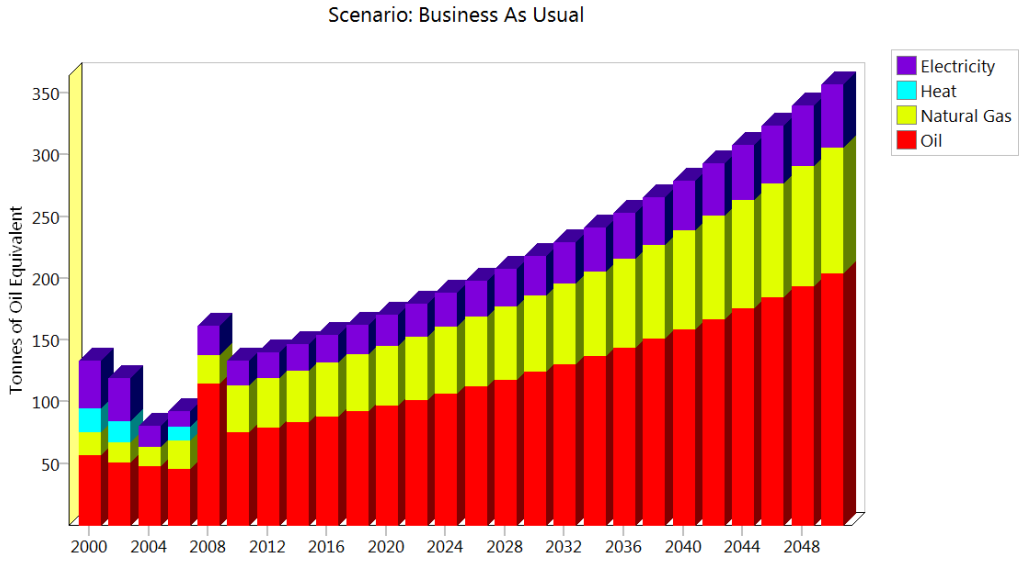

Figure 8: Final Energy Demand in Construction Subsector, toe.

Transport

Assumptions for *BAU Scenario:* growth rate of energy demand equal to growth rate of GDP. Since no policy measure is expected to be taken concerning energy savings or fuel switch, the energy demand is expected to increase following the trend of real GDP.

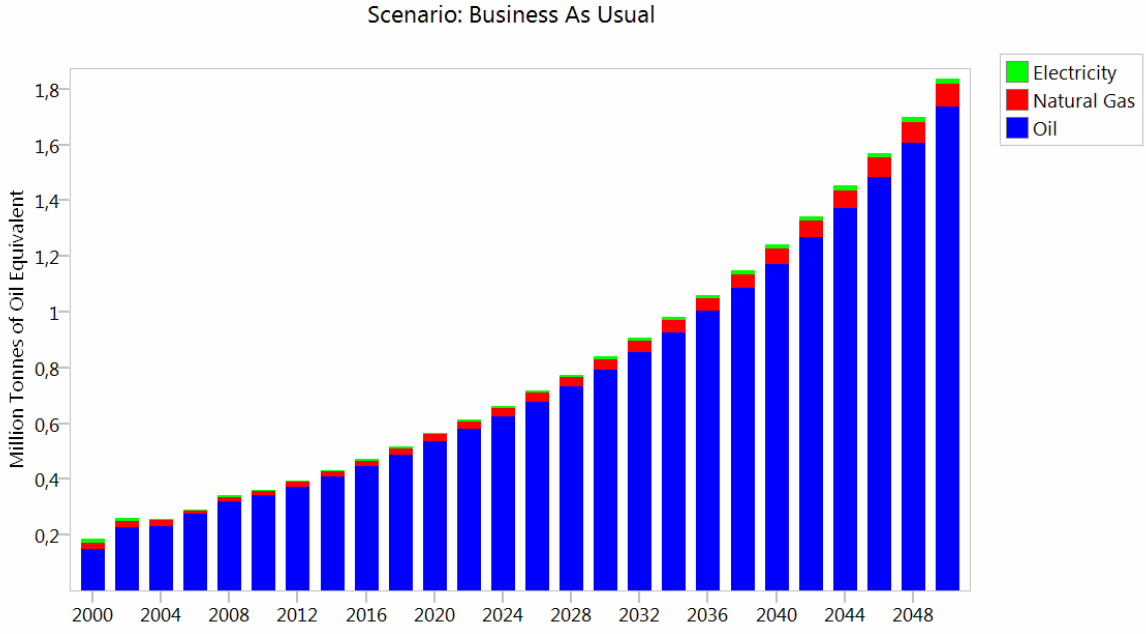

Figure 9: Final Energy Demand in Transport Sector, mln toe.

Oil remains the main fuel among used in the transport sector. Natural gas will record slow penetration into the structure of conventional fuels used in this sector.

Non Specified

For the purpose of this report the activity level and the energy data for non energy sector include: services, wholesale and retail trade, government, financial, professional, and personal services such as education, health care, real estate services, imputed bank service charges, import duties, and any statistical discrepancies.

Assumption for BAU is the same with the household sector due to the inclusion of services in this branch.

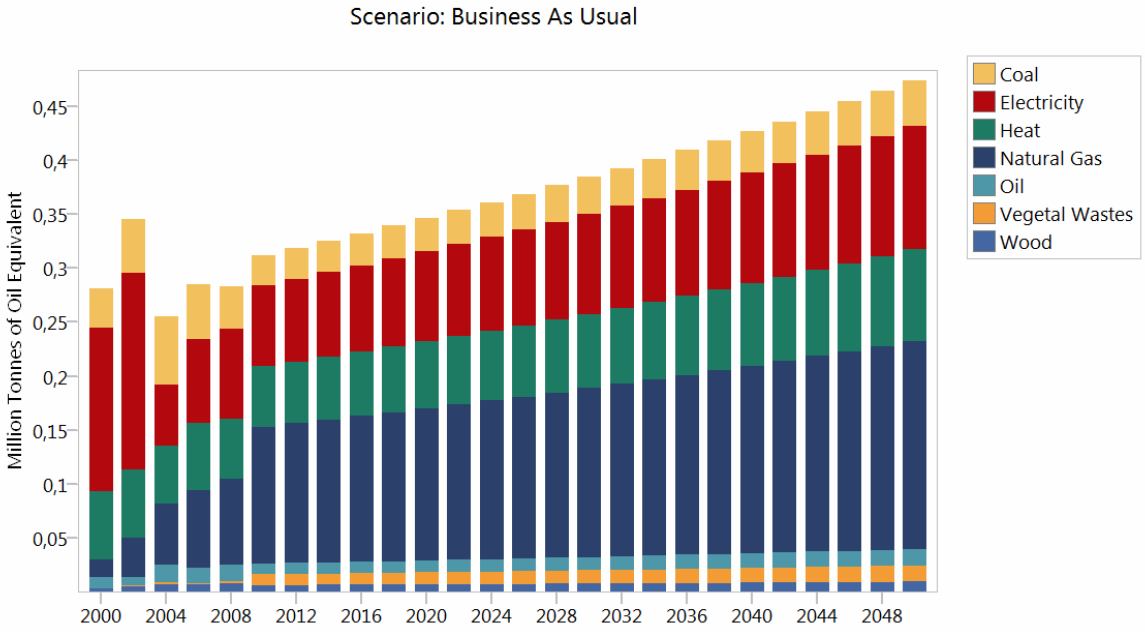

Figure 10: Final Energy Demand in Non Specified Sector, mln toe.

Transformation

Transmission and Distribution losses

In 2008 the share of technological and commercial losses at the distribution level was 14,5% decreased by 1,2% compared to the previous year 2007 (UNECE, 2009a; 2009b). The losses of the distribution companies that were submitted to the National Agency for Energy Regulation (ANRE) for 2008 amounted to 10,97% for RED North, 13,59% for RED North-West and 15,38% for RED Union Fenosa (UNECE, 2009). The total energy transmission and distribution losses range at 15-25% (UNECE, 2009).

Electricity distribution losses are still high and equal to 13,1% (ANRE, 2011). Electric power transmission and distribution losses include losses in transmission between sources of supply and points of distribution and in the distribution to consumers, including pilferage.

Assuming that: i) no modernization is planned neither for the power nor for the natural gas grid infrastructure and ii) that the equipment is "aging", the growth rate of T&D losses is set at +0,05% for the BAU scenario.

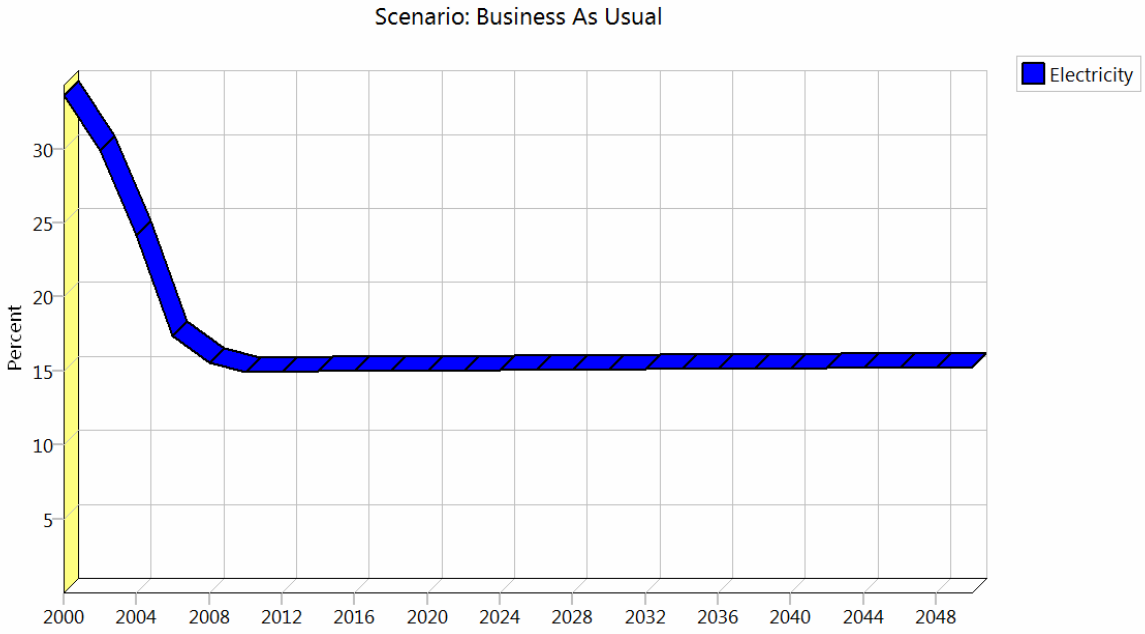

Figure 11: Transmission and distribution losses.

Electricity generation

Electricity production decreased by 15% in 2010 compared to 2001 (NSD, 2011). The largest share of electricity production – approximately 70-80% - for 2010 was from CHP-2 (NSD, 2011).

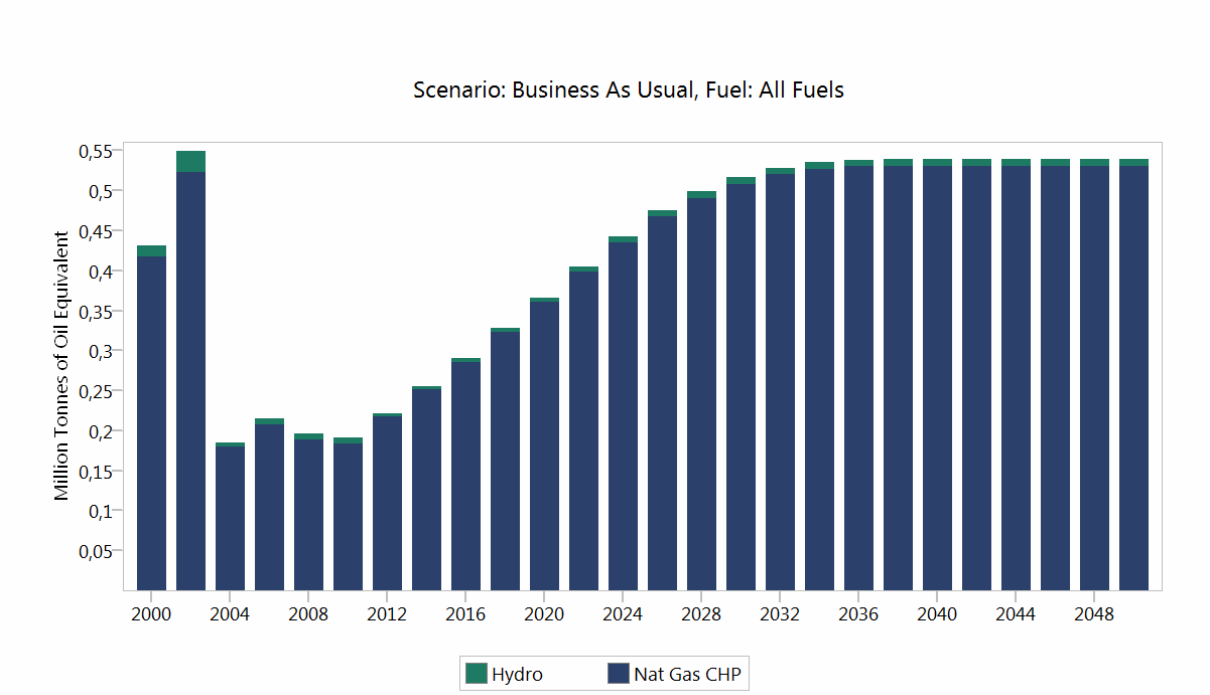

Figure 12: Electricity generation, mln. toe.

Heat production

In 2010, heat production increased approximately by 9% compared to 2009, but was reduced by 12,8% compared to 2001 (NSD, 2011). The largest share of heating – approximately 60-65% - was produced in 2010 by CHPs (NSD, 2011).

The heating index[43] is quite small at the CHP-1, CHP-North and at CHPs of sugar factories. It is indicative that in 1990 the total thermal capacity for the country was 16,8 GW, while the thermal capacity of the adjustable plugs and counter-pressure turbines from the public CHPs and CHPs of the sugar factories was only 1,7 GW (UNECE, 2009b).

[43] ratio between the installed thermal capacity of the installations that function in the co-generation cycle and the total thermal capacity (co-generation plus hot water boilers)

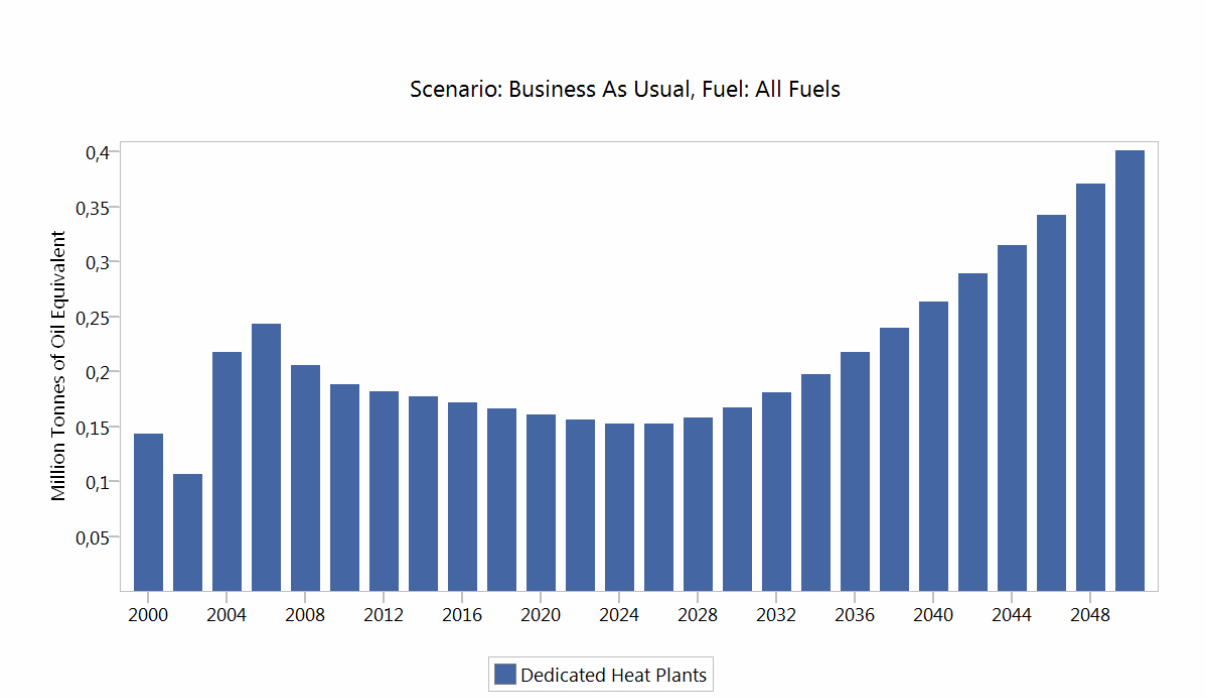

Figure 13: Heat production, mln. toe.

Gas Works

No data available about Gas Works.

Oil Refining

Moldova is a net oil importer, depending primarily on Russia for most of its supply. For BAU scenario the energy demand of the oil refining sector is assumed stable.

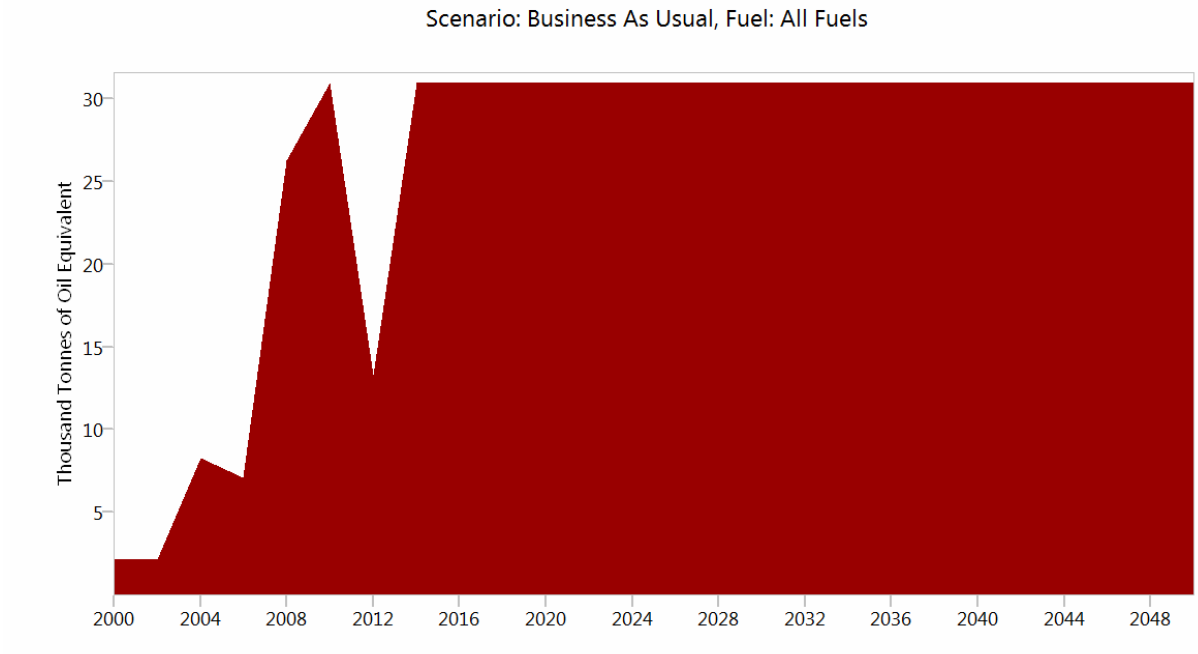

Figure 14: Transformation: Oil Refining, th. toe.

Global warming potential (GHG emissions)

Figure 17 shows that the annual Global Warming Potential (GWP) in CO_2eq of the country amounts to 7,953 MtCO_2eq in 2000, and will reach 25,549 MtCO_2eq in 2050.

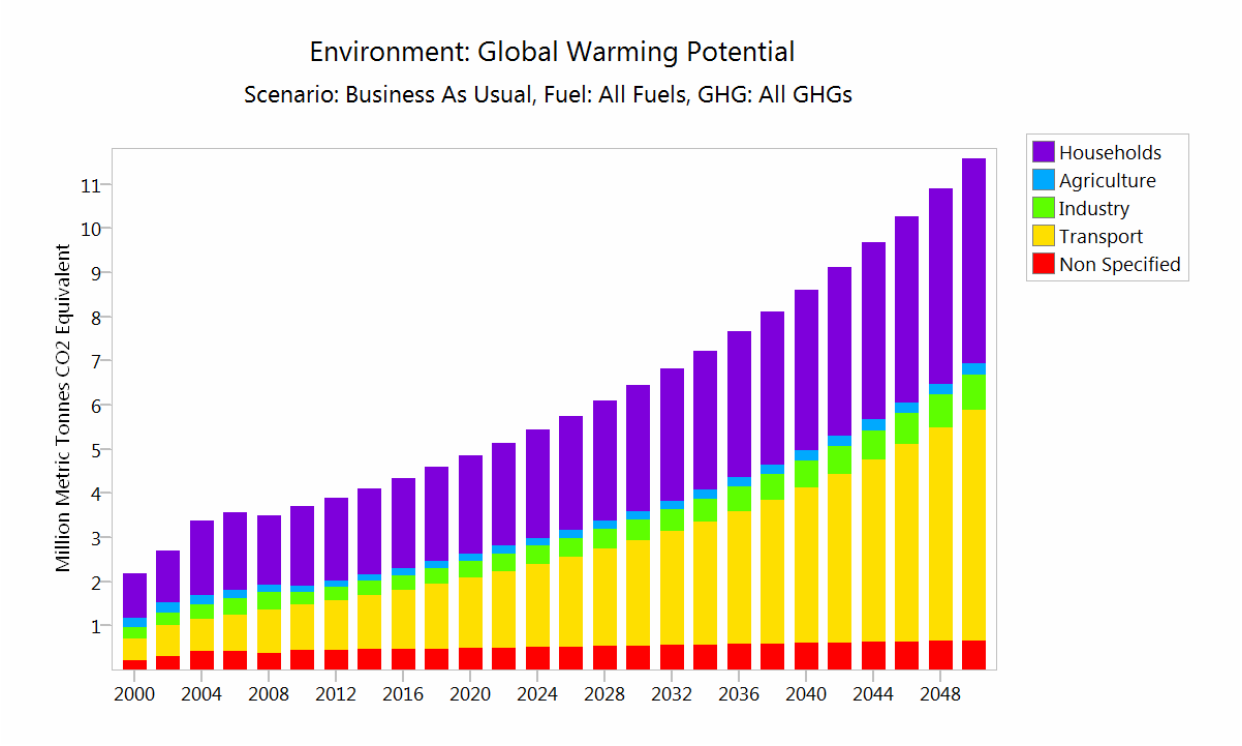

Figure 15: Global Warming Potential per Sector, mln metric tonnes CO_2 eq.

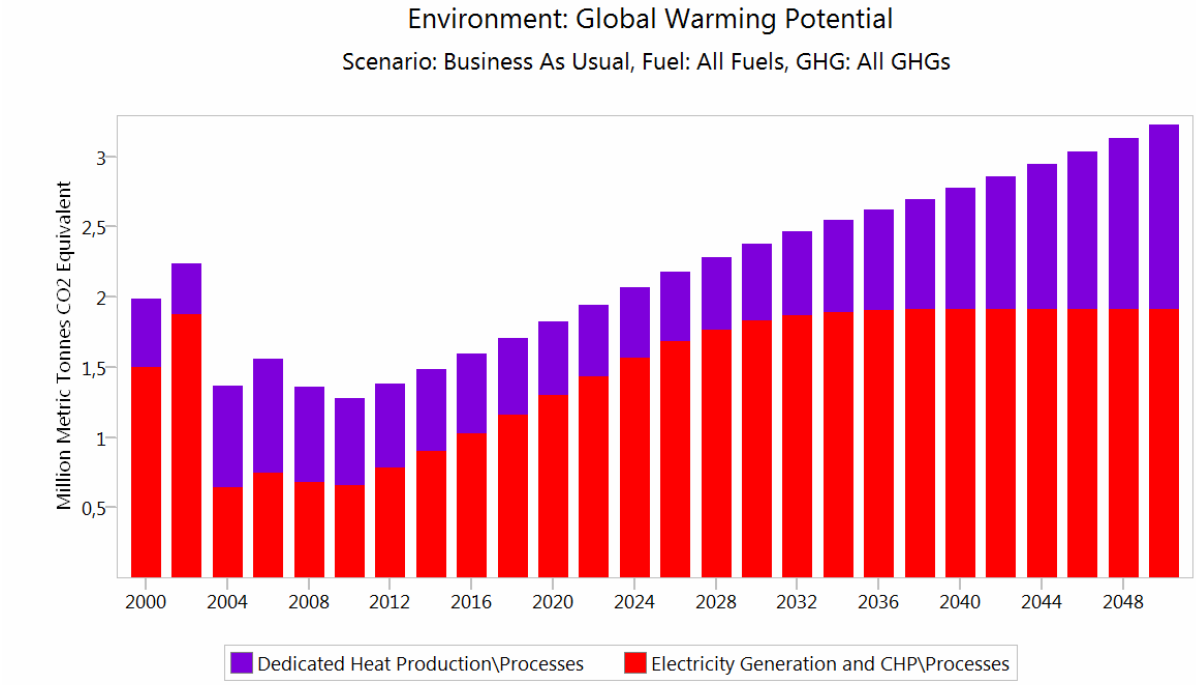

Figure 16: Global Warming Potential in Transformation, mln metric tonnes CO_2 eq.

The non – energy sector concerns the emission sources and sinks attributed to land use change, agriculture and forestry. No data on the emissions of methane due to waste are presented.

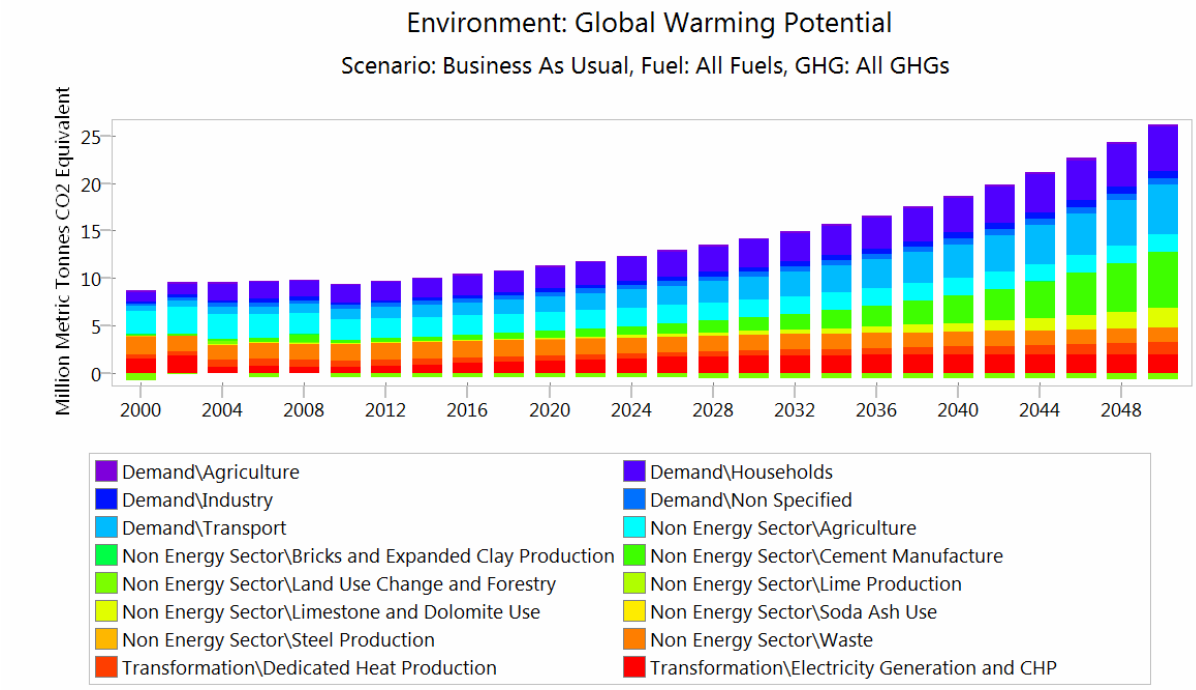

Figure 17: Global Warming Potential, mln metric tonnes CO_2 eq.

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OPTIMISTIC SCENARIO (2000 – 2050)

Optimistic scenario description

General comments

The integration of the country into the EU is one of its priorities (PWC and MIEPO, 2012). The first step for this objective was the signature of the Partnership and Co-operation Agreement on 28 November 1994 by the EU and the Republic of Moldova. The Agreement came into force four years later (PWC and MIEPO, 2012). In February 2005 the Republic of Moldova and the EU signed the Action Plan that for three years that followed defined the strategic objectives of the cooperation between Moldova and the EU (PWC and MIEPO, 2012).

These efforts resulted to the following activities and priorities. Environmental, climate change and energy-related considerations are key elements of the sustainable development approach developed by the Moldovan government in the National Development Strategy 2008 and stated in the National Indicative Programme of the European Neighbourhood and Partnership Instrument for the country regarding the time period 2011-2013 (EC, External Relations Directorate – General, 2011).

Key environmental issues are related to water resources and waste management, the state of the environmental infrastructure, soil degradation, air pollution and nature protection (EC, External Relations Directorate – General, 2011). The main problem for enhancing strategic planning, implementation and enforcement of environmental legislation, is the reinforcement of administrative capacity at national, regional and local level (EC, External Relations Directorate – General, 2011).

Moldova will receive for addressing its key priorities 273,14 million € from the European Neighbourhood and Partnership Instrument (ENPI) for the period. 2011-2013. One of the three Priority Areas[44] is "Trade and sustainable development" that will receive a share of 35-40% of the aforementioned amount. This Priority area concerns *Environment & energy efficiency / renewable energy and Diversification* (EC, External Relations Directorate – General, 2011). By strengthening administrative capacity at national, regional and local level the country will be able to: i) implement and enforce its environmental legislation, including regional and international multilateral agreements; ii) converge with EU legislation and policy approaches on energy and climate change issues. Particularly regarding energy efficiency and renewable energy laws, regulations, standards and best practices (through also the Energy Community Treaty).

Regarding convergence the Ministry of Economy has set a time frame for the liberalization of the Moldovan electricity market by 2015 and not earlier because of unsolved technical issues regarding the transmission and dispatching company Moldelectrica (UNECE, 2009). Approximately 10% of the total electricity demand is from the consumption of eligible consumers, who are directly connected to the highest voltage level and procure their energy on negotiated contracts (UNECE, 2009).

Under such a perspective this scenario will be consistent with the EU climate change policy. This scenario is linked with stringent climate policy options and relatively high need for adaptation policy instruments to handle climate change impacts for Moldova. The whole spectrum of mitigation options and adaptation needs as presented in the previous sessions will be taken into account. The main characteristics of this policy portfolio is the promotion of Renewable Energy Sources, the introduction of energy efficiency measures in all sectors, the encouragement of investments through the Clean Development Mechanism, the implementation of adaptation activities.

[44] The other two are: Good governance, rule of law and fundamental freedoms and Social and human development

Policy portfolio for this scenario

Mitigation

A. Existing policy instruments

For RES

Law on Regulating Entrepreneurial Activity through Licensing (451-XV/ 30.06.2001, amended Published: 04.03.2011 in Official Gazette No. 34-36 art No. 7: date of coming into force: 18.02.2011)[45]

The old version of the Law regulated general requirements on licensing without specifying RES. The new law concerns also investments for RES due to the creation of free zones in order to accelerate socio-economic development of certain territories and the country as a whole by domestic and foreign investment attraction, implementation of modern technologies and equipment, the development of export-oriented production, etc.

For Energy Efficiency

Decision No. 401, Date: 12.06.2012

This Decision concerns the activities of the Energy Efficiency Fund.

Law "Decreasing the energy consumption through energy efficiency and RES usage"

It is considered as crucial. It was approved after 01.01.2011 and is partly in line with the Renewable Energy Sources Directive (2009/ (SEC(2011) 1028). Through this Law Moldova can attempt to fully exploit its RES potential in biomass, hydropower, geothermal, wind and solar energy.

Dissemination policy instruments

An awareness campaign was scheduled for 2012 regarding energy efficiency issues[46].

B. Additional policy instruments

For RES

Financial policy instruments - New Feed-in-tariffs and subsidies

There are proposals for replacing the existing Methodology for RES tariffs calculations[47] by Feed-in- incentives (V. Parlicov, 2012[48]) and subsidy programs[49]. Feed-in-tariffs at higher prices will support more the usage of RES.

No concrete level of subsidies is considered for promoting investments in Moldova for all types of RES up to now. For the purposes of this scenario subsidies are set to 10% of the capital cost of the RES investment.

Incorporation of EU Directives into national legislation

Moldova has to provide an implementation plan for the national renewable energy development, covered by the Directives (2001/77/EC and 2003/30/EC) and later on amending

[45] http://lex.justice.md/index.php?action=view&view=doc&lang=1&id=324901 and http://lex.justice.md/md/337739/

[46] http://www.energy-community.org/pls/portal/docs/1274193.PDF

[47] Methodology for the determination, approval and application of tariffs for the electricity generated from renewable sources and for bio-fuel. Official Monitor no 45-46 from 27.02.09. http://lex.justice.md/

[48] www.cnr-cme.ro/foren2012/PPT/.../VICTOR%20PARLICOV.pdf

[49] Energy Efficiency Fund. GD no 401 from 12.06.12, Official Monitor no 126-129 from 22.06.12

new EU Renewable Energy Directive 2009/28/EC, with a mandatory target of 20% of RES by 2020 (Ministry of Economy of the Republic of Moldova, 2012).

For Energy efficiency

Due to the insufficient operation of existing CHPs, their tariff is high, showing that they will not be viable for the future. For the period 2007–2008, there was a decrease in heat supplied because consumers preferred gas, coal, and wood (Ministry of Economy of the Republic of Moldova, 2012). This behaviour change had a negative impact on the municipal heat supply system CHP and energy generation (Ministry of Economy of the Republic of Moldova, 2012). Therefore energy efficiency standards are needed and best available technologies (BAT) are required.

Regulatory policy instruments

In 2012 the Ministry of Regional Development and Construction elaborated both the draft Law for Energy Efficiency in buildings[50] and the Moldova Road Map for energy efficiency in the buildings[51]. They are in the process of public consultation and are oriented to transpose Directive 2010/31/EU.

The Energy Efficiency Fund will receive from the national budget the 10% of the amount contributed by donors[52] (Ministry of Economy of the Republic of Moldova, 2012; NEEP, 2011). The Fund recipients (households, industries, commercial sector, municipalities and ESCO) will be able to proceed with grants and loans at a reduced rate of interest for energy efficient projects (Ministry of Economy of the Republic of Moldova, 2012; NEEP, 2011).

Incorporation of EU Directives into national legislation

Moldova as an Energy Community member will implement the following European Commission Directives (Decision No 2010/02/MC-En-C of 24 September 2010 updated the acquis by amending Decision 2009/05/MC-En-C of 18 December 2009 (Ministry of Economy of the Republic of Moldova, 2012):

- Directive 2010/30/EU[53] on the indication by labeling and standard product information of the consumption of energy and other resources by energy-related products;
- Directive 94/2/EC implementing Council Directive 92/75/EEC regarding energy labeling of household electric refrigerators, freezers and their combinations, as amended by Commission Directive 2003/66/EC ("Directive 94/2/EC");
- Directive 95/12/EC implementing Council Directive 92/75/EEC regarding energy labeling of household washing machines, as amended by Commission Directive 96/89/EC ("Directive 951121 EC");
- Directive 95/13/EC implementing Council Directive 92/75/EEC regarding energy labeling of household electric tumble driers ("Directive 95/13/EC");
- Directive 96/60/EC implementing Council Directive 92175/EEC regarding energy labeling of household combined washer-driers ("Directive 96/60/EC");
- Directive 97/17/EC implementing Council Directive 92/75/EEC regarding energy labeling of household dishwashers, as amended by Commission Directive 1 999/9/EC ("Directive 97/17/EC")' ;

[50] http://www.particip.gov.md/proiectview.php?l=ro&idd=345

[51] http://www.google.md/url?sa=t&rct=j&q=eficienta%20energetica%20a%20cladirilor%20moldova&source=web&cd=6&cad=rja&ved=0CFQQFjAF&url=http%3A%2F%2Fwww.cnp.md%2Fen%2Fworking-groups%2Feconomic-development%2Fitem%2Fdownload%2F805&ei=-YEvUIWvIcnCswanwYGQDQ&usg=AFQjCNFIEHb2D38lOS_4XEfjxUONAiWmaQ

[52] Sweden, EBRD, EU Delegation in Moldova, Giz, UNDP, USAID, World Bank, Regional initiatives and Programs (Ministry of Economy of the Republic of Moldova, 2012)

[53] http://eur-ex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0001:01:en:HTMLl

- Directive 98/11/EC implementing Council Directive 9217tlEEC regard to energy labeling of household lamps ("Directive 98/11/EC");
- Directive 2002/31/EC implementing Council Directive 92/75/EEC regarding energy labeling of household air-conditioners ("Directive 2002/31/EC"):
- Directive 2002/40/EC implementing Council Directive 92/75/EEC regarding energy labeling of household electric ovens ("Directive 2O02/40/EC");

For the industrial sector

According to the National Energy Efficiency Program two policy instruments are under consideration for this sector (NEEP, 2011). Long term voluntary agreements are estimated to result into 10-20% energy savings through the development of an action plan oriented to industrial energy efficiency (NEEP, 2011). The government is also examining the case of setting into force a system of "White certificates". Both policy instruments will be linked with dissemination of information and training on energy management (NEEP, 2011).

For the transport sector

Regulatory policy instruments

96% of the country roads are considered bad and very bad (estimation from the year 2006, NDS Moldova 2020) and such roads lead to up 20% of GHG increase (NDS Moldova 2020). That is why road rebuilding is considered one of the main national development priorities (NDS Moldova 2020). By 2015 it is planned to rehabilitate 900 km of roads and by 2020 – 1900 km of roads, so that by 2020 the roads qualified as very good to constitute 38% and as good – 42% (NDS Moldova 2020). In order to reach this goal, the Transport Fund was established (Law no 138 from 29.12.2009). For 2010 580 million lei (36 million Euro) were allocated from the country budget. In 2011-780 million lei (49 million Euro).

In order to consolidate transport connections with neighbor to EU regions from East and South, at the moment European Commission is implementing the new Action Plan in the framework of EU Transport Neighbourhood Policy. The Plan propose more than 20 concrete measures for short and long terms, having the goal to make the transport relations more homogenous, more secure and viable[54].

Energy efficiency standards

Policy instruments for improving energy efficiency of transport modes and vehicle technology can be used. This option is also consistent with the Moldova priorities in climate change policy since the vehicle fleet is old (Second National Communication of Moldova to UNFCCC, 2009). In Moldova 70% of the vehicle fleet is older than 10 years[55]. Additionally, the fuels used for vehicles are of quite low quality in Moldova[7].

The strategic direction in the transport sector is focused on: i) improving the traffic security and reduction of its environmental impact via legislative consolidation; ii) improving the transport system efficiency via rehabilitation of the land transport infrastructure and iii) implementing techniques and technologies that will reduce fuel consumption (SNC, 2009). These objectives are included in:

A) Consolidation of the Legislative and Regulatory Framework;

[54] http://moldova.azi.md/ro/story/19593

[55]http://www.google.md/url?sa=t&rct=j&q=varsta%20transportului%20in%20moldova&source=web&cd=3&cad=rja&ved=0CEoQFjAC&url=http%3A%2F%2Fwww.agir.ro%2Fbuletine%2F518.pdf&ei=ntovUIOtO8jusga8mYGYAQ&usg=AFQjCNEWU_VQE78Unb1p65XA_NMURIgwDw

B) Rehabilitation and Development of the Road Transport Infrastructure. According to Road Transport Infrastructure Strategy for 2008-2017 (Government Resolution No. 85 of 01.02.2008) the total costs for these purposes are assessed at 40,1 billion MDL (USD 3,2 billion);
C) Identification and Implementation of the Logistics and Technology Measures to Reduce Emissions.

Dissemination policy instruments

Introduction of eco-driving and setting of speed limits (EC, 2011c). Awareness campaigns (TV shows, radio, web site etc) and "green days" are also foreseen (Ministry of Economy of the Republic of Moldova, 2012; NEEP, 2011).

Financial policy instruments

Tax exemptions, subsidies or soft loans can be used for the promotion of new technologies in this sector (EC,2011c).

Policy instruments for promoting biofuels – transport and agricultural sectors

Alternative fuels such as biofuels are expected to contribute in fuel efficiency. This option can be implemented through regulatory instruments for the performance and maintenance of vehicles such as standards for CO_2 emissions, vehicle labeling for CO_2 emissions and fuel efficiency (EC, 2011c). The share of biofuel consumption is expected to reach the level of 6% for the transport sector in 2015 and of 12% in 2020 (NDS Moldova 2020).

Policy instruments for agricultural sector

The role of agriculture in national economy has declined in the past two decades (UNDP, 2009, 2009b). Particularly without subsidies and guaranteed access to the market which the sector had secured during the Soviet period, its share of GDP and its total labour force are shrinking. Between 1994 and 2006, this sector registered one of the most dramatic declines of output of all CIS and CEE countries (UNDP, 2009). This situation will worsen due to climate change even with minimum impacts.

Therefore, subsidies can be given for purchasing:
- New irrigation equipment;
- New plant species that can face climate change impacts.

Policy instruments for emission trading

EU ETS

All thermal power plants, larger heat plants in the district heating sector will fall under the scheme and will receive allowances. This will increase the operational cost of the entities, particularly for the electricity generation. On the other hand, investments in RES and energy efficiency will be encouraged.

Assuming emission reductions of 18% in Moldova, as some commentators suggest could be expected from improvements in the heat and power sector, would provide trading benefits.

CDM

According to the World Bank "Termocom" investment plan about 3 mln tones of CO_2 could be mitigated. Other sectors (e.g. Energy Efficiency) offer even bigger potentials[56].

[56]http://www.google.md/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=2&cad=rja&sqi=2&ved=0CEMQFjAB&url=http%3A%2F%2Fwww.get-moldau.de%2Fdownload%2Fpolicybriefings%2F2011%2FGET_Moldova_PB-09-

For Climate change policy related issues

Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants

It is to be implemented by 31 December 2017 (Ministry of Economy of the Republic of Moldova, 2012).

Policy instruments for promoting carbon capture and storage (CCS) technologies

Carbon capture and storage technologies are considered as an expensive component[57]. Since Moldova is an emerging economy these technologies were not considered as part of the policy portfolio.

Adaptation

Policy instruments for water management

For protection from floods Moldova will need to transpose into its legislation the Flood Directive (Directive 2007/ 60/EC on the assessment and management of flood risks[58]). This Directive aims at the reduction and management of the risks that floods pose to human.

Policy instruments for forest management

Forests are carbon sinks, protect from soil erosion and provide fuel wood for energy (FAO, 2010). Considering these, Moldova intends to maintain and increase the area covered by forests and their productivity by the ecologically, economically and socially acceptable methods, by

Dissemination policy instruments for climate change

Raising awareness campaigns for climate change (energy efficient behavior, eco-driving, walking, bike-cycling modes).

Main characteristics of this policy portfolio

This policy portfolio sets stringent mitigation targets in all sectors. It is oriented towards the principles of the EU climate change policy and adjusted according to the needs of Moldova. The transposition of the relevant EU Directives and Regulations will facilitate the achievement of the expected energy savings.

2011_en.pdf%3FPHPSESSID%3D7b37dba6fb1101d4c5aaeb72850be396&ei=V-IwUMmZF4yRswbRvIGAAw&usg=AFQjCNFWzjNrOplxDafq-RQ2SXHES8lSbw&sig2=Bk1fUB1iR0c0MW0WsYx8Sw

[57] http://ec.europa.eu/clima/policies/lowcarbon/ccs/index_en.htm

[58] http://ec.europa.eu/environment/water/flood_risk/index.htm

Key assumptions

The key assumptions used for the development of scenarios are similar to those used in previously published studies and papers for Moldova. The categories of the key parameters are common for all scenarios and are divided as follows:

Demographics

The average annual growth rate of the population follows the "medium variant" of the population projections that was used for the *BAU* scenario.

Economy

Gross Domestic Product

The growth rate is set as in BAU scenario for this report. The growth rate for agriculture is 2% and for manufacturing-industry 3,5% based on the information already provided in the respective "key assumptions" of BAU.

GDP per capita

Projections of this key driver are based on those of GDP and population. LEAP calculates them automatically based on the projections of the other two key drivers as they are defined for each scenario.

GDP distribution per sector

As in BAU.

Average annual household income

In 2010, in Moldova, the average annual income per capita was 1,1 thousands Euros[59]. The assumption is the same as in BAU.

Gini coefficient

Measures of income assessment of policy portfolios in AMS method.

Climate Statistics

Precipitation

Precipitation will decrease by 0.005% per year until 2050 based on the information quoted in the respective session for BAU scenario.

Temperature

The temperature will increase by 1,6^{o}C in 2050 based on the information quoted in the respective session for BAU scenario.

Frequency of extreme events

Flash floods

The frequency of flash floods will increase as in BAU scenario (due to the insignificant decrease of precipitation and to the lack of data).

[59] http://www.timpul.org/en/news/detail/stiri300511.html

Heat waves

Since no other information is available the assumptions for the Opt scenario is that the increase in the frequency of the heat waves follows the increase of the temperature in the same scenario. They are assumed to be 22 by 2050.

Frost days

Since no other information is available the assumptions for the Opt scenario is that the increase in the frequency of the heat waves follows the increase of the temperature in the same scenario. They are assumed to be 5 by 2050.

Water resources

Surface waters

Since no other information is available the assumptions for the Opt scenario is that the growth rate for surface waters will follow the growth rate of precipitation in the same scenario.

Groundwater

Since no other information is available the assumptions for the Opt scenario is that the growth rate for surface waters will follow the growth rate of precipitation in the same scenario.

Total renewable freshwater resources

Since no other information is available the assumptions for the Opt scenario is that the growth rate for surface waters will follow the growth rate of precipitation in the same scenario.

Policies and Measures

Feed – in – tariff system

As described in BAU scenario.

Subsidies

Described in the policy portfolio of this scenario.

Land management

Described in the policy portfolio of this scenario.

Surface of arable land

No available information.

Surface of forest land

The surface of forest land is assumed to increase by 1,3% annually for this scenario taking into consideration the information presented in the session about the adaptation needs of the country.

Global trends

Crude oil price

Projections for the crude oil prices regarding the Reference scenario of the IEA, World Energy Outlook 2010 will be used.

Coal price

As in BAU scenario.

Natural gas price

As in BAU scenario.

EUA price

Projections about the EUA price will be used based on the relevant literature.

ERU price

The average CER price was 18€/tCO_2 based on the first 11 months of 2008 (Rotfub W. et al., 2009). The same growth rates that are adopted for the EUA price will be used for the CER price also.

Adaptation

Water use for irrigation

Based on the information presented in the session about the adaptation needs of the country and the respective session of the "Key assumptions" for the BAU scenario, the water use for irrigation is expected to increase by 1,5% annually for this scenario.

Energy Demand

Households

The country has set a target of 20% reduction of the total primary energy consumption by 2020 compared to that of year 2009 (this was presented in the session about the "Objectives" of the national climate change policy). It is assumed that the energy savings of this sector for this scenario are according to the share that this sector has in the total primary energy consumption. These energy savings will be achieved according to the policy portfolio of this scenario. The share of use of oil and natural gas are assumed to be reduced, while renewable energy sources (wood, vegetal wastes, solar energy and biogas) have an increased fuel share for this sector. More specifically, they are used for water heating, space heating and cooking.

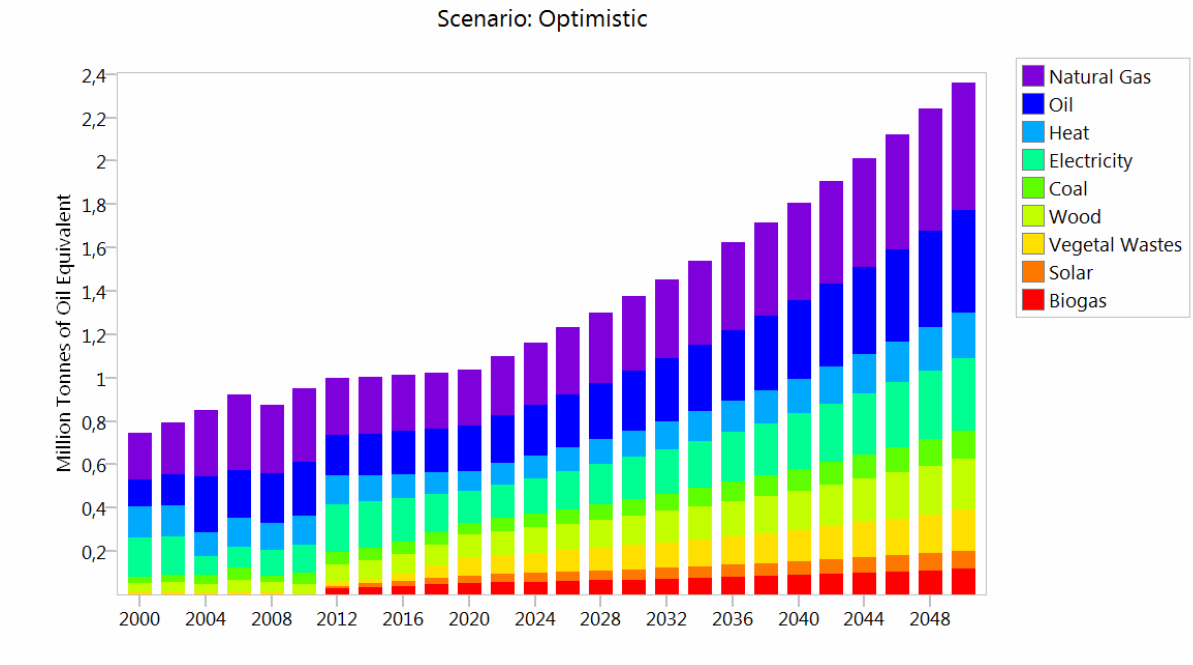

Figure 18: Demand: Final Energy Demand in Household Sector, mln toe.

Agriculture

Same assumptions with BAU scenario. For the reduction of the oil use in this sector there is increased use in solar, wood and vegetal wastes. These types of RES are used for drying agro-products, water heating and space heating.

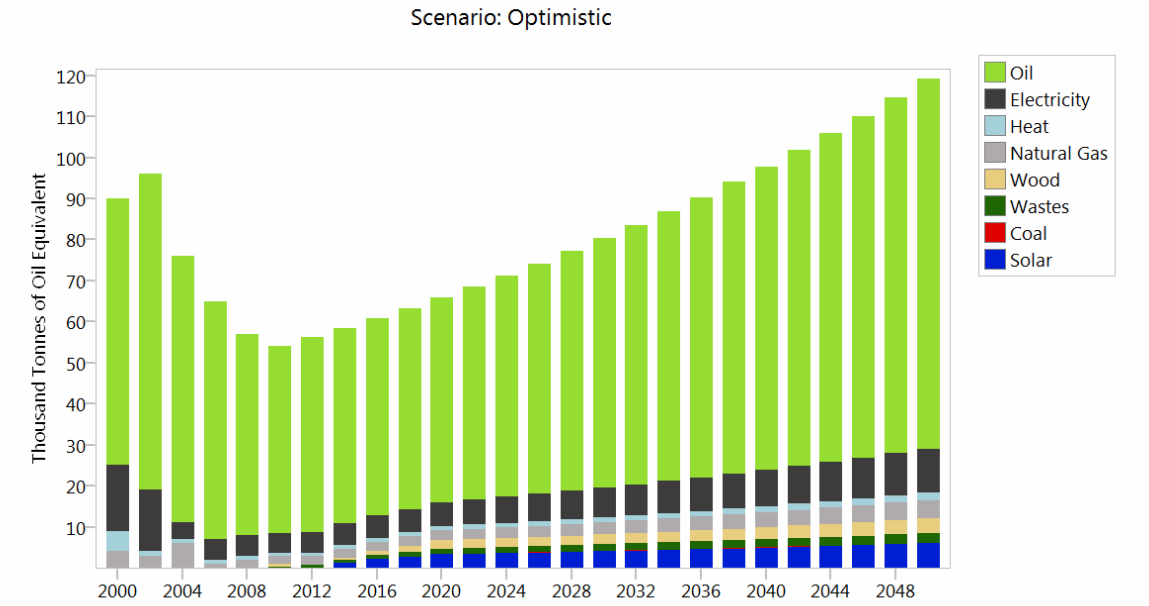

Figure 19: Demand: Final Energy Demand in Agricultural Sector, mln toe.

Industry

The country has set a target of 20% reduction of the total primary energy consumption by 2020 compared to that of year 2009 (this was presented in the session about the "Objectives" of the national climate change policy). It is assumed that the energy savings of this sector for this scenario are according to the share that this sector has in the total primary energy consumption. These energy savings will be achieved according to the policy portfolio of this scenario. Biogas and solar energy have an increased fuel share in this sector.

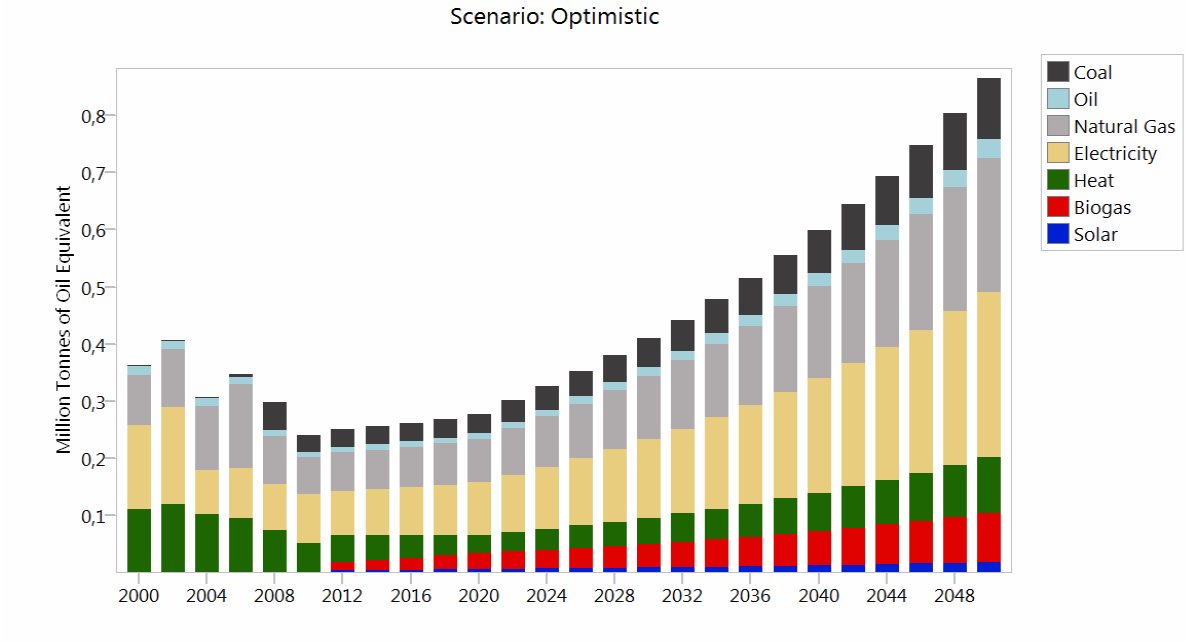

Figure 20: Demand: Final Energy Demand in Industrial Sector, mln toe.

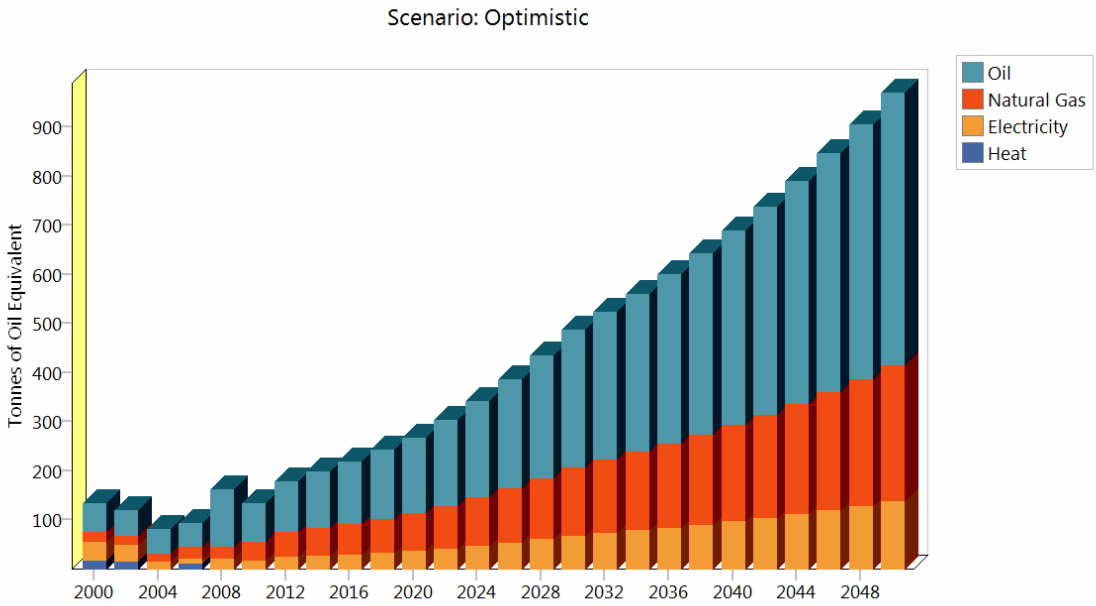

Figure 21: Demand: Final Energy Demand in Construction subsector, toe.

Transport

The country has set a target of 20% reduction of the total primary energy consumption by 2020 compared to that of year 2009 (this was presented in the session about the "Objectives" of the national climate change policy). It is assumed that the energy savings of this sector for this scenario are according to the share that this sector has in the total primary energy consumption. These energy savings will be achieved according to the policy portfolio of this scenario. Due to the intention of replacing diesel oil and gasoline with liquefied gas, the fuel shares were increased for natural gas and biofuels.

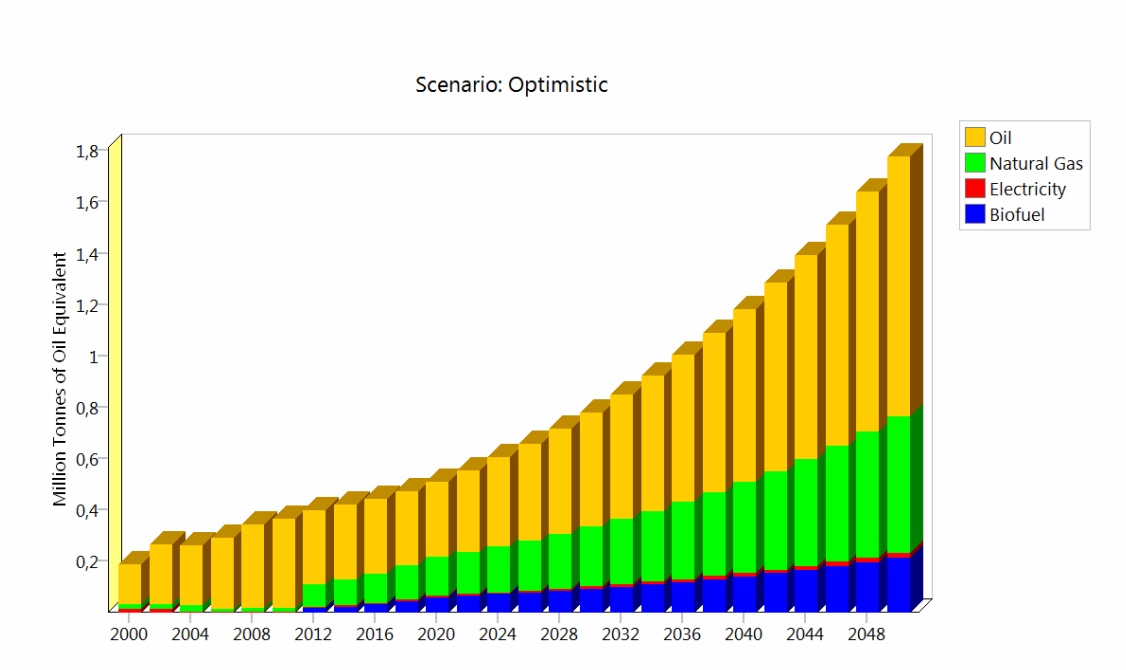

Figure 22: Demand: Final Energy Demand in Transport Sector, mln toe.

Non Specified

The country has set a target of 20% reduction of the total primary energy consumption by 2020 compared to that of year 2009 (this was presented in the session about the "Objectives" of the national climate change policy). It is assumed that the energy savings of this sector for this scenario are according to the share that this sector has in the total primary energy consumption. These energy savings will be achieved according to the policy portfolio of this scenario. Same assumptions as in the household sector.

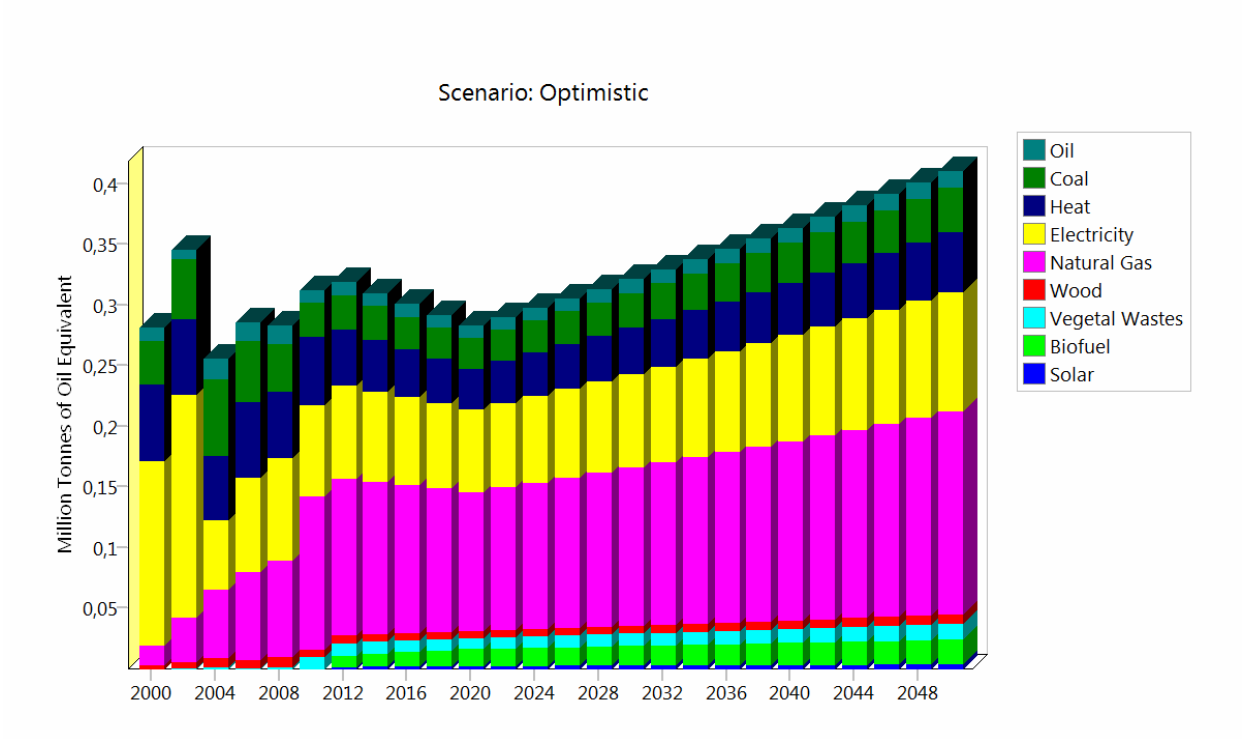

Figure 23: Demand: Final Energy Demand in Non Specified Sector, mln toe.

Transformation

Transmission and Distribution losses

Losses in electricity distribution are assumed to be 10,7% in 2020 – achieving the target that is set (NEER, 2011).

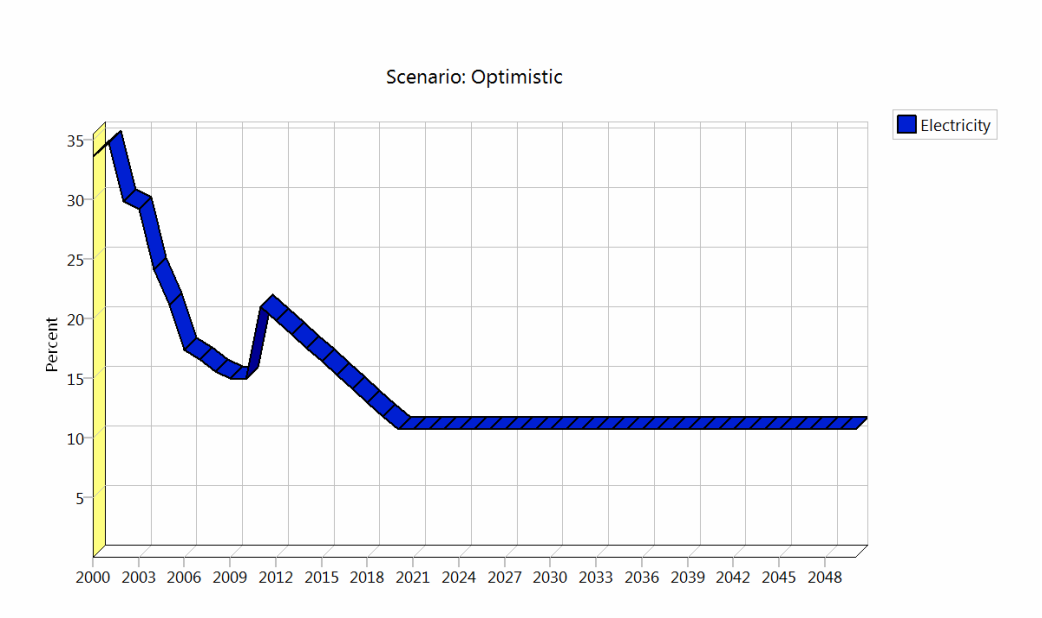

Figure 24: Transformation: Transmission and Distribution Losses, %.

Electricity Generation

It is assumed that the share of RES in the electricity generation will be the following: Wind – 600MW by 2050; Solar – 600MW by 2050 and Biogas – 50MW by 2050. The total efficiency of the thermal power plants of the new combined cycle will not be less than 80% and for electrical efficiency 45-50% (NEER, 2011).

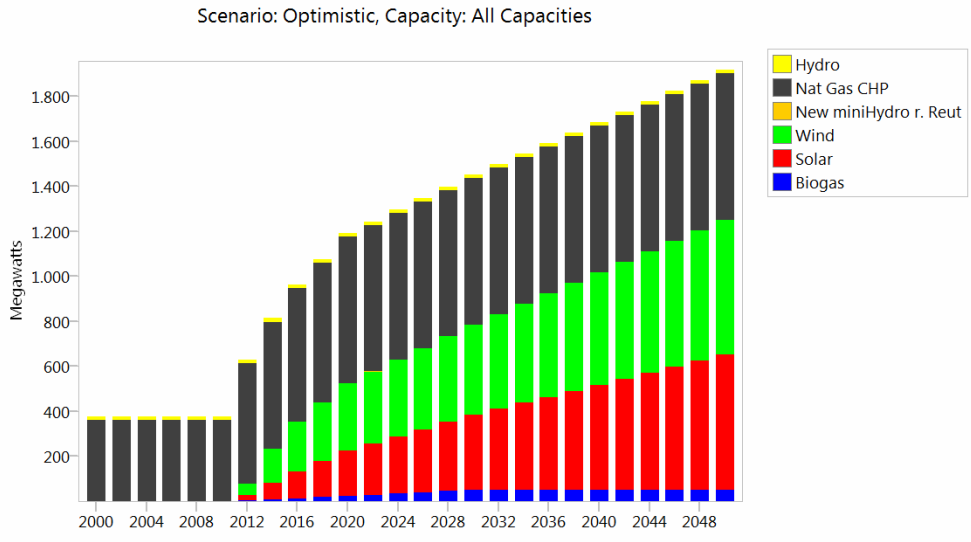

Figure 25: Power plants Capacity, MW.

Global warming potential (GHG emissions)

The graph shows the GHG emissions which are attributed to each "energy consuming" sector. The non – energy sector, presented above, concerns the emission sources and sinks attributed to land use change, agriculture and forestry. No data on the emissions of methane due to waste are presented.

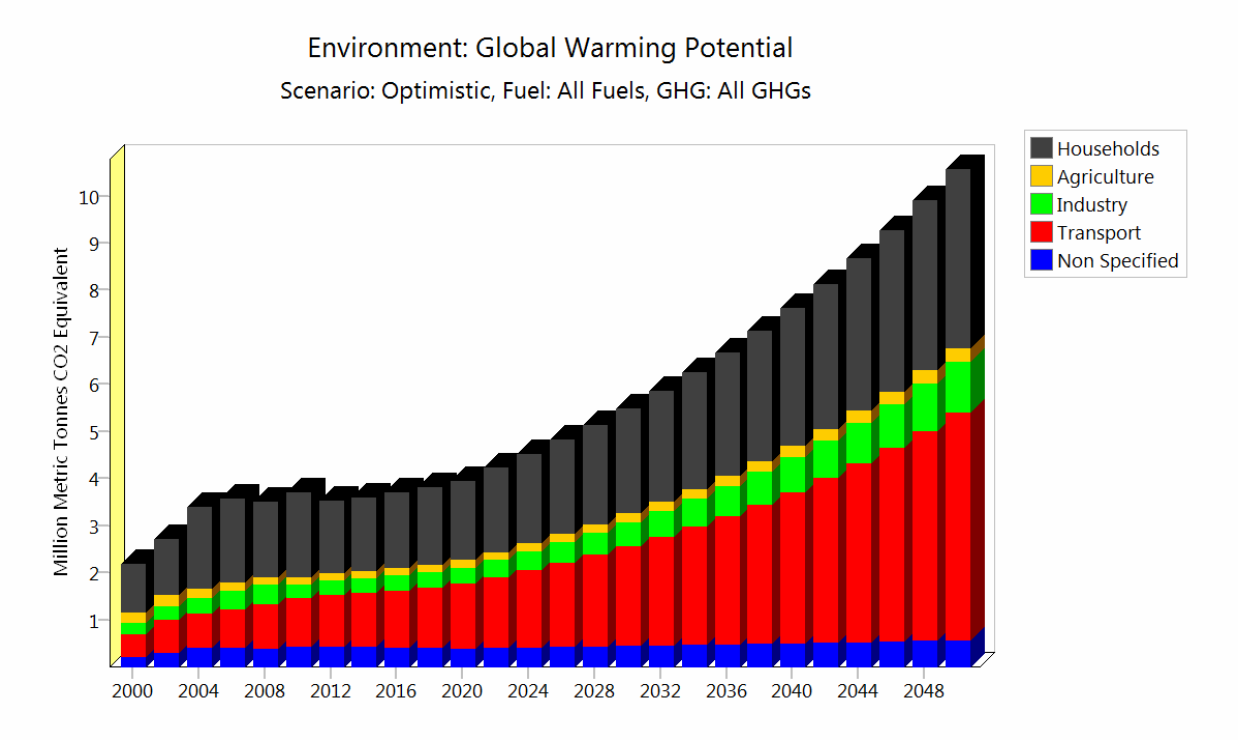

Figure 26: Global Warming Potential in Demand, mln metric tonnes CO_2 eq.

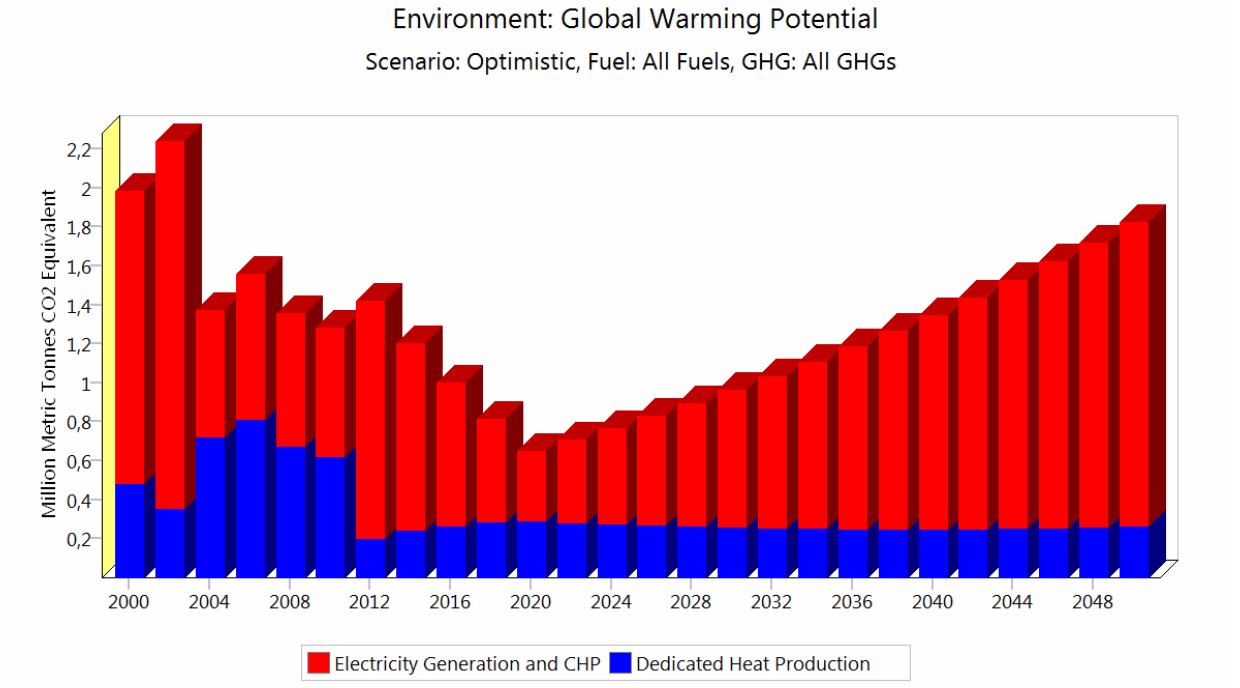

Figure 27: Global Warming Potential in Transformation, mln metric tonnes CO_2 eq.

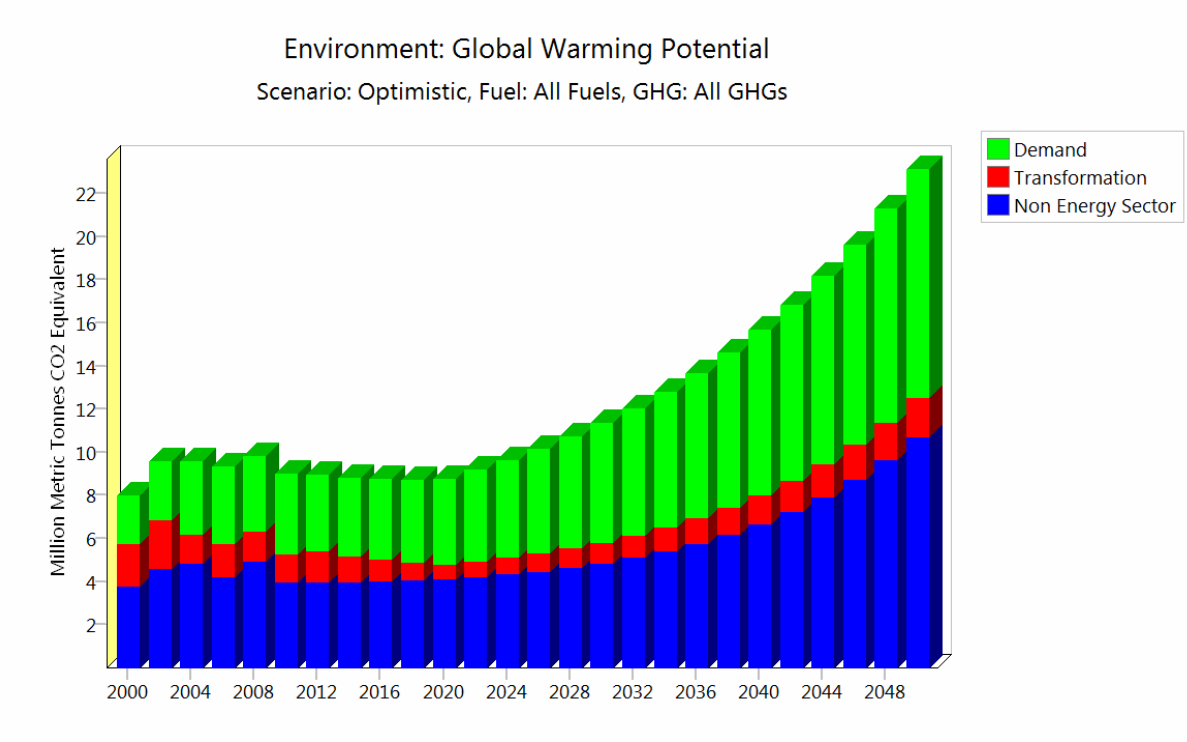

Figure 28: Global Warming Potential, mln metric tonnes CO_2 eq.

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PESSIMISTIC SCENARIO (2000 – 2050)

Pessimistic scenario description

General comments

The development policy objectives of the country will define the type of cooperation that the country needs since Moldova has one third of Albania's GDP and the lowest GDP per capita in Europe (EC, 2011). With a GDP per capita of 1000€ per annum, about 30% of the population of Moldova ('the poorest country in Europe') live in absolute poverty and 4,5% live in extreme poverty (EC, External Relations Directorate – General, 2011). That is why social spending remains a major component of public expenditure. Two thirds of Moldova's state budget is spent on health, education and social assistance. In this context, Moldova's basic economic and social priorities have remained steadily focused on reducing poverty levels and stimulating economic activity to sustain rapidly increasing social commitments (EC, External Relations Directorate – General, 2011).

The Moldovian government considers as one of its priorities for the forthcoming period the "safe, good quality and secure supply of energy and natural resources to consumers". This priority will be achieved through the continuous technological modernization of the existing facilities/systems/sources, increased use of RES and energy efficiency (NDS Moldova 2020, 2012). The last objective is important since Moldova is not rich at all in energy resources. With the current level of production, which provides for only 5% of the national needs, import of energy sources is expected to be maintained in the future (95%), and can reach more share if serious state measures are not implemented so as to stimulate increased energy efficiency and use of renewable energy sources.

For this scenario the increase of energy efficiency is considered as an energy policy component rather than a climate change policy one. This is justified since the energy efficiency of the country is very low, almost three times lower compared to European countries, leading to a substantial increase in the costs of energy resources (NSD, 2011). The main constraints for energy efficiency growth in the country are: i) high energy consumption which leads to increased energy intensity; ii) increasing energy prices because of the morally and physically outdated technology and equipment; and iii) lack of knowledge and skills in the area of energy efficiency and use of renewable energy resources which does not allow the successful implementation of the relevant policy instruments (NSD, 2011).

The development and modernization of the energy sector will not only allow reduction of GHG emissions, but will also create a more preferable framework for foreign investments in the country. The attraction of investments requires the: (i) creation and strengthening of mechanisms for bringing in the country and using efficiently funding for energy projects (NSD, 2011); (ii); use rationally state investment and private investment in energy development projects; (iii) developing an information base and a database for energy project funding (NSD, 2011). Efforts need to concentrate on: (i) strengthening the sector reform, including by adopting new energy legislation harmonized with EU requirements; (ii) implementation of measures promoting energy efficiency; (iii) attracting investment in the sector; (iv) strengthening institutional capacity in this area (NSD, 2011).

The priorities for this scenario are the non-climate policies. The efforts of the country will focus on the energy sector. The penetration of RES technologies for this scenario concerns mainly biomass. Efforts for energy efficiency will concern the energy sector and the residential sector since these are energy consuming more compared to the others.

Policy portfolio for this scenario

Mitigation

Existing policy instruments

The policy instruments that are planned to be implemented are also included in this policy portfolio, but with difficulties and delays (ESCOs, building law, Introduction of energy efficiency measures due to the respective Directives).

The Energy Efficiency Fund is assumed to receive less than the percentage given in the Opt scenario and the projects will concern mainly the energy sector.

Policy instruments for the transport sector in Moldova

No national policy instruments will be implemented under this scenario for this sector. Any improvements in technological performance of vehicles will follow the international trends as described in the Opt scenario.

Policy instruments for emission trading

CDM only for the energy sector.

Additional policy instruments

Policy instruments for the energy sector

Financial policy instruments

- Increase in electricity prices for allowing investments in the power sector.
- To implement constant feed-in-tariffs for RES.
- Tax exemptions and subsidies for the encouragement of investments in the energy sector.

Adaptation

No policy instruments are proposed.

Main characteristics of this policy portfolio

This policy portfolio does not sets stringent mitigation targets for the sectors. The main efforts concern the penetration of RES and energy efficiency so that energy consumption is reduced and the use of national available resources is increased. The policy portfolio is improved compared to that of BAU because of the planned introduction into the national legislation of EU Directives that concern RES and energy efficiency.

Key assumptions

The categories of the key parameters are common for all scenarios and are divided as follows:

Demographics

The same assumption with those in the BAU scenario.

Economy

Gross Domestic Product

As in the BAU scenario.

GDP distribution per sector

The growth rate for the agricultural sector was set at 1%, while for the manufacturing-industry sector at 2%.

Average annual household Income

Same assumption as in the previous two scenarios.

Gini coefficient

Same comments with the other scenarios.

Climate Statistics

Precipitation

Annual precipitation in Moldova for the *Pes scenario* will slight decrease by -0,010%.

Temperature

For this scenario temperature will increase by 2,5°C (reaching the figure 13,9°C) by 2050.

Frequency of extreme events

Flash floods

The frequency of flash floods will increase to 10 by 2050 for this scenario.

Heat waves

Since no other information is available the assumptions for the Pes scenario is that the increase in the frequency of the heat waves will be 25 by year 2050.

Frost days

Since no other information is available, the assumptions for the Pes scenario is that the frequency of the heat waves is reduced and reaches the figure of 3 by 2050.

Policies and Measures

Feed – in – tariff system

For the Pes Scenario the values follow the development of the costs in international level for each RES technology type (V. Parlicov, 2012)[60].

[60] http://www.cnr-cme.ro/foren2012/PPT/WF%202/

Land management

As described in the policy portfolio for this scenario.

Surface of forest land

The surface of forest land is increased by 0,7% annually.

Adaptation

Water use for irrigation

Based on the information presented in the session about the adaptation needs of the country and the respective session of the "Key assumptions" for the BAU scenario, the water use for irrigation is expected to increase by 1% annually for this scenario. The activity level of the Agricultural sector is restricted in this scenario.

Energy Demand

Households

The energy savings and the fuel shares for this sector are assumed to be half of those for the Opt scenario. This is due to delayed implementation of the necessary policy framework.

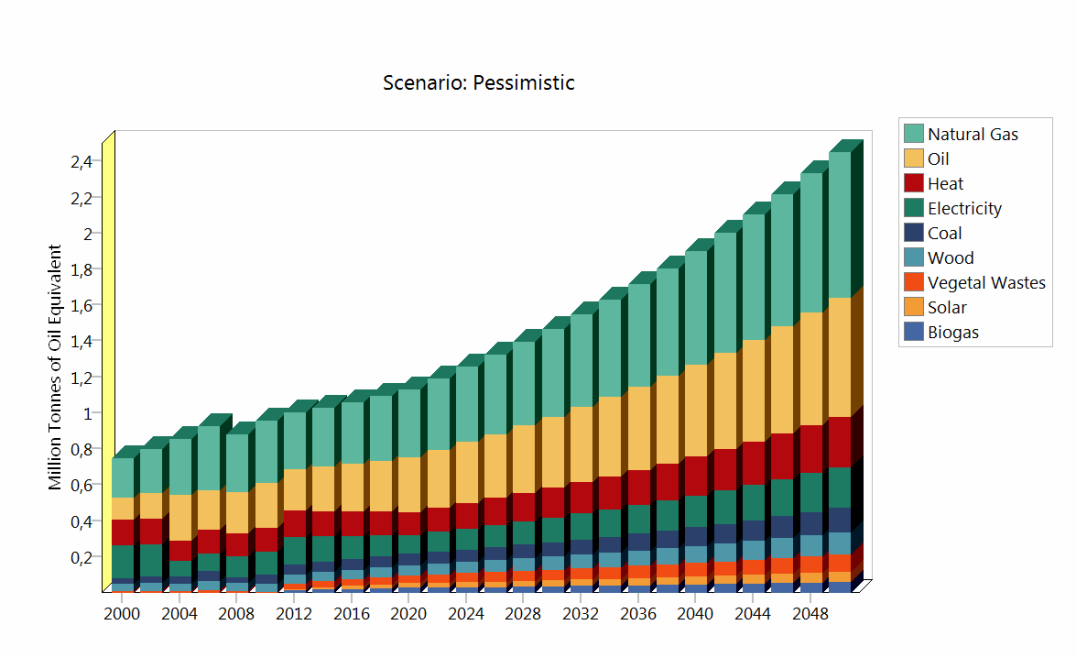

Figure 29: Demand: Final Energy Demand in Household Sector, mln toe

Agriculture

Same approach for assumptions as in the BAU scenario.

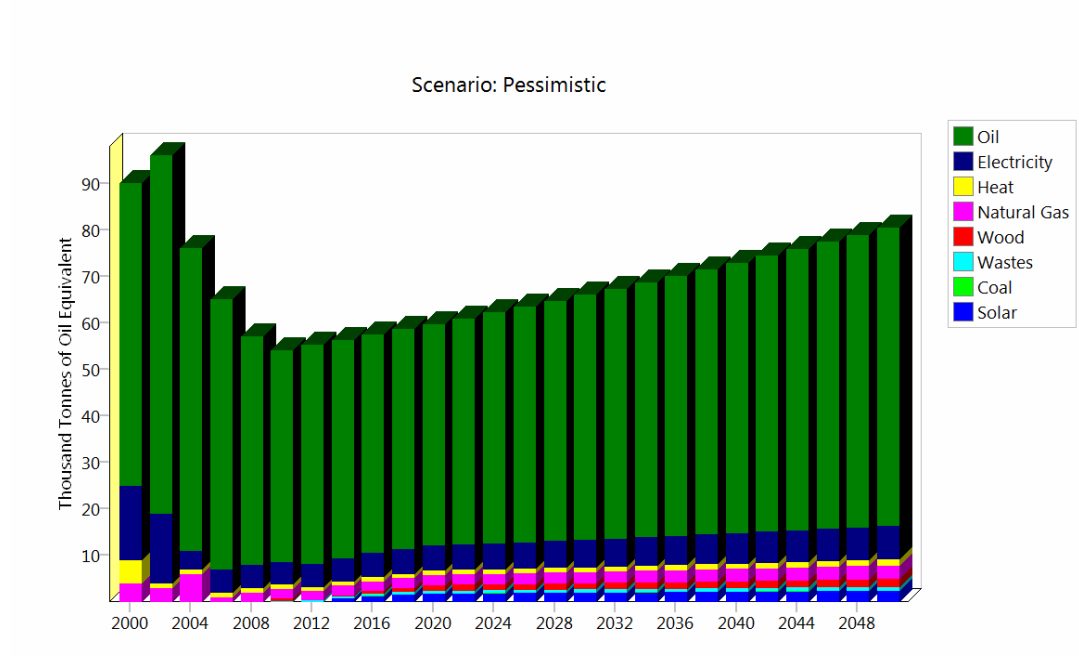

Figure 30: Demand: Final Energy Demand in Agricultural sector, th. toe.

Industry

The energy savings and the fuel shares for this sector are assumed to be half of those for the Opt scenario. This is due to delayed implementation of the necessary policy framework.

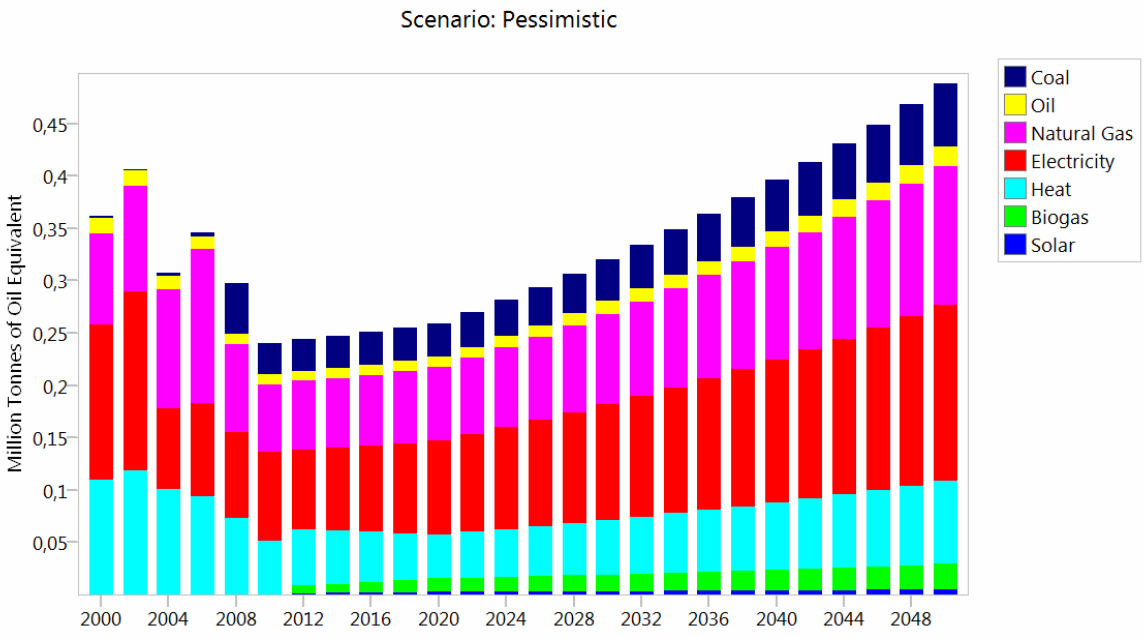

Figure 31: Demand: Final Energy Demand in Industrial Sector, mln toe.

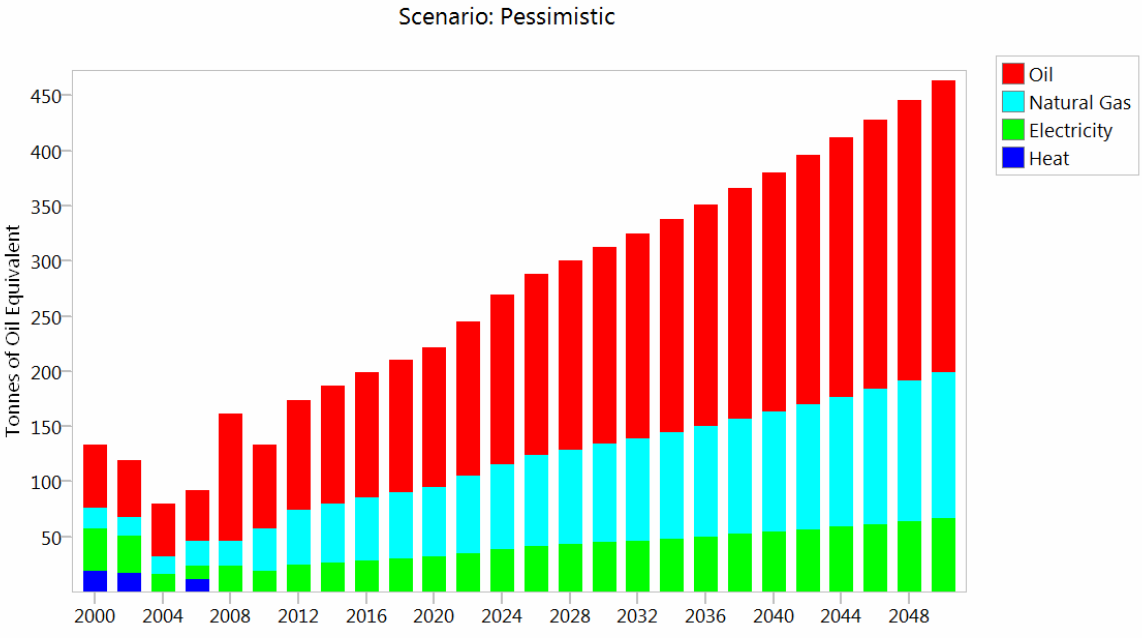

Figure 32: Demand: Final Energy Demand in Construction Subsector, toe.

Transport

The energy savings for this sector are assumed to be half of those for the Opt scenario. This is due to delayed implementation of the necessary policy framework.

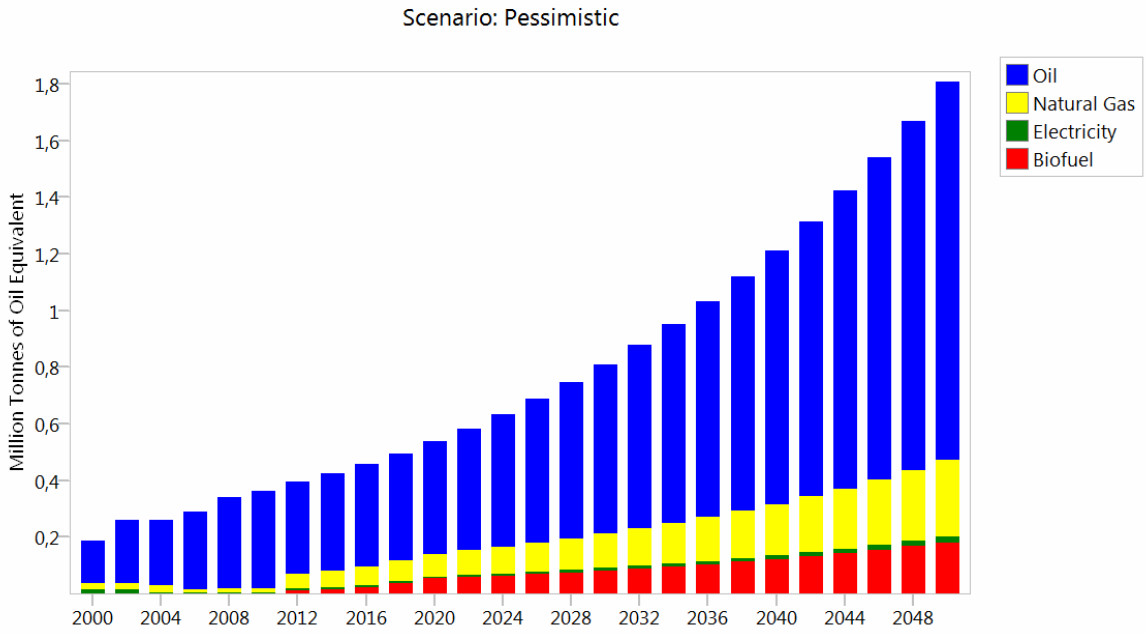

Figure 33: Demand: Final Energy Demand in Transport Sector, mln toe.

Non Specified

The energy savings for this sector are assumed to be half of those for the Opt scenario. This is due to delayed implementation of the necessary policy framework.

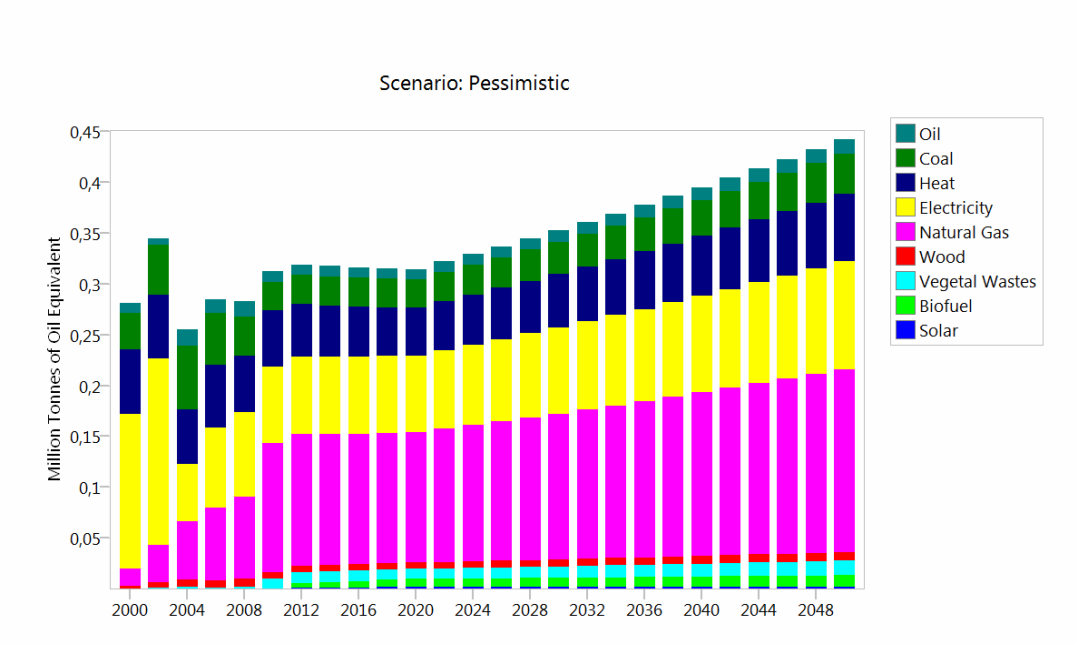

Figure 34: Demand: Final Energy Demand in Non Specified Sector, mln toe.

Transformation

Transmission and Distribution losses

The losses are assumed to be 12,5% by 2020, since for the year 2011, the target of 13,1% was not achieved according to the available data that were collected for PROMITHEAS-4.

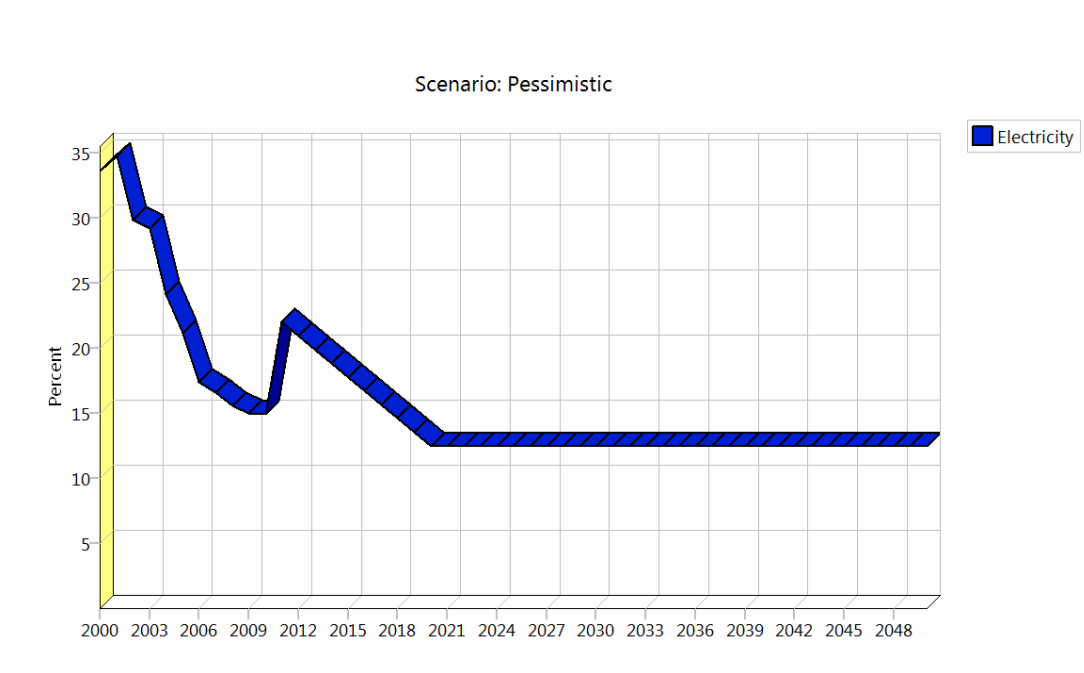

Figure 35: Transformation: Transmission and Distribution Losses.

Electricity generation

The RES share is less than that assumed for Opt. Instead of 80% for the total efficiency of the thermal power plants in Opt, the assumption here is of 70%. The assumption is 42% for the electrical efficiency in Pes instead of 45% in Opt.

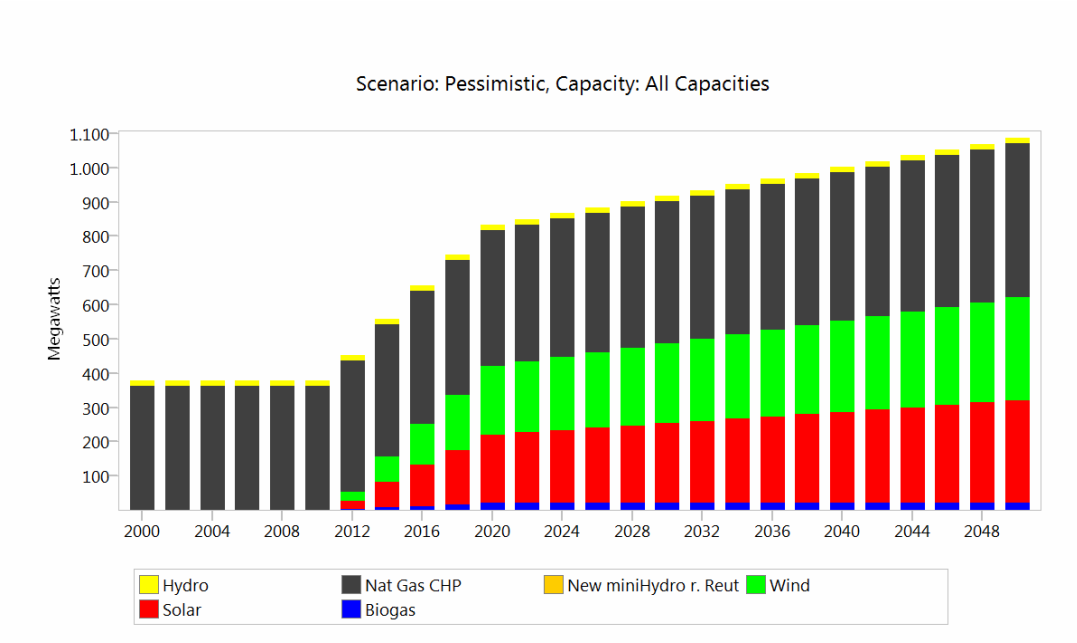

Figure 36: Transformation: Power plants Capacity.

Global warming potential (GHG emissions)

The graph shows the GHG emissions which are attributed to each "energy consuming" sector. The non – energy sector, presented above, concerns the emission sources and sinks attributed to land use change, agriculture and forestry. No data on the emissions of methane due to waste are presented.

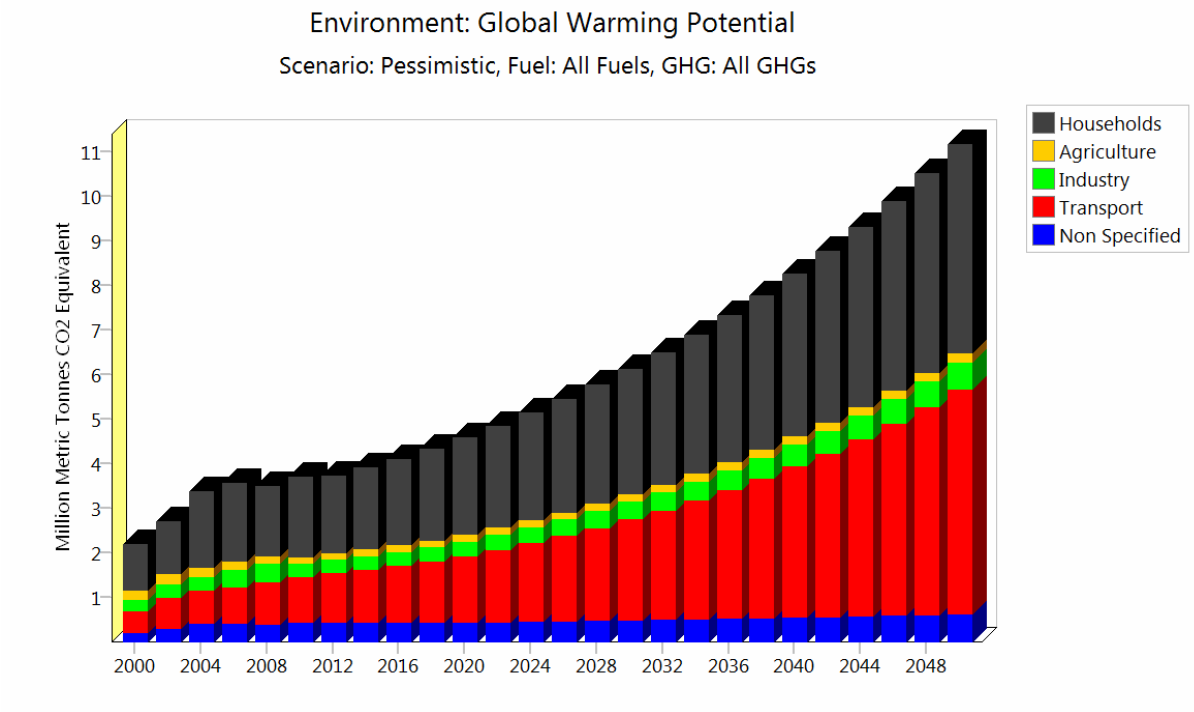

Figure 37: Global Warming Potential in Demand, mln metric tonnes CO_2 eq.

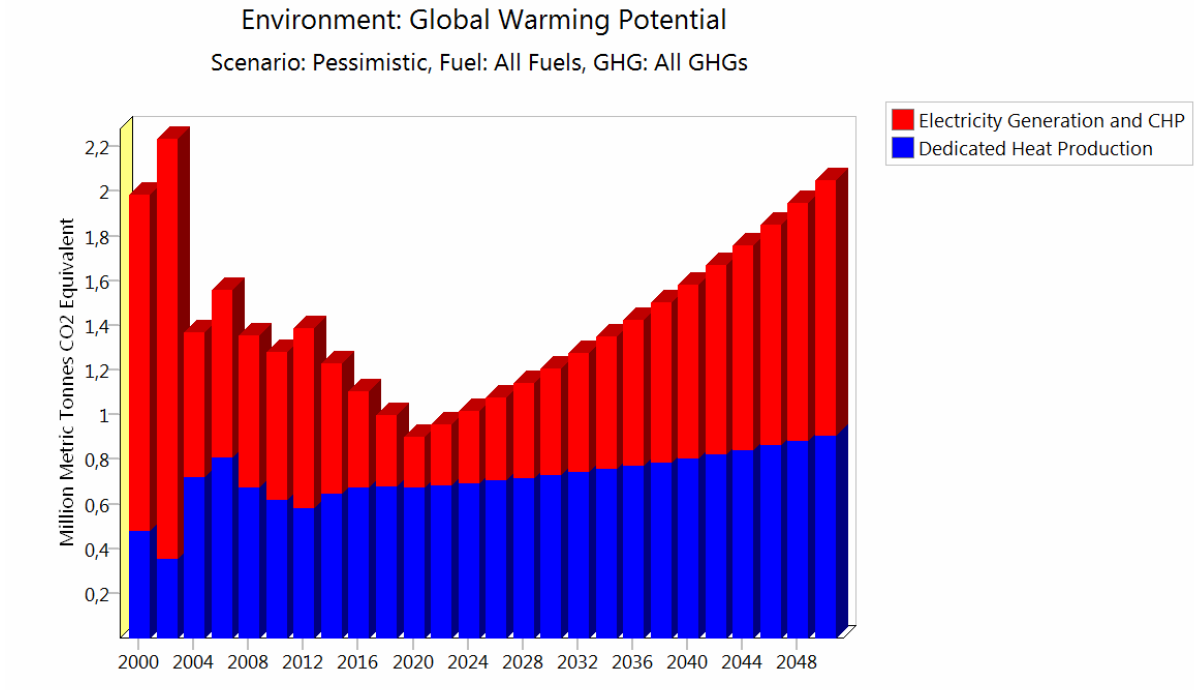

Figure 38: Global Warming Potential in Transformation, mln metric tonnes CO_2 eq.

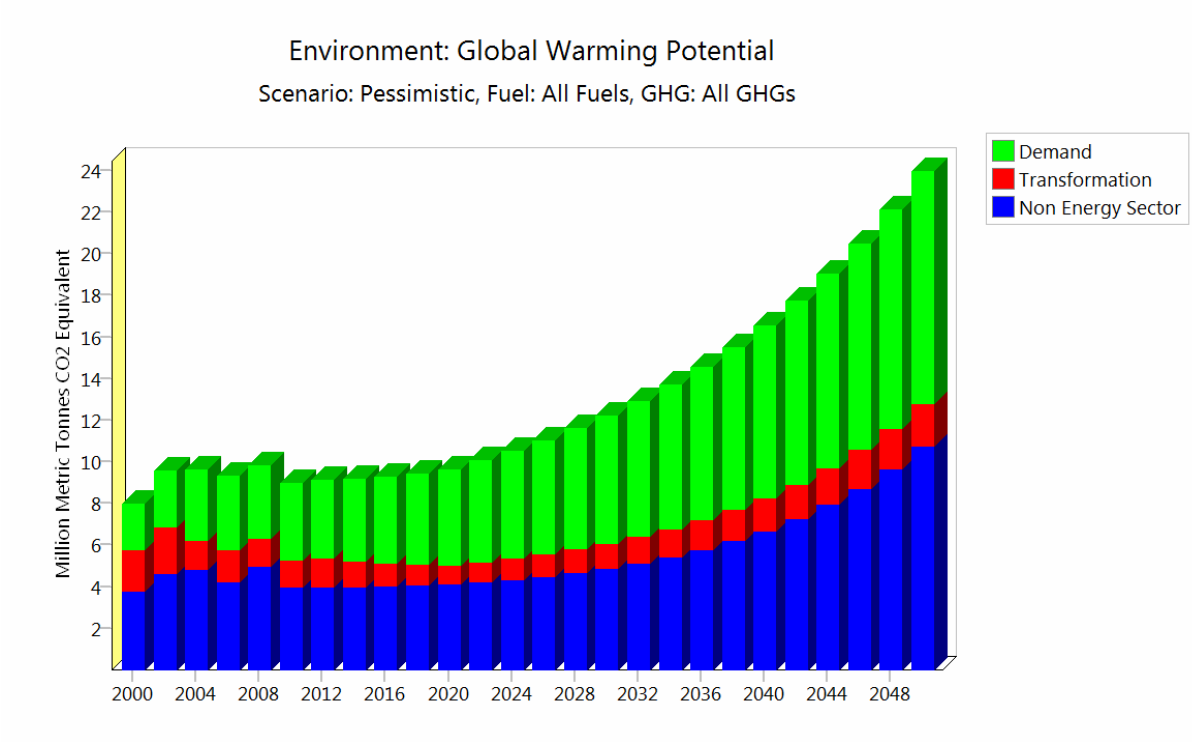

Figure 39: Global Warming Potential, mln Metric tonnes CO_2 eq.

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The final energy demand for all three scenarios is shown in Figure 40.

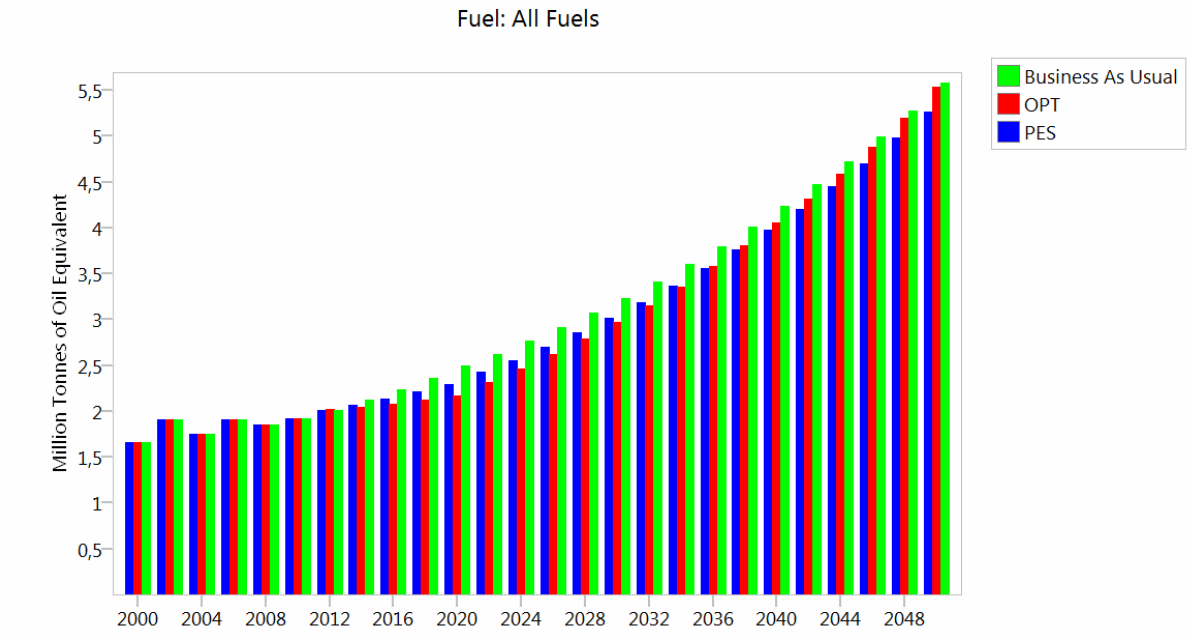

Figure 40: The evolution of the energy demand for the three analysed scenarios.

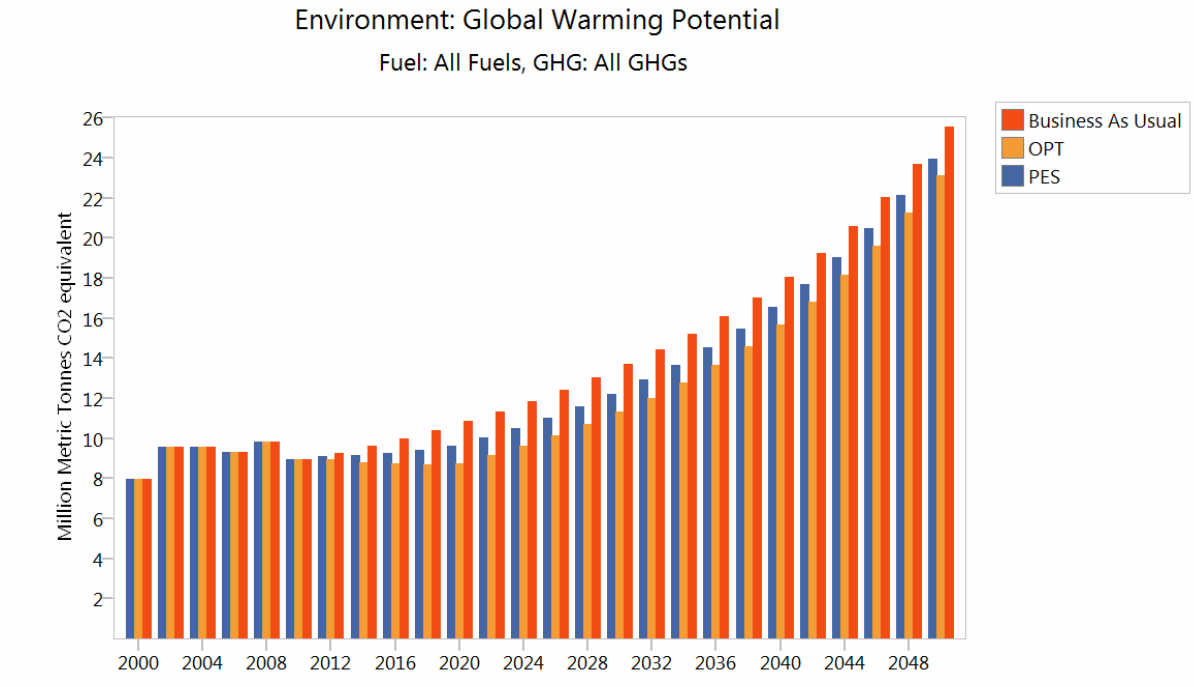

Figure 41: The evolution of the global warming potential for the three analysed scenarios.

ASSESSMENT OF THE THREE DEVELOPED SCENARIOS FOR MOLDOVA, THROUGH THE MULTI - CRITERIA METHOD AMS

General comments

Each scenario will be assessed for its performance under the criteria/sub-criteria of the AMS method which is the combination of three standard multi-criteria methods: the Analytical Hierarchy Process (AHP), the Multi-Attribute Utility Theory (MAUT) and the Simple Multi-Attribute Ranking Technique (SMART) (P.Konidari and D.Mavrakis, 2007; 2006). AMS is developed for evaluating climate policy instruments (PI) or relevant Policy Mixes (PM) and with suitable modification for evaluating their interactions as well.

Required data

The LEAP provides the following outcomes for all three scenarios:

Table 3: Total emissions for the country.

Scenario	Total GHG emissions (in $MtCO_2eq$)		
	2000	**2020**	**2050**
BAU	7,953	10,838	25,549
Opt	7,953	8,741	23,128
Pes	7,953	9,181	23,964

Table 4: Emissions per sector for the country.

Scenario	GHG emissions (in $MtCO_2eq$)		
	2000	**2020**	**2050**
Households			
BAU	1,022	2,228	4,653
OPT	1,022	1,664	3,786
PES	1,022	2,158	4,690
Agriculture			
BAU	0,207	0,167	0,260
OPT	0,207	0,159	0,288
PES	0,207	0,151	0,203
Non Specified			
BAU	0,211	0,487	0,666
OPT	0,211	0,398	0,578
PES	0,211	0,443	0,622
Industry			
BAU	0,257	0,373	0,781
OPT	0,257	0,346	1,078
PES	0,257	0,321	0,606
Transport			
BAU	0,485	1,610	5,223
OPT	0,485	1,379	4,840
PES	0,485	1,501	5,058
Electricity generation			
BAU	1,502	1,829	1,910
OPT	1,502	0,703	1,557
PES	1,502	0,475	1,136
Heat Production			
BAU	0,483	0,528	1,320
OPT	0,483	0,291	0,266
PES	0,483	0,679	0,910

Table 5: Other environmental effects for the country under each scenario

Scenario	Million Metric Tonnes CO_2 eq		
	2000	2020	2050
Environmental effects (Carbon Monoxide (CO)- Nitrogen Oxides (NOx)- Non Methane Volatile Organic Compounds- Sulfur Dioxide)			
BAU	0,102	0,280	0,843
OPT	0,102	0,827	2,560
PES	0,102	0,521	1,250

Table 6: Water Use.

Scenario	Billion m^3		
	2000	**2020**	**2050**
Agriculture			
BAU	0,107	0,071	0,038
OPT	0,107	0,092	0,133
PES	0,107	0,092	0,120

Assignment of grades

The software ClimAMS-2012 is used for the evaluation of the scenarios (Figure 43).

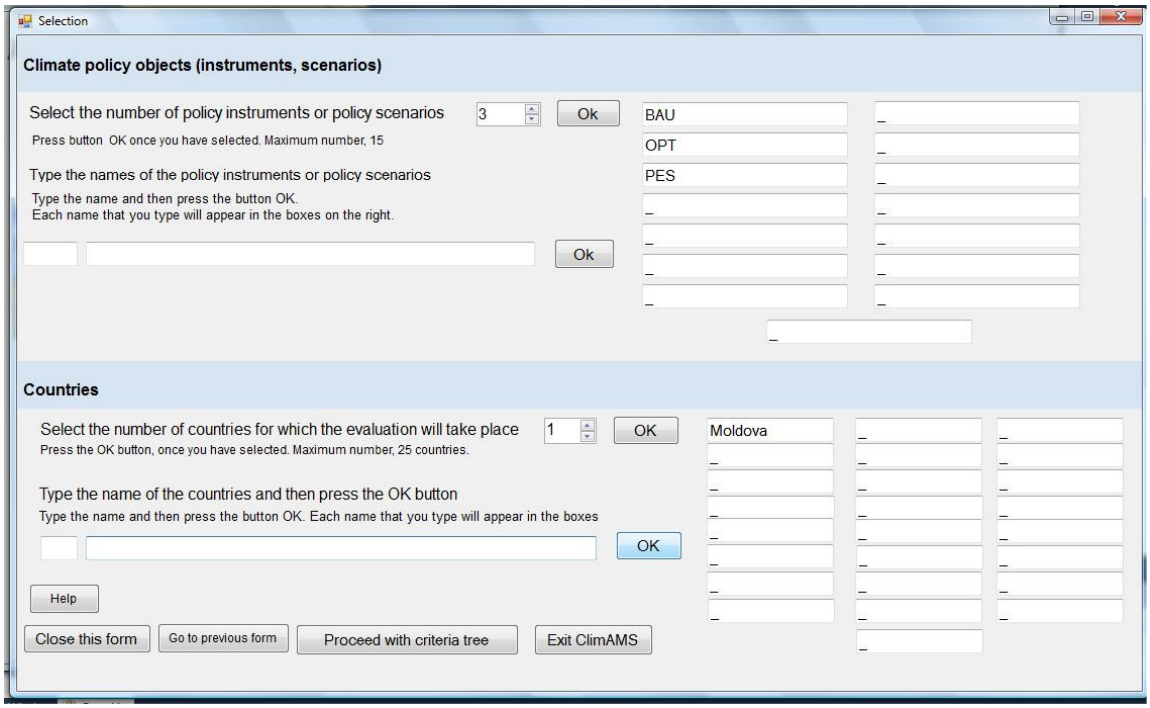

Figure 42: ClimAMS-2012.

Criterion 1: Environmental performance

Direct contribution to GHG emission reductions: For this sub-criterion, the outcome of LEAP for the total expected GHG emissions in year 2020 are used (Table 3). The scenario with the fewer amounts of emissions has the best performance for this sub-criterion.

Indirect environmental effects: The total amount of the total environmental effects provided by LEAP (Table 5) is used to assess the sub-criterion.

As a next step, the 2020 data is entered in ClimAMS (with negative value) to calculate respectively the direct effect on GHG emissions and indirect environmental effects.

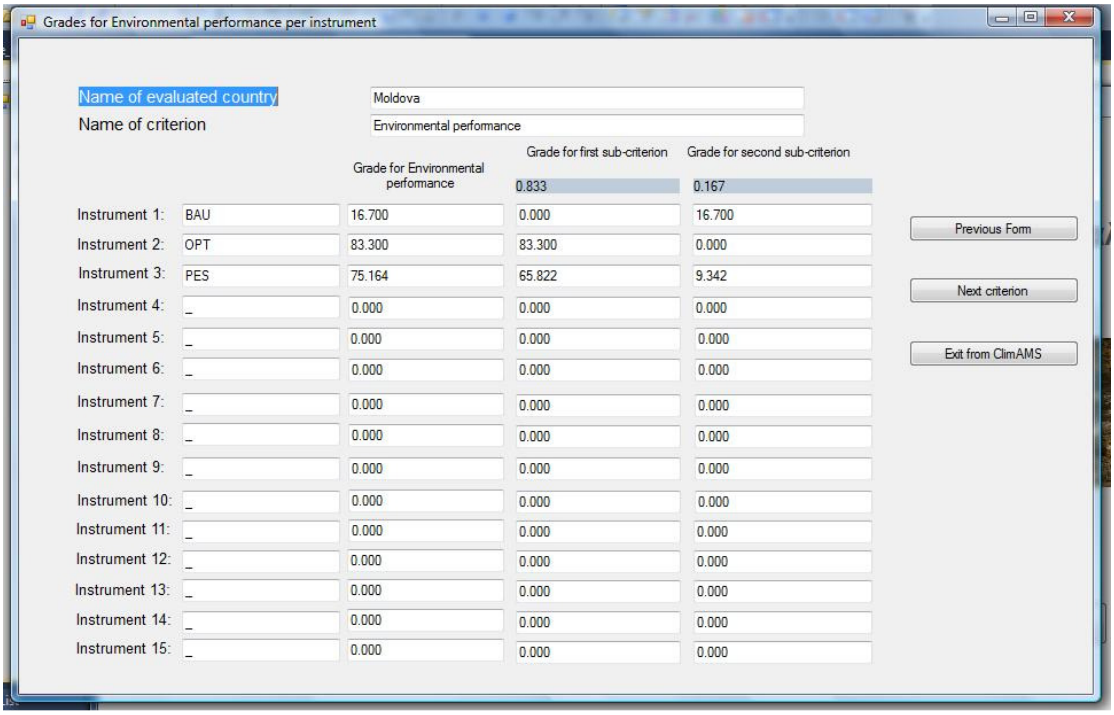

Figure 43: Grades for Environmental performance.

Criterion 2: Political acceptability

Each scenario is evaluated against each of the five sub-criteria of this criterion.
For ***cost efficiency*****:** For the first sub-criterion the mean CEI for each sector was calculated depending on the policy instruments that were under each scenario. Each value was multiplied with the respective amount of GHG emission reductions that were estimated by LEAP outcomes. The reductions were calculated against those of the BAU scenario for each sector.

Concerning adaptation, due to no available data these were not calculated for Moldova. Additionally, there were no specific measures for the described sectors in the respective previous session about the adaptation needs of the country that could be taken into consideration. The total values are inserted in ClimAMS, but as positive ones.

The policy portfolio with the lowest total cost is the one with the best performance for year 2020.

Table 7: Mean CEI for each sector depending on the policy instruments of the BAU scenario.

Mitigation					
Scen.	**Sector**	**Technological options**	**Policy instrument**	**CEI**	**Mean CEI**
BAU	Buildings	-	-	-	-
	Industry	-	-	-	-
	Transport	-	-	-	-
	Energy	Promotion of RES technologies	Regulation standards (Methodology - Guarantees of origin) (Regulation – ANRE Decisions No. 321/2009 and No. 330/2009)	-0,75	(-0.75-0,25-0,75)/3= -0,583
		Promotion of RES technologies	Subsidy (Feed-in-tariffs) (Law No. 160-XVI, 2007)	-0,25	
		Energy management	Performance standards (energy certificates,) (Law No. 142/2010)	-0,75	

Table 8: Mean CEI for each sector depending on the selected policy instruments of the OPT scenario.

Mitigation					
Scen.	**Sector**	**Technological options**	**Policy instrument**	**CEI**	**Mean CEI**
OPT	Buildings	Energy management	Performance standards (Draft Law – Road map – incorporating Directives for labeling)	-5,75	(-5,75-2,5-2,5-0,25)/4 = -2,75
		Energy efficient lighting	Performance standards (Incorporating Directive 98/11/EC)	-2,5	
		Energy efficient appliances	Performance standards (Incorporating Directives for home appliances)	-2,5	
		Energy management	Behavior change - Proposed	-0,25	
	Industry (also for non-specified)	Best Available Technologies for restricting air pollution	Technological or design standards (incorporating Directive 2001/80/EC)	+1,25	(+1,25-0,25-1,25-0)/4 = -0,063
		Promotion of RES and EE technologies	Tradable permits – Proposed	-0,25	
		Energy efficient technologies	Voluntary agreements (Proposed)	0	
		Energy efficient technologies	Regulatory standards (White certificates) (Proposed)	-1,25	
	Transport	Energy efficiency	Performance standards (transport management, speed limits) – Planned - Proposed	+0,5	(+0,5+0,25-1,75-0,25-0,25)/5 = -0,4
		Energy efficiency	Fuel switch (promotion of biofuels)	+0,25	
		Energy efficient vehicles	Technological standards (standards for CO2 emissions, vehicle labeling, fuel efficiency) - Proposed	-1,75	
		Energy efficiency	Behavior change - Proposed	-0,25	
		Energy efficient vehicles	Financial policy instruments (Subsidy) – Proposed	-0,25	
	Energy	Promotion of RES technologies	Regulation standards (Methodology - Guarantees of origin – free zones) (Regulation – ANRE Decisions No. 321/2009 and No. 330/2009)	-0,75	(-0,75-0,25-0,75+1,25-0,25)/5= -0,15
		Promotion of RES technologies	Subsidy (Feed-in-tariffs) (Law No. 160-XVI, 2007)	-0,25	
		Energy management	Performance standards (energy certificates) (Law No. 142/2010)	-0,75	
		Best Available Technologies for restricting air pollution	Technological or design standards (incorporating Directive 2001/80/EC)	+1,25	
		Promotion of RES and EE technologies	Tradable permits – Proposed	-0,25	
Adaptation					
	Agriculture	Irrigation systems, plantations	Subsidy - Proposed	+0,5	(0,5-1/6)/2 = 0.167
			Awareness	-1/6	

	Water management		Land management	-1/6	-1/6
	Forestry		Land management	+0,5	+0,5

Table 9: Mean CEI for each sector depending on the selected policy instruments of the PES scenario.

Mitigation					
Scen.	**Sector**	**Technological options**	**Policy instrument**	**CEI**	**Mean CEI**
PES	Buildings	Energy management	Performance standards (Draft Law – Road map – incorporating Directives for labeling)	-5,75	(-5,75-2,5-2,5)/3 = -3,583
		Energy efficient lighting	Performance standards (Incorporating Directive 98/11/EC)	-2,5	
		Energy efficient appliances	Performance standards (Incorporating Directives for home appliances)	-2,5	
	Industry	Best Available Technologies for restricting air pollution	Technological or design standards (incorporating Directive 2001/80/EC)	+1,25	+1,25
	Transport	Energy efficiency	Fuel switch (promotion of biofuels)	+0,25	+0,25
	Energy	Promotion of RES technologies	Regulation standards (Methodology - Guarantees of origin – free zones) (Regulation – ANRE Decisions No. 321/2009 and No. 330/2009)	-0,75	(-0,75-0,25-0,75+1,25-0,25)/5= -0,15
		Promotion of RES technologies	Subsidy (Feed-in-tariffs) (Law No. 160-XVI, 2007)	-0,25	
		Energy management	Performance standards (energy certificates) (Law No. 142/2010)	-0,75	
		Best Available Technologies for restricting air pollution	Technological or design standards (incorporating Directive 2001/80/EC)	+1,25	
		Promotion of RES and EE technologies	Tradable permits – Proposed	-0,25	
Adaptation					
	-	-	-	-	-

Table 10: Overall cost efficiency for the three scenarios.

Scen.	Mitigation/Adaptation Cost										Total
	Buildings		Non-specified		Industry		Transport		Energy		
	M	A	M	A	M	A	M	A	M	A	
BAU	0	0	0	0	0	0	0	0	0	0	0
OPT	-1,551	0	-0,006	0	-0,002	0	-0,092	0	-0,205	0	-1,853
PES	-0,251	0	+0,055	0	+0,065	0	+0,027	0	-0,203	0	-0,307

For *"**dynamic cost efficiency**"* – renewable energy technologies and energy efficient appliances and equipment are encouraged mainly in the OPT scenario. The other two scenarios perform badly in this sub-criterion since there are no policy instruments to promote these technologies. Additionally, no research efforts for other RES technologies are promoted in any scenario. The assigned grades: BAU – 4, OPT – 5 PES – 4.

For *"**competitiveness**"* - The Republic of Moldova has a relatively small and open economy (OECD, 2011). Although legislation related to investment policy is up to standard and refers to national treatment of foreign investors, the latter still face heavy restrictions in specific areas such as the acquisition of agricultural land (OECD, 2011). A more favorable business environment is created in the OPT scenario due to the incorporation of a considerable number of EU Directives for energy efficiency and renewable energy sources into national legislation. OPT through emission trading attempts to support investments for RES and EE technologies. However, without defined priorities for CDM projects and more incentives foreign private investors are not encouraged. Without policy instruments for the agricultural sector so as to face climate change impacts, there will be a need to restrict production or change types of products.

The competitiveness of the country in attracting investments for RES was very low in 2012 – not included within the 40 most competitive countries of the world (Ernest & Young, 2012).

The assigned grades are: BAU – 4, OPT – 5 PES – 4.

For *"**equity**"*- Taking into consideration the need to compare the scenarios under a regional level the ratio GHG emission reductions in $MtCO_2eq$ to capita is calculated for each scenario. The larger the ratio is the fairer is the scenario in sharing the burden among the sectors. In the Opt scenario almost all sectors participate in contributing to emission reductions.

Table 11: Equity measurement.

Scenario	Total amount of 2020 GHG emissions ($MtCO_2eq$)	Reductions compared to BAU	Population in 2020 (in million)	Ratio reductions tCO_2eq per capita
BAU	10,838	0	3,352	0
OPT	8,741	1,960	3,352	0,626
PES	9,181	1,299	3,352	0,494

For *"**flexibility**"* - The scenarios are compared towards the incentives and the options that they offer to target groups. The Opt scenario offers more options (subsidies and feed-in-tariffs) compared to the other two ones. So, BAU – 4, Opt – 5, Pes – 4.

For *"**stringency for non-compliance**"* - the scenarios do not foresee penalties, fees on any other sanctions. So, all are assigned with 4.

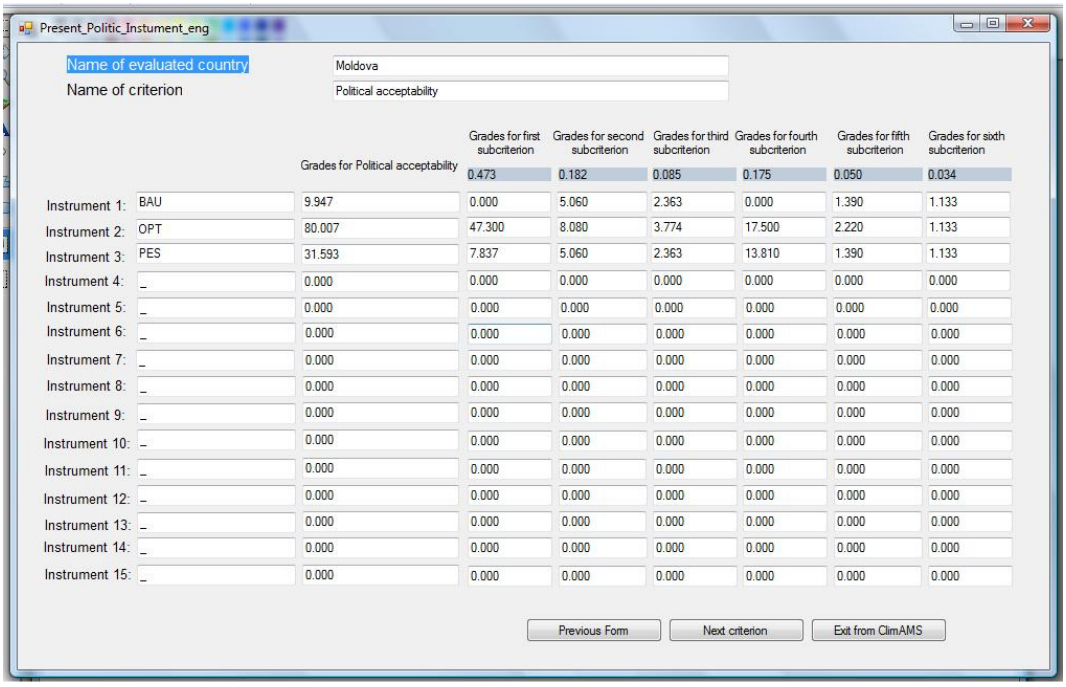

Figure 44: Grades for political acceptability.

Criterion 3: Feasibility of Implementation

The scenarios were evaluated against 3 sub-criteria.

For the "***implementation network capacity***", the scenarios have a poor performance. There is limited number of official reports regarding climate change policy issues for the country. The reports are not updated. The web-sites are not user friendly and the information is not directly accessible. In most of them there is no English version to facilitate foreign researchers. Users need to devote time is searching for the necessary information. The Climate Change Office under the Ministry of Environment and the Designated national Authority for CDM do not have their own web-sites.

The following entities form the Moldovian implementation network:

- Ministry of Economy and Trade[61];
- Ministry of Agriculture and Food Industry[62];
- Ministry of Environment[63];
- ANRE[64]
- Forestry Agency "Moldsilva"[65].

For implementing a stricter national climate policy the implementation network needs to be reinforced, educated and to increase its capacity building. The assigned grades are: BAU – 4, OPT – 3, PES – 3.

For "***administrative feasibility***", the scenarios have a poor performance. The existing policy portfolio is not characterized by readiness in achieving its tasks. First National Communication under the UNFCCC (2000), Second National Communication under the UNFCCC (2009), Third National Communication under the UNFCCC (under development),

[61] http://www.mec.gov.md/
[62] http://www.maia.gov.md/index.php?l=en
[63] http://www.mediu.gov.md/index.php/en/
[64] http://www.anre.md/index.php?vers=3
[65] http://www.moldsilva.gov.md/index.php?l=en

National Inventory Report for the period 1990-2005 (2009). The preparation of a National Action Plan for Renewable Energy Sources is also delayed. The problems presented in the session about the "Main characteristics of the BAU scenario" reflect also the poor performance of current policy portfolio in this sub-criterion. The assigned grades are: BAU – 4, OPT – 4, PES – 4.

For "***financial feasibility***", the scenarios have again poor performance. The country has limited financial sources to implement any of the three policy portfolios. The OPT scenario due to possible revenues from the sold CERs from CDM projects may be used for the necessary subsidies in the transport sector. The grades are: BAU – 3, Opt – 5 and Pes – 4.

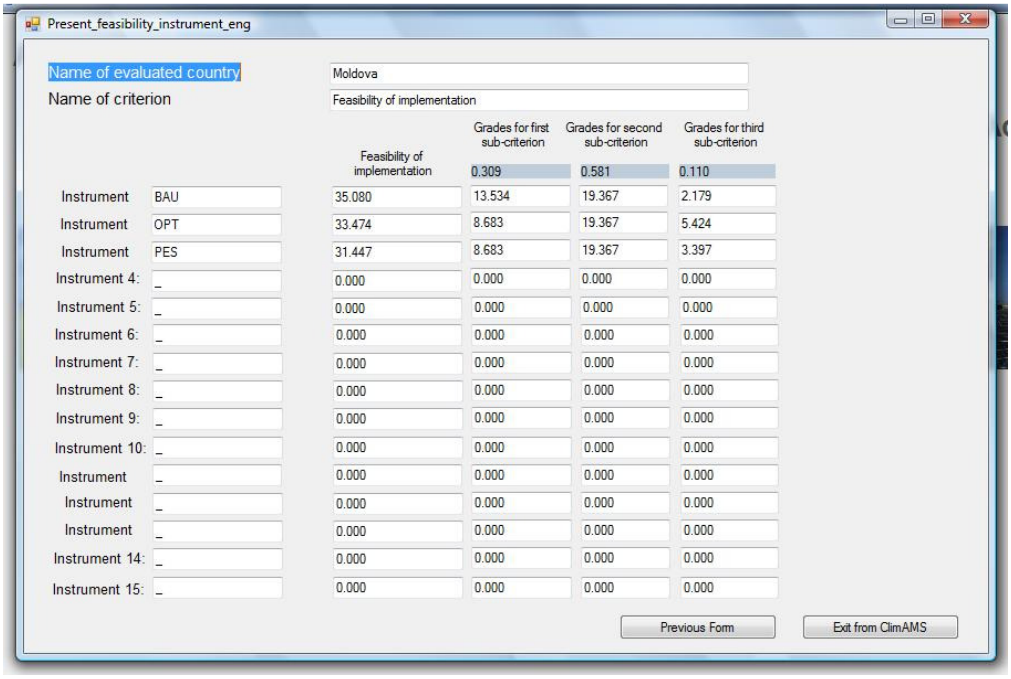

Figure 45: Grades for Feasibility of implementation.

Results

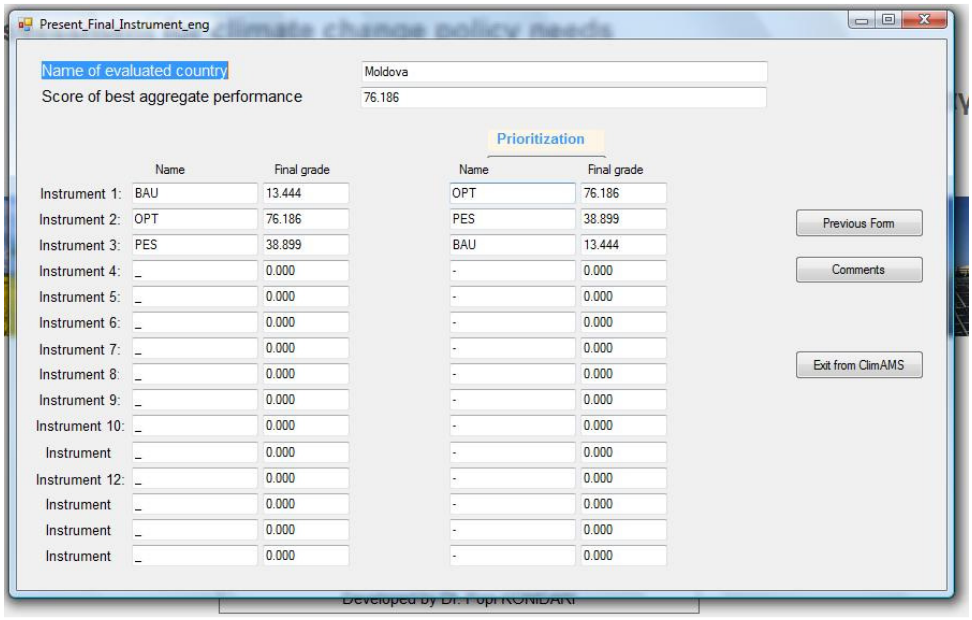

Figure 46: Score of best aggregate performance.

Table 12: AMS results for each scenario.

Criteria	Scenarios		
	BAU	**OPT**	**PES**
Direct contribution to GHG emission reductions (0,833)	0	83,300	65,822
Indirect environmental effects (0,167)	16,700	0	9,342
Environmental performance (0,168) - A	**16,700**	**83,300**	**75,164**
Cost efficiency (0,474)	0	47,300	7,837
Dynamic cost efficiency (0,183)	5,060	8,080	5,060
Competitiveness (0,085)	2,363	3,774	2,363
Equity (0,175)	0	17,500	13,810
Flexibility (0,051)	1,390	2,220	1,390
Stringency for non-compliance (0,032)	1,133	1,133	1,133
Political acceptability (0,738) - B	**9,947**	**80,007**	**31,593**
Implementation network capacity (0,309)	13,534	8,683	8,683
Administrative feasibility (0,581)	19,367	19,367	19,367
Financial feasibility (0,110)	2,179	5,424	3,397
Feasibility of implementation (0,094) - C	**35,080**	**33,474**	**31,447**
Total (A+B+C)	**13,444**	**76,186**	**38,899**

Comments

The results for each scenario are presented in the Table 12. The final grades demonstrate which of the three M/A policy portfolios has the better performance in responding to the climate change policy needs of the country taking into consideration the national framework.

REFERENCES

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OECD, 2011. Competitiveness and Private Sector Development – Republic of Moldova – Fostering SME Development. Available at: http://www.mec.gov.md/docs_news/competitiveness-and-private-sector-development-republic-of-moldova-2011.pdf

CONCLUSIONS

This report concerns the development and assessment of three (3) climate change mitigation and adaptation policy scenarios for Moldova. Each of them is characterized by a different policy portfolio and is named after it as Business As Usual (BAU), Optimistic (OPT) and Pessimistic (PES).

All scenarios of this report take into consideration the following national objectives: i) 20% share of RES in the total energy mix by 2020 and ii) 20% reduction of the total primary energy consumption by 2020, compared to that of year 2009. As a non-Annex I Party, Moldova has no commitment to reduce its GHG emissions under the Kyoto Protocol. However, the country has set a voluntary target under the Copenhagen Accord which is to reduce by 25% its total GHG emissions by 2020 compared to those of the base year 1990. According to the data provided by the UNFCCC database for the GHG emissions of Moldova, the country has already reduced its national emissions considerably. More specifically the GHG emissions of year 2005 are reduced by approximately 72% compared to those of the base year 1990.

BAU scenario

The BAU scenario concerns the time evolution of the already implemented mitigation and adaptation policy instruments (set into force before 31 December 2010) in Moldova until the year 2050 and serves as the reference against which the outcomes of the other scenarios are compared.

The currently implemented Moldavian mitigation policy has three main components: i) penetration of RES in the national energy mix, ii) support to increase energy efficiency; iii) GHG emission reductions through CDM. Concerning the adaptation policy, there are no relevant implemented policy instruments.

According to the outcomes of the model Long range Energy Alternatives Planning System (LEAP) for the BAU scenario in 2020 the GHG emissions are approximately 11MtCO_2eq[66]. The share of RES in the total energy mix by 2020 is 5% and the total primary energy consumption increases by 43% compared to that of year 2009[67].

OPT scenario

The OPT scenario concerns the time evolution of an enhanced Mitigation/Adaptation policy portfolio that Moldova will implement during the time interval 2011 - 2050. This enhanced policy portfolio takes into account the policy instruments adopted after 1st January 2011 as well as plans of the country and supports: i) the introduction of efficient technologies in almost all sectors targeting to the maximum reduction of GHG emissions through the maximum exploitation of the potential of the country in energy efficiency and renewable energy sources and ii) the necessary infrastructure for the adaptation of the country towards the minimum – in size and extent - expected climate change impacts.

The policy portfolio of this scenario includes thirteen (13) EU Directives[68] whose majority will be incorporated into the national legislation within the next five years and will reinforce the implementation of the aforementioned policy components in BAU. The adaptation policy instruments will meet adaptation needs in the agricultural sector and in water and forest management.

[66] GHG emission sources which are taken into consideration in this study do not include land use change and forestry, waste management and the whole spectrum of industrial processes due to missing data. They are mostly those related to the mitigation policy measures which are implemented.
[67] Based on the relevant outcomes of the LEAP model and the available historical data.
[68] Directives 2001/77EC, 2003/30/EC, 2009/28/EC, 2010/30/EC/94/2/EC, 95/12/EC, 95/13/EC, 96/60/EC, 97/17/EC, 98/11/EC, 2002/31/EC, 2012/40/EC, 2007/60/EC.

Based on the outcomes of the LEAP model the OPT scenario overcomes by 2% the set target for the RES share in the total energy mix by 2020. In this scenario the total primary energy consumption is reduced only by 4% compared to that of year 2009. This low percentage is atttributed to the following reasons: i) there is limited information within the country regarding energy efficient technologies and practices that does not allow the achievement of the required amount of energy savings; ii) aged equipment and infrastructure are responsible for losses and without the necessary amount of investments there will be gradually higher losses; iii) there are not yet official reports concerning the estimation of the potential in energy savings per sector and activity. The GHG emissions in 2020 are 8,7MtCO_2eq, which is less compared to those of the BAU scenario.

PES scenario

The PES scenario concerns the time evolution of a Mitigation/Adaptation policy portfolio that the country will implement up to 2050 without exploiting fully the national potential in energy efficiency and renewable energy sources and by facing the worse expected impacts of climate change, taking into account the policy instruments adopted after 1st January 2011.

This scenario assumes less ambitious mitigation policy by limiting the possible technological options only to a selected number of sectors with the highest energy efficiency potential and the most promising for the country types of RES. The scenario considers the implementation of all policy instruments approved (existing or planned), but no additional ones apart from those in line with the EU climate change policy and the national priorities. Despite the huge needs of adaptation (driven by the high global GHG emission levels and the related temperature changes), there are no planned adaptation policy instruments.

The outcomes of LEAP for this scenario provide a 13% share of RES in the total energy mix of year 2020, a 13% increase in the total primary energy consumption compared to year 2009 and GHG emissions are 9,6MtCO_2eq (more than OPT, less than BAU).

Assessment outcomes[69]

Using the multicriteria method AMS, the three (3) policy portfolios were assessed against their environmental performance (amount of GHG emissions and secondary environmental effects), political acceptability (attitude of the involved entities (target groups) towards the relevant policy portfolio) and feasibility of implementation (applicability of the policy portfolio from the point of the governmental and national pertinent entities).

The BAU scenario drives to the largest amount of GHG emissions and to the lowest indirect environmental effects. On the contrary the OPT scenario demonstrates lower GHG emissions and higher indirect environmental effects due to the higher shares of biomass and biofuels in the total energy mix of this scenario.

The OPT scenario has the best performance in political acceptability since it is the most cost effective for the target groups (residential, industrial, energy and transport sectors) compared to the other two policy portfolios. It offers a fair distribution of the "climate change" burden among the respective sectors. Moreover, OPT and partially PES encourage the introduction of innovative technologies, such as solar, biomas, biogas, but do not promote research. In BAU, innovations are not encouraged.

The implementation network (the governmental and national entities that will implement the policy instruments) does not provide the relevant information for climate change policy issues in none of the three policy portfolios. It is copying with the currently implemented policy portfolio, but it fails to respond properly in the cases of OPT and PES. This is justified by the fact that BAU includes a limited number and relatively simple policy instruments, but the other two scenarios have a larger number of policy instruments, the majority of which require a more capable implementation network.

[69] The assessment outcomes depend on the level of expertise of the person who makes the assessment as well as the degree of justification concerning the sub-criteria.

Given the above, the Mitigation/Adaptation policy portfolio which characterizes the Optimistic scenario is the one that reaches sufficiently the targets of the climate change policy of Moldova. Nevertheless, the success of this policy portfolio requires the demonstrated effectiveness of the implementation network and a more stringent frame for non-compliance.

In this report, the component of adaptation in climate change policy is not fully developed since the country hasn't set an adequate framework to reduce its vulnerability to climate change. Moreover, the design and assessment of relevant policy instruments require data related to the frequency of extreme events, water resources and use, low-income groups, biodiversity, the health sector, etc., which are not available at the moment.

Concluding, the scenarios of this report were developed under the same assumptions for the evolution of GDP and population for the period 2011-2050. In order to perceive the performance and applicability of the three (3) policy portfolios, the report should include six (6) more scenarios with the combinations "low population growth – high GDP growth" and "high population growth-low GDP growth", according to the socioeconomic frameworks presented in the IPCC pathways (new generation of IPCC scenarios).

ANNEX I

PROMITHEAS_4 database: user's manual

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This manual accompanies the data base itself. The development of the data bases, the elaboration of the manual as well as the preparation of the accompanied Excel and Access files have been accomplished by Mrs Barbara KASSELOURI and Mr Fragkiskos PIERROS, members of the NOA team in the Promitheas-4 project.

Introduction

General

In the frame of the PROMITHEAS-4 project[70] implemented in the period 2011-2013 the National Observatory of Athens (NOA) led the Work Package 1 "Evaluation of available data and information" regarding the 12 beneficiary partner-countries of the project: Albania, Armenia, Azerbaijan, Bulgaria, Estonia, Kazakhstan, Moldova, Romania, Russian Federation, Serbia, Turkey and Ukraine.

The present manual briefly describes the data gathered during this project, while it gives a full account of all necessary information about how these data can be used by the interested user. Twelve data bases have been generated from the data gathered by the above mentioned beneficiary countries. More specifically this manual is accompanied by:

1. the whole data base of the project in Access format, containing the data of the 12 beneficiary countries, i.e. the file *Promitheas_4* contains 12 tables, 48 queries and 1 form;
2. the Excel files entitled *PROMITHEAS_4_Data_part_1* and *PROMITHEAS_4_Data_part_2* containing the data of the 12 aforementioned countries.

Brief description of the gathered data

In its typical form the data base template should be filled in with data time series for the period 1990-2010 regarding the following data categories and subcategories: *demographics*, *climate statistics*, *economy* (the required reference year was set to 2009 and currency to Euro), *industry*, *water use*, *area of the country*, *transportation*, *policies and measures* regarding carbon tax, Feed in Tariffs (FITs) etc., *energy demand* divided into various subcategories (e.g. households, agriculture, tourism, health services, industry, transport etc.), *statistical differences* regarding primary and secondary fuels, *transformation processes* divided into various subcategories (e.g. transmission and distribution losses per fuel, energy for own use, pumped storage electricity production, heat production, electricity production per fuel - renewable energy sources (RES) included etc.), biofuel production, coal transformation, CHP production etc.), *stock changes* regarding primary and secondary fuels, *resources* regarding primary and secondary fuels and *GHG emissions* regarding industrial processes, land-use change and forestry, agriculture, waste, cement manufacture, lime production and other industrial processes (specified exclusively by each beneficiary partner).

In Table 1 the key categories and the totals of subcategories and variables per key category are shown. For the detailed list of the variables (required units included) per subcategory and the subcategories per key category see sheet entitled *Variables* in the deliverable Excel file *All_databases*.

[70] http://www.promitheasnet.kepa.uoa.gr/Promitheas4/

This data base template was initially created in Excel due to the fact that the LEAP model collaborates with Excel only. The LEAP software has been used in order to create the M/A policy scenarios. This Excel data base template was prepared and distributed along with the necessary guidelines for filling it with the appropriate data. Nevertheless this process proved to be quite tedious and it came only to completion after the generation of the M/A policy scenarios.

In practice the reliability of the delivered data was tested as these data were fed into LEAP, which ran in order to derive correct results. After this procedure was complete, about half of the data initially used were rejected. The Excel sheet *Suggested_template* in the Excel file *All_databases* shows the typical data base template.

Table 1: Data key categories, number of subcategories and variables per key category (typical form).

Basic division in 7 catogories of the required variables	Number of subcategories	Number of variables
(1) KEY CATEGORIES	7	72
(2) ENERGY DEMAND	9	364
(3) STATISTICAL DIFFERENCES	2	22
(4) TRANSFORMATION PROCESSES	12	416
(5) STOCK CHANGES	2	22
(6) RESOURCES	2	22
(7) NON ENERGY SECTOR	6	13
ALL CATEGORIES	**40**	**931**

Each country was asked to add or adequately (using the required units) modify variables or even groups of variables if that was required by its own specificities (e.g. a specific fuel used). This proved to be risky regarding the homogeneity of the data. Situations like different arithmetic divisions (e.g. in economical and industrial data), currency-rate problems and non-availiability of data for former years played a significant role regarding the incompleteness of the delivered data and the big differentiations found among those from the 12 countries.

Technical description of the Promitheas_4 data base

General

The incompleteness of the delivered data and the big differentiations among them (already mentioned in previous session) are the reasons why the final *Promitheas_4* data base does not contain a unique table (with the country name as query) but 12 tables, each one corresponding to each beneficiary country. On the other hand, one unified data base for all countries might have resulted in a huge and unmanageable table or 12 tables full of null time series since, for example, there are countries that delivered data for the period 2007-2010 instead of the required one (1990-2010).

In Table 2 a part of the described list of variables in the Excel-type file is seen. In order to avoid the 4 levels of analysis in the tree structure (from category to variables) and primarily due to the existence of big differences in the data provided by the countries, a 3-level analysis was selected in the data base, namely category, subcategory and variable that also includes the parameter description wherever necessary.

Table 2: A part of the required data; 4 levels analysis (typical form).

CATEGORY	SUBCATEGORY	DESCRIPTION	VARIABLES-UNITS
Key Categories	Demographics	Population	Population (people)
Key Categories	Demographics	Population	Number of births (people)
Key Categories	Demographics	Population	Number of deaths (people)
Key Categories	Demographics	Population	Net migration (people)
Key Categories	Climate statistics	Precipitation	Annual mean precipitation (mm)
Key Categories	Climate statistics	Temperature	Annual mean temperature (°C)
Key Categories	Climate statistics	Frequency of extreme events	Floods per year
Key Categories	Climate statistics	Frequency of extreme events	Heat waves per year
Key Categories	Climate statistics	Frequency of extreme events	Frost days per year
Key Categories	Climate statistics	Water Resources	Surface Waters (km³)
Key Categories	Climate statistics	Water Resources	Groundwaters (km³)
Key Categories	Climate statistics	Water Resources	Overlap (km³)
Key Categories	Climate statistics	Water Resources	Total Renewable Fresh Water Resources (km³)

Installation and permissions

The user should follow the below instructions to "install" the Promitheas_4 data base in his/her computer:

1. The data base is delivered in a compressed zip file entitled *Promitheas_4.zip*. Unzip the file and you will get 2 files: *prom.mdw* and *promitheas_4.mdb*.
2. Create in your disk *C:* a folder by giving it the name *promitheas_4*.
3. Copy the files *prom.mdw* and *promitheas_4.mdb* in this folder (*C:\promitheas_4*).
4. Open the *promitheas_4.mdb* file and do the following: click on menu *Tools* and select *Security* and *Work group administrator*; in the window that pops up select *Join* and click on *Browse* to locate the file *prom.mdw* in the folder *C:\promitheas_4*; click *Open* to embed this file in the data base and finally click *OK* to close the settings in the *Work group administrator* window.
5. After the completion of instruction 4 a dialog window opens where yousimply have to give a *username* (e.g. user) and no password; click *OK* to open the data base.

A list of restrictions regarding the usage of the data base is given below:

- The user can open the countries tables, add records but he/she can not delete or modify the existing tables.
- The 4 queries per country needed for the *frmSelect* form to function can not be deleted or modified by the user.
- The *frmSelect* form can not be deleted or modified by the user.

Tables

Important remarks regarding the data base tables are the following:

- Each country is represented in *Promitheas_4* data base as a unique table entitled with the country's name, e.g. *Azerbaijan*. The data base includes 12 tables in all.
- The first 8 fields in all tables are common (see Table 3 for description).
- Each country's table has a different number of fields; this fact represents the different periods for which the countries delivered data; for example, Azerbaijan delivered data for 2007 to 2010 and that makes a total of 12 fields in the country's table (see Table

3), while Albania has a total of 29 fields with the 21 of them representing the years 1990 to 2010 for which the country delivered time series etc.

- Null (empty) time series are not included in the countries tables.

The following Table 3 describes the tables fields in the data base.

Table 3: Description of fields; e.g. Armenia.

Field name	Data type	Description
1) ID	Autonumber	It uniquely identifies each record – namely each data time series.
2) KEY CATEGORIES	Text	It represents the data key categories.
3) SUB CATEGORIES	Text	It represents the data subcategories per key category.
4) VARIABLE	Text	It represents the further classification of each subcategory per key category. In some cases it represents the final variable for which data are presented, while in others the next field entitled *DESCRIPTION* is needed to identify the variable. If necessary this field also includes further classification in its path-type name beyond the one defined by the subcategory. E.g. *Frequency of extreme events\Flash floods.*
5) DESCRIPTION	Text	It is a very important field since in many cases (as mentioned above) it is the one that uniquely identifies a specific variable. In other cases it has an auxiliary role; e.g. it clarifies that a % share variable entitled *All\Coal* in the subcategory *Households* of the key category *Demand* is a *Fuel share*.
6) Scale 7) units 8) per..	Text	3 fields that as a total represent the units used, e.g. Million \ Euro.
9) 2007 10) 2008 11) 2009 12) 2010	Numbers	Each of these fields represents the value of the specific variable for the specific year that the field name testifies. The specific group of fields is the one that differentiates – as mentioned above – the total of the fields per country table.

Regarding the content of the tables the following remarks must be made:

(a) For all the subcategories in the key category *Transformation* the variables *Maximum availability, Capacity credit, Process efficiency, Capital cost* and *Fixed OM cost* either possess unique values provided by each country or come from internal LEAP assumptions that have been applied for the whole period that the country delivered data.

(b) In some cases the LEAP model either interpolated missing values in the delivered time series or simply applied the temporally nearest real value for the missing data.

In order to increase the completeness of the Promitheas-4 data bases NOA decided to retain these records (regarding the aforementioned variables) in the tables of the countries. Both aforementioned cases (a & b) that concern the whole time series or single years, respectively, can be seen in the Excel file *All_databases* in the cells designated in yellow background.

Finally it must be noticed that in some cases several records were found to include data, which were calculated from existing ones. For example, a time series that includes the totals of a specific category energy demand could be calculated in a query by adding the totals of the energy demand for all subcategories belonging to the specific category. Nevertheless, very few such records (wherever present) have remained in the data base, thus implying technically a case of data redundancy.

The form frmSelect

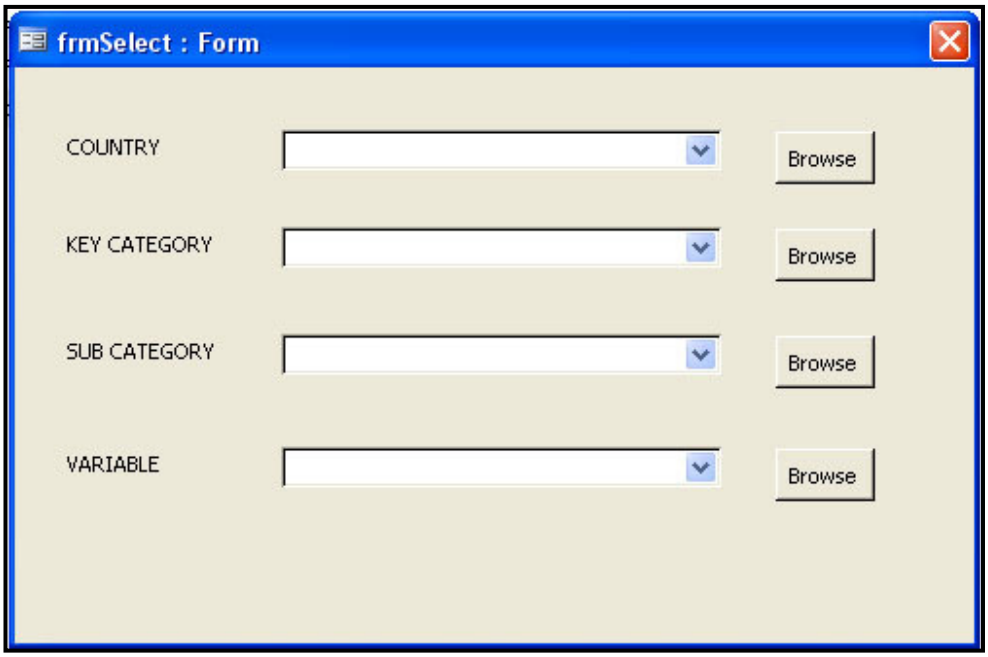


Figure 1: The form *frmSelect*[71].

The form *frmSelect* is the key functional tool for the data base users. A list of the most important properties of this tool follows:

- The form functions by calling specific queries (that exist in the data base by default), according to the user's selections.
- The user must click on the tab *Forms* to see and use the *frmSelect* form. That means that the form does not open automatically when the data base opens.
- The user must select one country at least and click the *Browse* button to see (in this case) the whole table of the selected country. If the user stops in the 2nd level of selection – namely by selecting key category apart from country – he/she must click the *Browse* button to see all data included in the specific key category and so on. The deepest that the selections can go – using the *frmSelect* form – is down to the level of variable. In this case the user sees the time series of the selected variable for all years that exist in the country's table.
- It is not possible to select more than one countries simultaneously in the *frmSelect* form but it is possible to have simultaneously open more than one queries that correspond, for example, to the 1st and the 2nd use of the *frmSelect* form by the user (see Figure 2). Specifically in the bottom part of Figure 2 the query has resulted from the following choices of the user: *Azerbaijan\Demand\Households*. Leaving the Azerabaijan's query open, the user used the *frmSelect* form once again to make the

[71] The data base has been created in a Greek version of Microsoft Access. Therefore, the screenshots inserted in the current manual may contain Greek words in the titles. That is not the case if the user opens the data base in an English version of the Microsoft Access.

choices that are seen in the upper part of the figure. In the middle part of the figure, the query is seen that resulted from the choices that the user did the second time. This process can go on so many times as the user wishes.

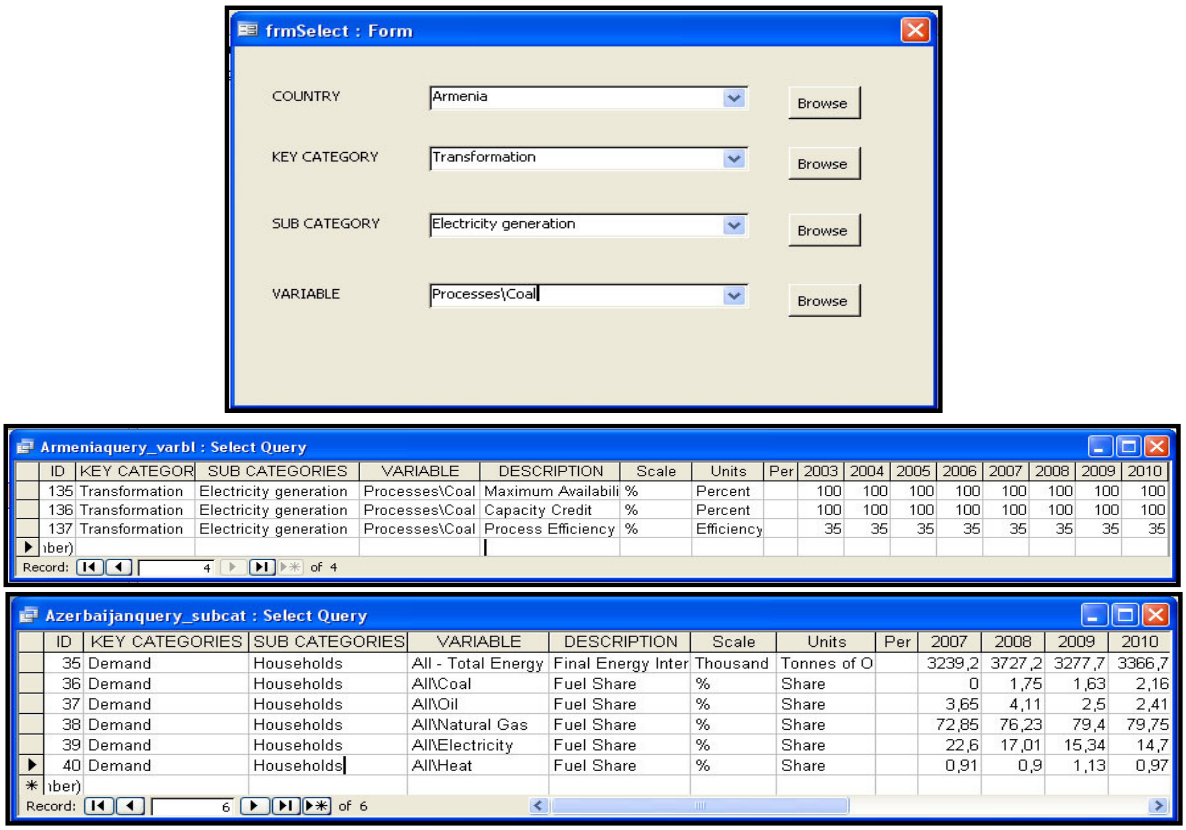


Figure 2: Using the *frmSelect* form.

Functionally the form is supported by the appropriate Visual Basic code in the background that realizes the connections between existing queries and the frmSelect form.

Queries, forms and reports

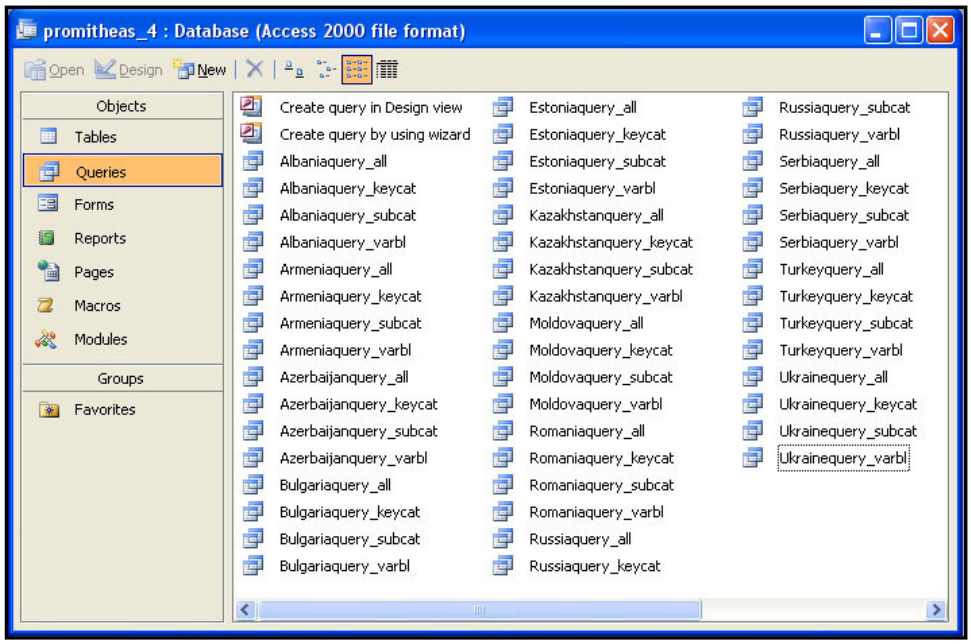
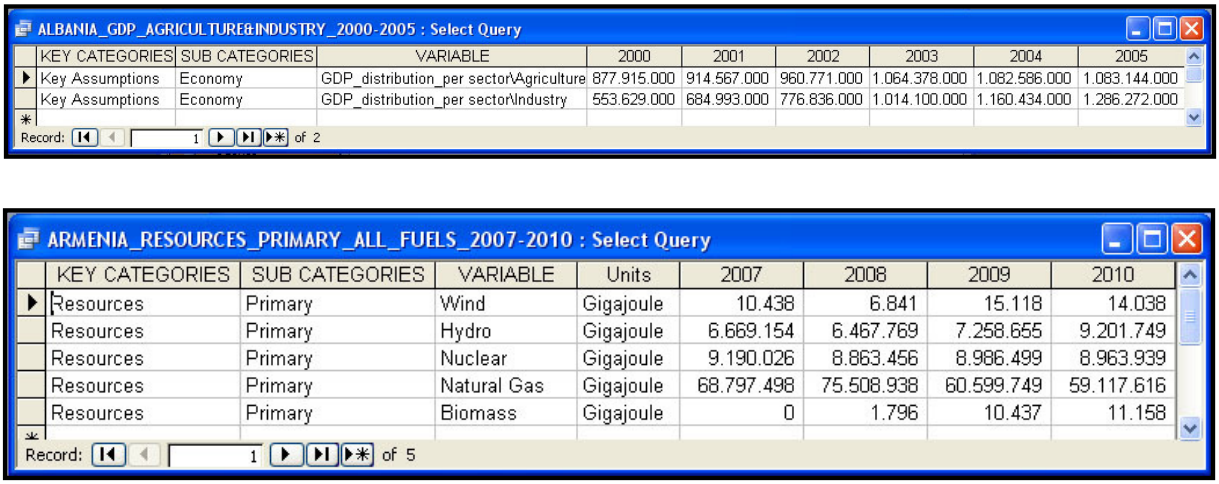


Figure 3: Queries that support the functionality of the *frmSelect* form.

The *frmSelect* form needs 4 queries per country to function as described above. In Figure 3 these queries for all 12 countries are shown. Out of these 4 queries per country the user can only open the ones entitled by *Countrynamequery_all*. The other 3 queries per country entitled by *Countrynamequery_keycat, Countrynamequery_subcat* and *Countrynamequery_varbl* are called by the *frmSelect* form according to the user's selections; these can not be opened by the user himself/herself since they need to obtain the necessary parameter externally (in this case from the form's code), i.e. the key category, the subcategory and the variable, respectively.

For every country it would be possible to create queries that would give specific answers for the data used in a more efficient way than the *frmSelect* form can provide. That would mean selection of variables. For example, the experienced user can design queries that would elaborate a temporal data search, by locating values that would satisfy specific criteria (e.g. comparative operators, =, <>, <= etc.).



ALBANIA_GDP_AGRICULTURE&INDUSTRY_2000-2005 : Select Query

KEY CATEGORIES	SUB CATEGORIES	VARIABLE	2000	2001	2002	2003	2004	2005
Key Assumptions	Economy	GDP_distribution_per sector\Agriculture	877.915.000	914.567.000	960.771.000	1.064.378.000	1.082.586.000	1.083.144.000
Key Assumptions	Economy	GDP_distribution_per sector\Industry	553.629.000	684.993.000	776.836.000	1.014.100.000	1.160.434.000	1.286.272.000

Record: 1 of 2

ARMENIA_RESOURCES_PRIMARY_ALL_FUELS_2007-2010 : Select Query

KEY CATEGORIES	SUB CATEGORIES	VARIABLE	Units	2007	2008	2009	2010
Resources	Primary	Wind	Gigajoule	10.438	6.841	15.118	14.038
Resources	Primary	Hydro	Gigajoule	6.669.154	6.467.769	7.258.655	9.201.749
Resources	Primary	Nuclear	Gigajoule	9.190.026	8.863.456	8.986.499	8.963.939
Resources	Primary	Natural Gas	Gigajoule	68.797.498	75.508.938	60.599.749	59.117.616
Resources	Primary	Biomass	Gigajoule	0	1.796	10.437	11.158

Record: 1 of 5

Figure 4: Queries that the experienced user could create[72].

In Figure 4 the following two queries are seen:

2. ALBANIA_GDP_AGRICULTURE&INDUSTRY_2000-2005: as the selected name testifies, the specific query shows the development of the GDP regarding the Agriculture and Industry sectors in Albania for the period 2000 to 2005. Since the unit is common (Euro) for all economical sectors,it is not shown.
3. ARMENIA_RESOURCES_PRIMARY_ALL_FUELS_2007-2010: as the selected name testifies, this query shows the registration of the primary resources in Armenia as far as all fuels are concerned (presented in the data base) for the period 2007-2010.

Except of the aforementioned restrictions that guarantee the Promitheas_4 data base functionality as described, the experienced user that has access to the whole functionality of an Access environment can design forms and reports using the existing tables and queries.

[72] These two queries, used in Figure 4 as example, **do not exist** in the *Promitheas_4* data base.