

UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE

# Innovation Policy for Green Technologies

Guide for Policymakers in  
the Transition Economies  
of Europe and Central Asia



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## NOTE

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## FOREWORD

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Many transition economies in Europe and Central Asia are endowed with rich natural resources and biodiversity. At the same time, global climate change and associated extreme weather events are already affecting these countries, with serious economic and social consequences.

These countries are now seeking new ways to accelerate the use of green technologies as a measure for adapting to the effects of the changing climate. For them to be successful in this effort, they need to put the right conditions in place to support the take-up and diffusion of green technologies. This will require tailor-made innovation policies that integrate and reflect each country's environmental concerns. Countries will need to strengthen the capacity of their policymakers for designing and executing these integrated policies in order to ensure suitable infrastructure, better access to external knowledge, and an enabling business environment..

This Guide reflects the findings of assessments on innovation policy—with special reference to green technologies—that were conducted by the UNECE for Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan in 2012 and 2013. It can be used as a textbook for group training or for self-learning.

At the UNECE, we are strongly committed to building the innovation capacity of our member States, as an important tool for reaching policy objectives in areas such as economic development and climate change adaptation. This guide is another important element in our “toolbox” for assisting national policy makers - one with a specific focus on supporting the adoption and implementation of green technologies. We look forward to working with countries on its application, and to seeing the results.



Sven Alkalaj  
Executive Secretary

United Nations Economic Commission for Europe



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## ABREVIATIONS

### SUBREGIONS AND COUNTRY CODES

#### *SOUTH-EASTERN EUROPE (SEE)*

Albania (ALB)	Montenegro (MNE)
Bosnia and Herzegovina (BIH)	Serbia (SRB)
The former Yugoslav Republic of Macedonia (MKD)	Turkey (TUR)

#### *EASTERN EUROPE, CAUCASUS, AND CENTRAL ASIA (EECCA)*

Armenia (ARM)	Republic of Moldova (MDA)
Azerbaijan (AZE)	Russian Federation (RUS)
Belarus (BLR)	Tajikistan (TJK)
Georgia (GEO)	Turkmenistan (TKM)
Kazakhstan (KAZ)	Ukraine (UKR)
Kyrgyzstan (KGZ)	Uzbekistan (UZB)

#### *NEW EU POST-COMMUNIST MEMBER STATES (NMS)*

Bulgaria (BGR)	Lithuania (LTU)
Croatia (HRV)	Poland (POL)
Czech Republic (CZE)	Romania (ROU)
Estonia (EST)	Slovakia (SVK)
Hungary (HUN)	Slovenia (SLO)
Latvia (LAT)	

#### *EU ADVANCED INDUSTRIAL ECONOMIES (EU-15)*

Austria (AUT)	Italy (ITA)
Belgium (BEL)	Luxembourg (LUX)
Denmark (DNK)	Netherlands (NLD)
Finland (FIN)	Portugal (PRT)
France (FRA)	Spain (ESP)
Germany (DEU)	Sweden (SWE)
Greece (GRC)	United Kingdom (GBR)
Ireland (IRE)	

#### *OTHER ECE MEMBER STATES*

Andorra (AND)	Malta (MLT)
Canada (CAN)	Monaco (MCO)
Cyprus (CYP)	Norway (NOR)
Iceland (ISL)	San Marino (SMR)
Israel (ISR)	Switzerland (CHE)
Liechtenstein (LIE)	United States (USA)

**Note:** Transition Economies in Europe and Central Asia (TECA) = SEE + EECCA + NMS.

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**ACRONYMS**

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<b>ADB</b>	Asian Development Bank
<b>CAD</b>	Canadian Dollar
<b>CAREC</b>	Central Asia Regional Economic Cooperation
<b>CBA</b>	Cost-benefit analysis
<b>CDM</b>	Clean Development Mechanism
<b>CIS</b>	Commonwealth of Independent States
<b>CO<sub>2</sub></b>	Carbon dioxide
<b>EBRD</b>	European Bank for Reconstruction and Development
<b>ECE</b>	Economic Commission for Europe
<b>EEA</b>	European Environment Agency
<b>EU</b>	European Union
<b>FDI</b>	Foreign direct investment
<b>GDP</b>	Gross domestic product
<b>GHG</b>	Greenhouse gases
<b>GII</b>	Global Innovation Index
<b>GNI</b>	Gross national income
<b>GNI</b>	Gross national income
<b>HDI</b>	Human development index
<b>HEI</b>	Higher education institution
<b>ICT</b>	Information and communications technology
<b>IDA</b>	International Development Association (member of the World Bank Group)
<b>IEA</b>	International Energy Agency
<b>IFC</b>	International Finance Corporation (member of the World Bank Group)
<b>IGES</b>	Institute for Global Environmental Strategies
<b>IPRs</b>	Intellectual property rights
<b>ISO</b>	International Organization for Standardization
<b>MSMEs</b>	Micro, small and medium-sized enterprises
<b>NGO</b>	Non-government organization
<b>NIS</b>	National innovation system
<b>OECD</b>	Organisation for Economic Co-operation and Development
<b>OSCE</b>	Organization for Security and Co-operation in Europe
<b>PES</b>	Payment for ecosystem services
<b>PISA</b>	Programme for International Student Assessment
<b>R&amp;D</b>	Research and development

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**ACRONYMS (CONTINUED)**

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<b>SMEs</b>	Small and medium-sized enterprises
<b>SPECA</b>	Special Programme for the Economies of Central Asia
<b>TECA</b>	Transition economies in Europe and Central Asia
<b>UKCIP</b>	UK Climate Impacts Programme
<b>UN</b>	United Nations
<b>UNDP</b>	United Nations Development Programme
<b>UNFCCC</b>	United Nations Framework Convention on Climate Change
<b>UNIDO</b>	United Nations Industrial Development Organization
<b>USD</b>	United States Dollar
<b>WHO</b>	World Health Organization
<b>WTO</b>	World Trade Organization

# MODULE I

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## INTRODUCTION

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## INTRODUCTION

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This module introduces key concepts that will enable you to gain a broad understanding of the challenges posed by unsustainable growth and what can be done to address them. Topics that are covered include:

- Sustainable development;
- Green growth;
- Carbon emission trends ;
- Energy efficiency trends;
- Ecological footprint and human development;
- Climate change adaptation and mitigation;
- Stages of the climate adaptation process;
- Invention, innovation and diffusion of innovations; and
- Green innovations.

Upon completion of the module, you should be able to:

- Identify the dimensions of sustainable development;
- Understand the need for a transition to green growth;
- Distinguish between climate change adaptation and mitigation;
- Understand the concepts of innovation and eco-innovation;
- Explain why policies are needed to support eco-innovation;
- Understand the discussion questions appearing in the final section; and
- Answer correctly all questions in the multiple choice quiz.

The main references utilized for the module include publications of international organizations (OECD, UNECE, UNIDO) and international financial institutions (EBRD, World Bank) that are listed in the reference page at the end of the module.

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## GREEN GROWTH AND SUSTAINABLE DEVELOPMENT

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### UNSUSTAINABLE GROWTH

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The industrial revolution has unleashed unprecedented economic growth over the last two and a half centuries, mobilizing massive resources and improving the standard of living in many parts of the world. However, this progress has been uneven, with billions of people still mired in abject poverty, and it resulted in increasing pressures on the natural environment.

In particular, air, water and the biosphere have long been regarded as public goods, owned by no-one in particular, and available free of charge as resources and as pollution receptacles. Since individual producers and consumers are typically not being charged the true cost to society of using these resources, they tend to disregard this cost in their production and consumption decisions. As a result, traditional industrial production and consumption patterns have become environmentally unsustainable. In the outcome document “The Future We Want” of the United Nations Rio+20 Conference on Sustainable Development, world leaders recognized the need to change unsustainable, and to promote sustainable, patterns of consumption and production as



an essential requirement for sustainable development. They also emphasised that adaptation to climate change represents an immediate and urgent global priority, and considered the green economy in the context of sustainable development and poverty eradication as one of the important tools available for achieving sustainable development.

## TOWARDS SUSTAINABLE DEVELOPMENT

Sustainable development entails three interdependent components – economic development, social development and environmental protection. This type of development implies sustainable consumption of natural resources and a high level of human development.

The objective of sustainable development has a broad support of international community. Governments of the UN member states have made broad commitments to environmental sustainability and poverty eradication since the early 1990s. It is expected that global leaders will strengthen such commitments in the UN post-2015 development agenda.

## GREENHOUSE GAS EMISSIONS AND CLIMATE CHANGE

Rising levels of air and water pollution became a major public concern in industrialized countries since the 1950s. This concern was reflected in government policies aiming to protect health of the public and natural environment. Since the 1970s most of these countries had environmental protection agencies or ministries that were tasked to formulate evidence-based policies and implement them with the aid of various standards and regulations. This type of government intervention was based on the insight that clean air and water are public goods (analogous to national defence or public health) that are unlikely to be provided well by markets.

Despite the initial success of environmental policies that improved air and water quality, the uninterrupted increase in greenhouse gas (GHG) emissions and loss of biodiversity indicate that economic activity has continued to be unsustainable. A large majority of climate scientists agree that climate change and global warming, caused to a large extent by human activities, are inevitable unless the GHG concentration in Earth's atmosphere can be stabilized. Carbon dioxide (CO<sub>2</sub>) is the primary greenhouse gas emitted through human activities. Since the beginning of the industrial era in the middle of the 18th century the concentration of carbon dioxide in the atmosphere has increased by 44 per cent and continues to grow. According to the latest available data, global CO<sub>2</sub> emissions are about 50 per cent over the 1990 level and rising (Olivier et al, 2013). China emits 29 per cent of global emissions, followed by the United States (16 per cent) and European Union (11 per cent). Figure 1 shows that territorial CO<sub>2</sub> emissions of Europe, Central Asia and North America have declined somewhat since 1990 while increasing strongly in other parts of the world.

Figure 2 shows that the share of Europe, Central Asia and North America in global CO<sub>2</sub> emissions decreased from 61 per cent in 1990 to 42 per cent in 2008. The decrease of the share of transition economies in Europe and Central Asia from 16 per cent to 7 per cent over the same time period is exceptional, reflecting the impact of the transition recession in the early 1990s as well as a reduction in carbon intensity of production resulting from economic restructuring and technical progress. Table 1 shows that territorial CO<sub>2</sub> emissions declined in most economies of the region between 1990

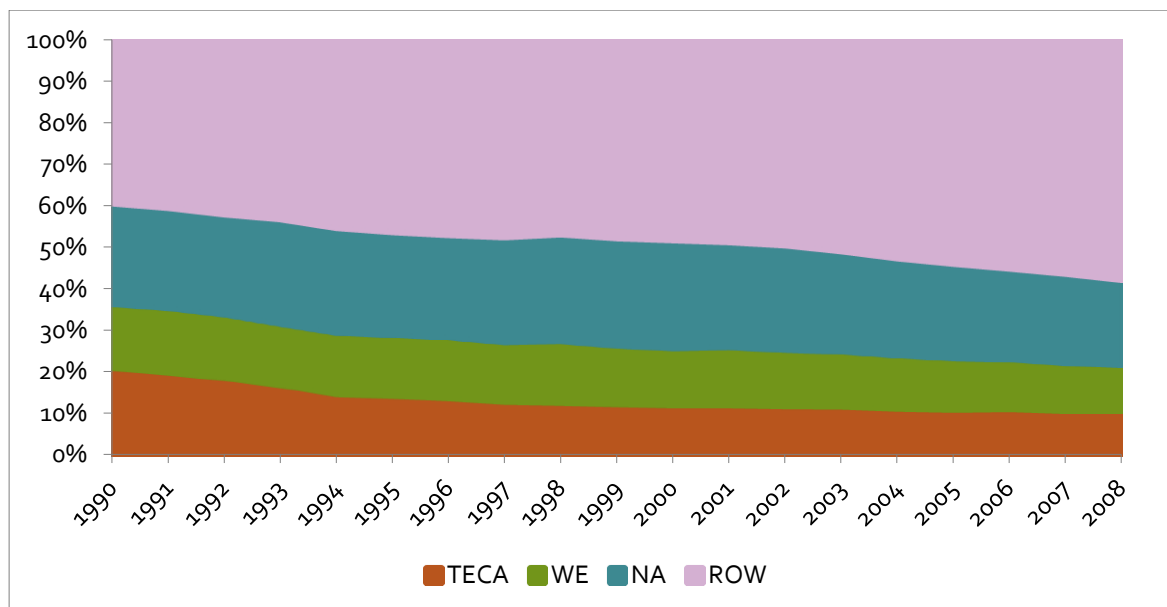
and 2008 with the exception of countries with relatively fast economic and population growth such as Turkey or the United States. However, the carbon emissions embodied in intermediate and final consumption increased in 29 countries over the same time period. This reflects to some extent the outsourcing of carbon intensive production to emerging economies outside the region. Thus sustainability remains an elusive target for the region and further emission cuts are needed in order to cope with climate change.

## THE ECOLOGICAL FOOTPRINT AND HUMAN DEVELOPMENT

Following the pioneering work of the Global Footprint Network (an international think tank of scientists based in the United States, Switzerland and Belgium), environmental sustainability is often assessed by the size of the ecological footprint that corresponds to the demand placed by economic activity on biosphere (measured by the area of land and water required to produce resources and absorb waste), given the state of technology and resource management. To ensure international comparability, ecological footprint is expressed in units of world-average biocapacity area referred to as global hectares (Borucke et al, 2013). The sustainable level of ecological footprint was estimated to be 1.8 global hectares in 2007.

Figure 3. shows that countries with a high level of human development have unsustainable levels of resource usage. And vice versa, countries with environmentally sustainable levels of resource usage (Albania, Azerbaijan, Armenia, Georgia, Kyrgyzstan, Moldova, Tajikistan and Uzbekistan) have not yet reached a high level of human development and are likely to generate heavier carbon footprints as their per capita income and consumption levels increase over time. A similar result could be obtained with alternative measures of sustainability such as carbon dioxide emissions or material consumption per capita (see UNIDO, 2012).

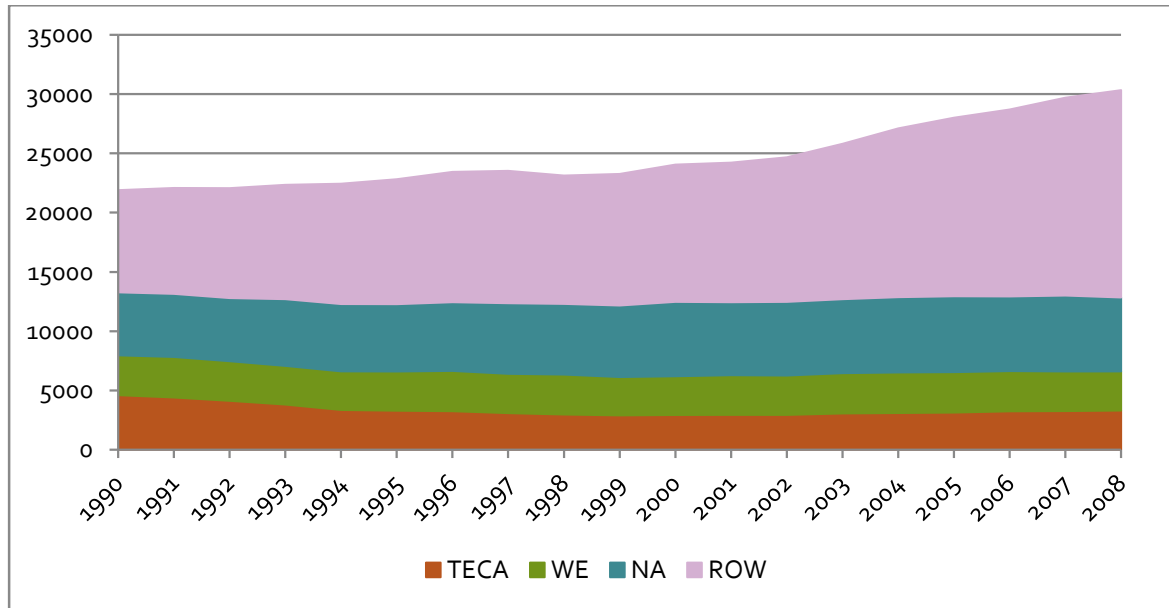
**FIGURE 1. TERRITORIAL CO<sub>2</sub> EMISSIONS BY REGION, MILLION TONNES**



*Note:* TECA = Transition economies in Europe and Central Asia, WE = Western Europe, NA = North America, ROW = Rest of world.

*Source:* UNECE calculations.

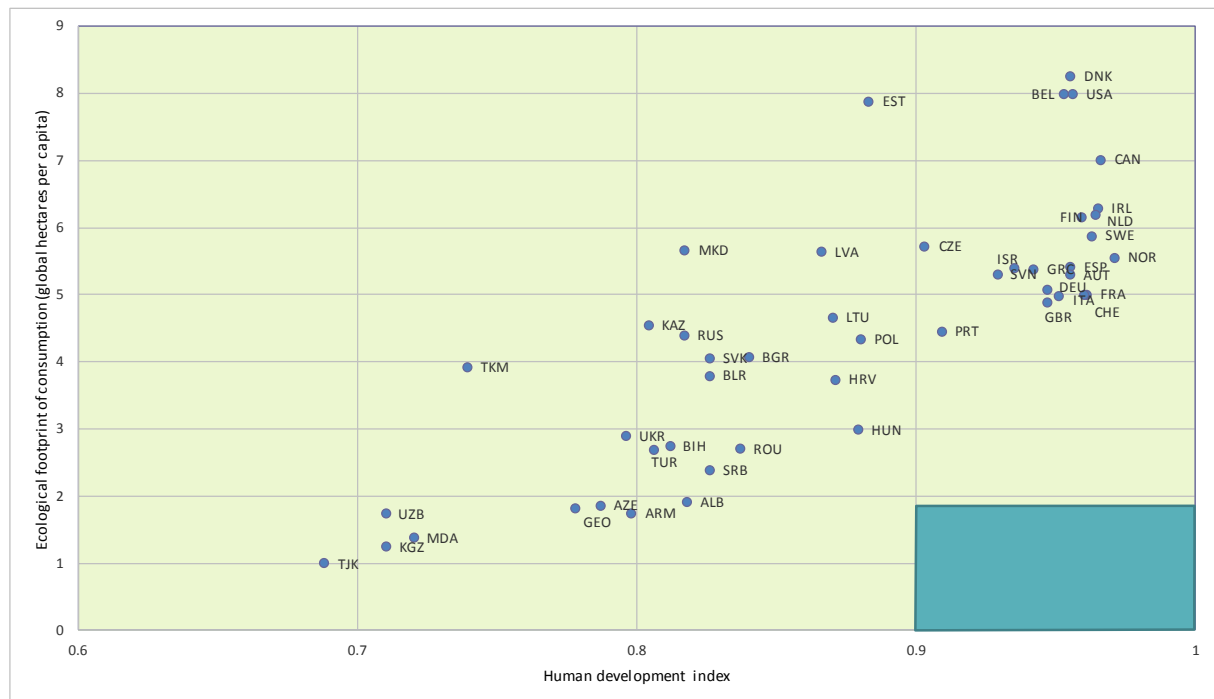
**FIGURE 2. TERRITORIAL CO<sub>2</sub> EMISSIONS BY REGION, PERCENTAGE SHARES**



*Note:* TECA = Transition economies in Europe and Central Asia, WE = Western Europe, NA = North America, ROW = Rest of world.

*Source:* UNECE calculations.

**FIGURE 3. THE ECOLOGICAL FOOTPRINT OF CONSUMPTION AND HUMAN DEVELOPMENT IN THE ECE MEMBER COUNTRIES, 2007**



*Source:* Results from National Footprint Accounts 2010 edition, [www.footprintnetwork.org](http://www.footprintnetwork.org). Extracted on October 13, 2010; UNDP (2009).

**TABLE 1. CHANGE IN ANNUAL LEVELS OF CO<sub>2</sub> EMISSIONS, 1990 – 2008**

Change in annual levels of CO <sub>2</sub> emissions, 1990-2008				
Country	Territorial	Emissions	Consumption	Emissions
	million tonnes	per cent	million tonnes	per cent
<b>Eastern Europe, Caucasus and Central Asia</b>				
Armenia	-1.1	-20.4	2.0	63.5
Azerbaijan	-21.3	-40.3	1.0	3.6
Belarus	-37.5	-35.9	5.0	8.2
Georgia	-2.9	-34.7	4.0	74.3
Kazakhstan	-51.2	-19.1	-73.0	-29.4
Kyrgyzstan	-3.5	-38.7	3.0	46.5
Moldova, Republic of	..	..	..	..
Russian Federation	-850.4	-34.8	-361.0	-21.5
Tajikistan	..	..	..	..
Turkmenistan	..	..	..	..
Ukraine	-262.1	-45.8	-146.0	-36.4
Uzbekistan	..	..	..	..
<b>South-Eastern Europe</b>				
Albania	-3.2	-42.3	-1.4	-20.7
Bosnia and Herzegovina				
Montenegro	..	..	..	..
Serbia	..	..	..	..
The former Yugoslav Republic of Macedonia	..	..	..	..
Turkey	147.0	100.6	117.1	55.6
<b>EU 28</b>				
Austria				
Belgium				
Bulgaria	-26.9	-35.0	-42.8	-45.0
Croatia	-2.0	-6.0	4.4	16.7
Cyprus	3.2	68.0	1.3	13.7
Czech Republic	-50.6	-30.9	-61.6	-37.7
Denmark				
Estonia	-11.1	-38.7	4.2	24.8
Finland				
France				
Germany				
Greece				
Hungary	-5.7	-9.1	4.2	5.6
Ireland				
Italy				
Latvia	-5.4	-41.9	7.2	100.8
Lithuania	-8.8	-37.2	-18.3	-48.3
Luxembourg				
Malta	0.3	13.2	3.5	126.9
Netherlands				
Poland	-17.6	-5.1	-64.1	-18.4
Portugal				
Romania	-69.4	-43.7	-74.5	-43.0
Slovakia	-16.2	-29.9	-10.1	-18.6
Slovenia	-2.1	-12.0	1.0	5.5

**TABLE 1. CHANGE IN ANNUAL LEVELS OF CO<sub>2</sub> EMISSIONS, 1990 – 2008** (*continued*)

Change in annual levels of CO <sub>2</sub> emissions, 1990-2008				
Country	Territorial	Emissions	Consumption	Emissions
	million tonnes	per cent	million tonnes	per cent
<b>EU 28 (<i>continued</i>)</b>				
Spain	117.2	51.2	160.2	57.1
Sweden	-3.7	-7.2	-11.6	-12.7
United Kingdom	-28.1	-4.9	101.6	16.8
<b>Other high income countries</b>				
Canada	113.4	25.2	145.4	31.9
Iceland	..	..	..	..
Israel	..	..	..	..
Norway	8.7	27.7	2.5	3.7
Switzerland	-2.1	-5.0	8.0	8.0
United States	809.4	16.6	1215.1	24.6
.. - data not available				

Source: UNECE calculations based on G. Peters et al (2010).

## HUMAN DEVELOPMENT INDEX

The level of human development is measured by a composite human development index (HDI), consisting of three components: the standard of living (measured by Gross National Income per capita), health status (measured by life expectancy at birth), and educational achievement (measured by years of schooling). More details on the measurement are provided in annual HDI reports of the UNDP.

The maximum value of the human development index is equal to one. A number of high-income countries have reached a high level of HDI that exceeds 0.9. Sustainable development is represented by the blue rectangle in Figure 3. The rectangle is empty, illustrating that no country in Europe, Central Asia and North America has been able to achieve high HDI and environmental sustainability. In fact no country in the world has been able to accomplish this feat yet.

## GREEN GROWTH AND ENERGY EFFICIENCY

Sustainable development could be supported by a transformation of the traditional economic growth model into a green growth model that achieves high employment and equitable income distribution without an irreversible destruction of natural assets and biodiversity (UNECE, 2012a). The concept of green growth assumes that economic growth objectives can be reconciled with distributional and environmental objectives. Green growth can be viewed as one of the mechanisms for achieving objectives of sustainable development (OECD, 2012).

Is the green growth model feasible? Yes, providing that energy efficiency can be improved in a major way. The energy sector accounts for about two-thirds of CO<sub>2</sub> and other GHG emissions. Energy is essential for economic development and for improving the quality of life. Ensuring sufficient, reliable and environmentally responsible supplies of energy is a major challenge for the countries of Europe and Central Asia and globally.

The global population will rise from 7 billion today to 9 billion by 2050. It will be necessary to reduce greenhouse gas emissions by 50 per cent to avert a climate change disaster while supporting economic development with the aid of secure, affordable, and sustainable energy supply. Improving energy efficiency from source to use is key to meeting this challenge.

The relatively low ecological footprint of lower income economies of transition economies in Europe and Central Asia reflects mainly low levels of consumption and in some cases (e.g. Kyrgyzstan and Tajikistan) also the high share of hydropower (a low-carbon technology) in energy supply. The energy use per unit of production tends to be comparatively high in a number of economies, which implies that their transition to higher levels of income and consumption would be environmentally unsustainable unless energy efficiency improves in a major way. Table 2 shows the evolution of energy efficiency during the 1990-2010 time period. The remarkable progress of transition economies reflects both economic restructuring and improved production efficiency. Nevertheless, resource-rich transition economies in Eastern Europe and Central Asia are still among the most energy-intensive countries in the world.

**TABLE 2. ENERGY USE (KG OIL EQUIVALENT)  
PER CAD 1,000 GDP (CONSTANT 2005 PPP CAD)**

Energy use (kg oil equivalent) per \$1,000 GDP (constant 2005 PPP \$)					
Country	1990	1995	2000	2005	2010 <sup>a</sup>
<b>Eastern Europe, Caucasus and Central Asia</b>					
Armenia	739.0	297.0	284.0	199.0	175.0
Azerbaijan	771.0	896.0	571.0	368.0	156.0
Belarus	695.0	578.0	425.0	322.0	243.0
Georgia	422.0	448.0	260.0	180.0	167.0
Kazakhstan	628.0	730.0	442.0	385.0	396.0
Kyrgyzstan	676.0	424.0	326.0	299.0	271.0
Moldova, Republic of	582.0	646.0	472.0	416.0	264.0
Russian Federation	470.0	547.0	491.0	384.0	335.0
Tajikistan	338.0	373.0	359.0	243.0	180.0
Turkmenistan	1428.0	1621.0	1388.0	819.0	572.0
Ukraine	602.0	816.0	736.0	543.0	435.0
Uzbekistan	1129.0	1278.0	1261.0	897.0	673.0
<b>South-Eastern Europe</b>					
Albania	207.0	117.0	120.0	119.0	72.0
Bosnia and Herzegovina	0.0	281.0	235.0	214.0	217.0
Montenegro	0.0	0.0	0.0	167.0	140.0
Serbia	220.0	311.0	272.0	253.0	208.0
The former Yugoslav Republic of Macedonia	156.0	199.0	184.0	185.0	153.0
Turkey	120.0	120.0	122.0	108.0	115.0

**TABLE 2. ENERGY USE (KG OIL EQUIVALENT)  
PER CAD 1,000 GDP (CONSTANT 2005 PPP CAD) (continued)**

Energy use (kg oil equivalent) per \$1,000 GDP (constant 2005 PPP \$)					
Country	1990	1995	2000	2005	2010 <sup>a</sup>
<b>EU 28</b>					
Austria	126.0	122.0	112.0	123.0	111.0
Belgium	193.0	199.0	188.0	174.0	159.0
Bulgaria	435.0	402.0	321.0	262.0	202.0
Croatia	138.0	149.0	139.0	128.0	118.0
Cyprus	127.0	130.0	132.0	117.0	119.0
Czech Republic	293.0	257.0	236.0	215.0	178.0
Denmark	133.0	132.0	110.0	105.0	110.0
Estonia	622.0	448.0	313.0	232.0	247.0
Finland	246.0	258.0	228.0	212.0	211.0
France	158.0	157.0	147.0	145.0	137.0
Germany	171.0	148.0	135.0	132.0	121.0
Greece	122.0	121.0	122.0	112.0	99.0
Hungary	211.0	214.0	179.0	161.0	150.0
Ireland	156.0	132.0	108.0	89.0	93.0
Italy	109.0	111.0	109.0	111.0	104.0
Latvia	366.0	375.0	230.0	185.0	182.0
Lithuania	377.0	353.0	232.0	192.0	180.0
Luxembourg	209.0	159.0	123.0	137.0	121.0
Malta	143.0	112.0	84.0	102.0	87.0
Netherlands	167.0	161.0	136.0	138.0	136.0
Poland	331.0	286.0	197.0	176.0	154.0
Portugal	104.0	115.0	114.0	117.0	102.0
Romania	342.0	283.0	236.0	189.0	148.0
Slovakia	317.0	306.0	259.0	216.0	158.0
Slovenia	174.0	191.0	163.0	155.0	138.0
Spain	117.0	122.0	121.0	119.0	103.0
Sweden	224.0	231.0	184.0	175.0	160.0
United Kingdom	160.0	155.0	130.0	113.0	101.0
<b>Other high income countries</b>					
Canada	279.0	283.0	252.0	240.0	212.0
Iceland	320.0	340.0	369.0	336.0	514.0
Israel	138.0	136.0	125.0	125.0	110.0
Norway	153.0	142.0	131.0	122.0	135.0
Switzerland	108.0	107.0	100.0	97.0	89.0
United States	240.0	229.0	204.0	184.0	171.0

<sup>a</sup> 2010 or latest year available.

*Note:* Energy use per GDP (Constant 2005 PPP \$) is the kilogram of oil equivalent of energy use per gross domestic product converted to 2005 constant international dollars using purchasing power parity rates. Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport.

*Source:* UNECE Regional MDG Database.

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## CLIMATE CHANGE ADAPTATION AND MITIGATION

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### CLIMATE CHANGE IMPACTS

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Global climate change and associated extreme weather events are bound to affect a number of goods-producing industries (such as agriculture, construction, energy and water utilities) as well as services (such as health, transport and tourism) and urban areas with large populations and infrastructure networks. In a few comparatively cold countries such as Canada or Russia the beneficial effects of rising average temperatures may exceed adverse effects of climate change. However, in most countries negative impacts tend to predominate (UNECE, 2012a). The available projections of local and regional climate changes imply that such impacts are likely to be considerable.

National reports on the implementation of the UN Framework Convention on Climate Change show that countries of transition economies in Europe and Central Asia are already experiencing serious climate change consequences, including warmer temperatures and a higher frequency of extreme weather events such as heat waves and floods. E.g. in 2010, a heat wave in Russia may have caused more than 50,000 deaths. In 2012, droughts destroyed over 50 percent of crops in Kazakhstan, 25 percent in Russia, and 20 percent in Ukraine. In 2013, extreme floods caused widespread damage in the Czech Republic and Russia. These weather events may well reflect adverse impacts of climate change and are expected to occur more frequently in the future. Within the region, countries of the Caucasus and Central Asia are particularly vulnerable to climate change effects (World Bank, 2009). At the same time the adaptive capacity and readiness to improve climate resilience tend to be weaker in these countries than in high-income economies.

### CLIMATE POLICIES

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Given the potentially devastating impacts of climate change, an interesting question is whether policy responses should focus on a mitigation of its rate and magnitude by reducing carbon emissions of economic activity or an adaptation to its inevitable consequences (e.g. by enhancing the resilience to extreme draught, heat waves and other adverse weather impacts). Climate change mitigation policies aim to reduce greenhouse gas emissions of economic activity. Climate change adaptation policies aim to enhance the capacity to cope with the effects of climate change.

Most studies conclude that the global cost of mitigating climate change is significantly lower than the cost of adapting to higher temperatures and extreme weather events (Shelburne, 2009). Nevertheless, there seems to be a growing consensus in the countries of transition economies in Europe and Central Asia that preventative actions including both mitigation and adaptation measures must be undertaken sooner rather than later because delays are bound to escalate the costs (UNECE, 2012a).

### ADAPTATION MEASURES

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How does one adapt to climate change? One option is to do nothing until the impacts of climate change materialize and then rely on standard disaster management. Another option is to anticipate such impacts and prepare for them with a view to reducing costs of climate disasters in the future. Figure 4 illustrates stages of a forward-looking adaptation process.



Adaptation measures aim to improve the climate resilience of infrastructure and preparedness for extreme weather events. An interesting example of adaptation measures is provided by the disaster risk-reduction activities undertaken in the Caucasus and Central Asia (Box 1).

**BOX 1. SUPPORTING DISASTER RISK REDUCTION IN THE CAUCASUS AND CENTRAL ASIA**

The governments of Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan are implementing disaster risk reduction and disaster preparedness activities at schools. These activities focus on vulnerable communities and institutions, and include:

- Addressing of needs and concerns of children while promoting a culture of safety;
- Strengthening capacities of local and national authorities in disaster preparedness and risk reduction;
- Identification and dissemination of good practices to all disaster risk reduction stakeholders;
- Incorporation of elements of disaster preparedness and risk reduction into education policies and strategies; and
- Improved ability of schools and preschools to undertake disaster preparedness and risk reduction.

Adapted from UNECE (2012a)

**FIGURE 4. STAGES OF THE CLIMATE ADAPTATION PROCESS**



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## MITIGATION MEASURES

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So far most climate policies and measures have aimed to mitigate climate change by reducing greenhouse gas emissions of economic activity. Despite ongoing mitigation efforts, carbon dioxide emissions from fossil fuel combustion are increasing, owing to investment in high-carbon infrastructure and increasing worldwide demand for energy and transport. These two sectors are responsible respectively for one-half and one-quarter of such emissions. At the same time, climate change impacts on energy networks and transport infrastructure have intensified, disrupting both local operations and global supply chains. Mitigation measures focus mainly on improvements in energy efficiency and fuel efficiency of motor vehicles. Despite a significant progress achieved by such measures, the total energy use and distance travelled by motor vehicles tend to increase more rapidly than efficiency improvements so that the volume of carbon emissions produced by energy and transport sectors continues to rise.

In the final analysis, production grows in response to effective demand for consumer goods and services. An inspection of Figure 3 implies the following question: why not improve sustainability by reducing consumption in high-income countries? Although some might prefer more leisure with less consumption to the opposite, it is extremely unlikely that a majority of people in these countries would be prepared to sacrifice their material standard of living for sustainable development (Georgescu-Roegen, 1976). It is also hard to see why most people living in low-income and middle-income countries would give up voluntarily their ambitions for higher living standards.

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## CLIMATE CHANGE SOLUTIONS

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Mitigation measures are cheaper than adaptation measures. However, benefits of mitigation are likely to materialize only in the long term and at the global level. By contrast, benefits of adaptation usually materialize in the short run or medium term at the local or regional level. This poses a problem because there are obvious incentives to renege on mitigation commitments. From a selfish local or national point of view, it would make sense to spend little on climate mitigation (while benefiting from mitigating actions of others) and invest more in adaptation with the aim to reducing negative local effects of climate change or taking advantage of positive effects (if any). Given the predominantly local nature of competitive politics, the reluctance of voters (and taxpayers) to finance measures that may benefit mainly other countries is understandable.

One possible solution to this free-riding problem is provided by international cooperation in the UN framework. In spite of diverse national interests, governments agreed at the Rio+20 conference in 2012 on a process leading towards the adoption of sustainable development goals that would become part of the UN post-2015 development agenda. The ongoing negotiations may well result in a balanced package of measures that strengthen the existing climate mitigation and adaptation pledges from UN member States and ensure increased accountability.

Even though the eradication of extreme poverty, better education, lower fertility and changing social norms may eventually reduce demand for consumer goods and services, for the time being climate change solutions will have to rely mainly on low-carbon innovations that reduce harmful environmental effects of production and consumption activities. Otherwise it is hard to see how sustainable development could be achieved by any country in the foreseeable future.

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## INVENTION, INNOVATION AND DIFFUSION OF INNOVATIONS

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### FROM INVENTION TO INNOVATION

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Classical economists such as Adam Smith in the 18<sup>th</sup> century and Karl Marx in the 19<sup>th</sup> century analyzed carefully business practices and changing production technology in various stages of industrialization. This tradition was further developed in the first half of the 20<sup>th</sup> century by Joseph Schumpeter, an Austrian economist who spent the final 18 years of his professional career at Harvard University. Schumpeter viewed new products and processes as the principal source of business cycles and introduced a useful analytical distinction between invention, innovation and diffusion of innovations.

Inventions (novel ideas or models) are generated in a more or less systematic pursuit of knowledge (technology) by various actors (university scientists, researchers in government or private laboratories, independent inventors acting on their own). A large number of inventions get patented every year and most of them never find any commercial use. Innovations are commercially viable applications of inventions, adopted by firms, households or governments. Innovations include product innovations (e.g. a smart phone), process innovations (e.g. a new manufacturing method), marketing innovations (e.g. internet advertising), and organizational innovations (e.g. team work systems). The diffusion of innovations throughout the economy is key for productivity growth and competitiveness. The capacity to absorb up-to-date knowledge and adapt imported technologies is essential for a transition of emerging market economies to innovation-based systems (UNECE, 2007).

### THE ORIGINS AND EVOLUTION OF INNOVATIONS

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While recognizing the importance of pioneering entrepreneurs for economic development, Schumpeter advanced a bold hypothesis that saw large firms with strong research and development (R&D) capabilities as the principal source of dynamic innovations and technical progress in capitalist economies. This hypothesis remains controversial until today because empirical evidence is rather inconclusive. Many major innovations were undoubtedly produced by large firms. For instance, successful innovations of Bell Labs in the United States include the transistor (late 1940s), solar cells (early 1950s), digital transmission of voice signals and communications satellites (early 1960s), mobile telephony (early 1970s), and digital signal processor (late 1970s). However, major innovations were also introduced by small start-ups created by enthusiastic young entrepreneurs. For instance, the microelectronic revolution was unleashed by Microsoft (Bill Gates and Paul Allen) and Apple (Steve Jobs and Steve Wozniak) in the mid-1970s and early 1980s.

Moreover, the overwhelming majority of inventions and innovations are incremental rather than fundamental and often take place during the diffusion process. Such incremental improvements can be discovered by large firms as well as small and medium-sized enterprises (SMEs). To understand the difference between fundamental and incremental innovations, picture technology as a large book of technical recipes. Fundamental innovations add new chapters to the recipe book. Incremental innovations entail small variations of existing recipes.

The evolution of diverse species of innovation is likely to be characterized by the continued dominance of incremental improvements. However, business leaders in 25 major economies expect that the following types of innovation will become increasingly important for the performance of their firms (Table 3):

- The development of new business models;
- The development of more sustainable processes, products or services;
- The development of entirely new products or services; and
- The development of new customer services.

**TABLE 3. BUSINESS EXPECTATIONS OF INNOVATION TENDENCIES**

What kind of innovations will/have contribute(d) the most to your company's performance?	In the past	Going forward	Change
The improvement of existing products or services	83 per cent	79 per cent	-4pts
The development of entirely new products or services	63 per cent	66 per cent	+3pts
The development of new business processes to improve profitability	61 per cent	63 per cent	+2pts
The development of more affordable new products and services	56 per cent	56 per cent	0
The development or improvement of products customized to local needs	55 per cent	53 per cent	-2pts
The development of new business models	46 per cent	52 per cent	+6pts
The development of more sustainable processes, products or services	44 per cent	48 per cent	+4pts
The development of new customer services	39 per cent	42 per cent	+3pts

*Note:* Based on responses of more than 3,000 executives from 25 countries.

*Source:* GE Global Innovation Barometer, January 2013,

(<http://files.publicaffairs.geblogs.com/files/2013/02/2013-GE-Global-Innovation-Barometer-Results-Summary-3.pdf>).

## CAPACITY FOR KNOWLEDGE GENERATION, ABSORPTION AND DIFFUSION

The capacity for knowledge generation is clearly superior in advanced industrialized countries with excellent private and public research universities, laboratories and institutes that attract best domestic and foreign talent. Although the discovery of new technology is extremely important for knowledge-based competitiveness, it does not guarantee success in a globalized competitive economy. Even business firms with strong research departments can lose market share or even go bankrupt (e.g. General Motors or Kodak).

The capacity to absorb advanced technology and diffuse it throughout the economy is essential for competitiveness. It provides an opportunity for emerging economies to catch up to higher productivity and income levels of leading industrialized countries while their firms become increasingly integrated in global supply chains. The obvious example of a successful catch-up story is provided by the Republic of Korea although a number of transition economies in Europe and Central Asia have been also catching up since the late 1990s.

In transition economies, technology transfer through the acquisition of patents, licenses and investment (both domestic and foreign) plays an important role in the catch-up process. It is important to note that the development of basic and specialized skills is needed for a successful absorption of advanced technology from abroad. In turn, the

diffusion of innovations depends on incentives of businesses, consumers and public institutions for their adoption.

## FOSTERING GREEN INNOVATION: LEADERS AND FOLLOWERS

Some experts predict that the emerging green economy will unleash a new low-carbon industrial revolution that will see huge changes in production and consumption patterns. According to them, emerging market economies, especially those in Eastern Europe and Central Asia, should participate fully in this revolution if they are not to be left behind (EBRD, 2011). Other experts are more circumspect and emphasize the questionable legacy of some low-carbon technologies (e.g. nuclear power generation) as well as physical laws that limit energy-efficiency improvements to a much greater extent than improvements in computing power or mobile telephony. Therefore, multiple small-scale green innovations are more likely than major breakthroughs (Joint Project, 2009).

To date green innovations have not unleashed a self-sustaining and cost-reducing technical progress comparable to the ICT revolution (OECD, 2011). For instance, most innovative technologies for renewable energy generation could not survive in the market without massive government subsidies. However, this may change in the future as new and cheaper green products and processes become available.

Be that as it may, green innovations (also known as eco-innovations) are likely to be important for the success of the oft-invoked diversification of transition economies. Although a number of green innovations have been adopted successfully by business firms in high-income countries, such investments are seldom undertaken in less advanced transition economies for many reasons, including outdated regulatory frameworks, environmentally harmful subsidies, weak property rights, financing constraints, and weak competition (OECD, 2012).

## WHAT CAN GOVERNMENTS DO TO SUPPORT ECO-INNOVATION?

Governments can support eco-innovation by funding research, providing grants for innovative start-ups, increasing demand for green technologies and improving the environment for doing business. Such policies will have to be coordinated across multiple domains to ensure the mainstreaming of sustainable development concerns in a variety of policy fields. The first step consists of developing a coherent national innovation programme or strategy that targets sustainable development. In this respect, Kazakhstan provides an example of good practice (Box 2).

### **BOX 2. THE STATE PROGRAMME FOR ACCELERATED INNOVATIVE INDUSTRIAL DEVELOPMENT**

The State Programme for Accelerated Innovative Industrial Development of Kazakhstan for the 2010-2014 period specifies a number of investment priorities with a view to ensuring sustainable economic development through diversification and improved competitiveness. The Programme is embedded in the national Strategy for Industrial and Innovative Development (2003-2015) that targets sustainable development and transition to a diversified knowledge-based economy.

Adapted from UNECE (2012b)

Given the uncertainty about the nature of technological progress and innovation in the foreseeable future, it would be risky for governments and public authorities to

gamble on specific technologies for climate change adaptation and mitigation. Instead government and the business sector should complement one another. This is best done if governments create a framework that enables the business sector to deploy its technology, managerial know-how and finance to full capacity. Under the right framework conditions, innovative firms and investors will be in a position to produce the services needed by government and society effectively and efficiently. These ideas will be further elaborated in subsequent modules.

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## SUMMARY

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1. Global emissions of greenhouse gases keep increasing and threaten to accelerate climate change with adverse effects on most countries. Emission trends are illustrated in Figures 1 and 2, and Table 1. Related energy efficiency trends are shown in Table 2.
2. Sustainable development implies sustainable consumption and a high level of human development. Figure 3 shows that no country achieved sustainable development to date. A transition from the industrial growth model to a green growth model can contribute to sustainable development.
3. Climate change mitigation can be achieved by measures that reduce greenhouse gas emissions. Climate change adaptation entails measures that improve climate resilience. Stages of the climate change adaptation process are illustrated in Figure 3.
4. The pursuit of knowledge results in inventions consisting of novel ideas or models. Some inventions find commercial use and become innovations. Innovations include new or improved products, processes, marketing methods or organizational forms. Most innovations are incremental improvements of existing technologies. Table 3 shows the future innovation trends expected by business leaders.
5. Green innovations or eco-innovations are less environmentally harmful than available alternatives. Advanced industrialized countries have generated and adopted green innovations extensively. Transition economies lag in this area due to a number of barriers to the absorption and diffusion of such innovations. Such barriers can be overcome with the aid of coherent policies that support eco-innovation.

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## GLOSSARY

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**Climate change** refers to a persistent change in the mean and/or the variability of climate properties.

**Climate change adaptation** refers to the adoption of policies and practices to prepare for the effects of climate change.

**Climate change mitigation** refers to the adoption of policies and practices that reduce greenhouse gas emissions of economic activity.

**Diffusion of innovations** refers to the way in which innovations spread, through market or non-market channels, to different consumers, countries, regions, sectors and firms.

**Eco-innovation** is an innovation whose use is less environmentally harmful than its alternatives.

**Green innovation** is an innovation whose use is less environmentally harmful than its alternatives.

**Green growth** is a type of economic growth that avoids unsustainable pressure on the quality and quantity of natural assets while achieving high employment and equitable income distribution.

**Greenhouse gases** refer to carbon dioxide, nitrous oxide, methane, ozone and chloro-fluorocarbons occurring naturally and resulting from human activities, and contributing to the greenhouse effect (global warming).

**Human development index** is a statistical tool used to measure a country's overall economic and social progress. The index value is determined by a weighted sum of the standard of living, health status, and educational achievement.

**Innovation** refers to new or significantly improved products, processes, marketing methods or organizational methods.

**Invention** refers to a new scientific or technical idea and the means of its embodiment or accomplishment. Most inventions are not economically feasible.

**Small and medium-sized enterprises** are independent firms with no more than 250 employees.

**Technology** refers to the state of technical knowledge.

**Sustainable development** is a process of development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains two key concepts: the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

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## ADDITIONAL RESOURCES

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The UK Climate Impacts Programme or UKCIP was established by the British government in 1997 with a view to supporting adaptation to the unavoidable impacts of a changing climate. UKCIP is based at the Environmental Change Institute at the University of Oxford and provides interesting materials pertaining to climate change adaptation without charge. These materials include climate adaptation news, case studies, tools and resources that can be accessed at <http://www.ukcip.org.uk/>.

A useful tool that can be downloaded at the same address is the UKCIP Adaptation Wizard that assists organizations with adapting to climate change through a 5-step process that has been introduced in figure 3. in an earlier part of this module. Look at the case studies of adaptations performed with the aid of the Wizard at <http://www.ukcip.org.uk/wizard/wizard-case-studies/> and consider object lessons for your own country or organization.



## QUESTIONS FOR DISCUSSION AND MULTIPLE CHOICE TEST

### QUESTIONS FOR DISCUSSION

1. Would a green growth model be beneficial to your country? Who would be the potential winners and losers?

.....  
.....

2. Consider the expected impacts of climate change in your country. Are negative impacts likely to be greater than positive impacts?

.....  
.....

3. People adapted to climate change in the past mainly by migration. Do you think that there are better adaptation options available to people affected by warmer and more variable weather in your country? If so, what are they?

.....  
.....

### MULTIPLE CHOICE TEST

Check the best answer. (Correct answers can be found on page 144)

#### QUESTION 1

Sustainable development includes the following dimensions:

- A. Economic dimension.
- B. Environmental dimension.
- C. Social dimension.
- D. All of the above.

Your answer:.....

#### QUESTION 2

Which of the following countries have reached sustainable development?

- A. All 28 Member States of the European Union.
- B. France, Germany and the Netherlands.
- C. Kyrgyzstan and Tajikistan.
- D. None.

Your answer:.....

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### QUESTION 3

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Figure 3 shows that in 2007 the level of consumption was environmentally sustainable in:

- A. Kazakhstan.
- B. Tajikistan.
- C. Turkmenistan.
- D. All of the above.

Your answer:.....

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### QUESTION 4

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The human development index is influenced by:

- A. Per capita national income.
- B. Level of education.
- C. Life expectancy at birth.
- D. All of the above.

Your answer:.....

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### QUESTION 5

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Effects of climate change mitigation policies are predominantly:

- A. Local or regional.
- B. National.
- C. Global.
- D. None of the above.

Your answer:.....

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### QUESTION 6

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Effects of climate change adaptation policies are predominantly:

- A. Local or regional.
- B. National.
- C. Global.
- D. None of the above.

Your answer:.....

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**QUESTION 7**

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Climate change mitigation policies aim to:

- A. Reduce greenhouse gas emissions.
- B. Address local impacts of climate change.
- C. Improve the distribution of national income.
- D. All of the above.

Your answer:.....

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**QUESTION 8**

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Climate change adaptation policies aim to:

- A. Address impacts of climate change.
- B. Improve climate mitigation technologies.
- C. Reduce consumption levels.
- D. None of the above.

Your answer:.....

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**QUESTION 9**

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Innovations include:

- A. Product innovations.
- B. Process innovations.
- C. Organizational innovations.
- D. All of the above.

Your answer:.....

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**QUESTION 10**

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The green growth model ...

- A. ... is based on the assumption that economic growth objectives can be reconciled with equitable income distribution and environmental sustainability.
- B. ... can help achieve sustainable development.
- C. Both A and B.
- D. None of the above.

Your answer:.....

# MODULE II

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## CLIMATE ADAPTATION CHALLENGES AND PRIORITIES IN KEY SECTORS

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## My Notes

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## INTRODUCTION

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This module will introduce you to the challenges posed by climate change in the following sectors and areas:

- Agriculture;
- Water;
- Energy;
- Transport;
- Health; and
- Urban areas.

The module will describe the basic measures needed to cope with climate change effects in various sectors and urban agglomerations. It will also show you the main building blocks of adaptation strategies.

Upon completion of this module, you should be able to:

- Identify climate adaptation challenges in vulnerable sectors and urban areas;
- Identify priority adaptation measures in vulnerable sectors and urban areas;
- Distinguish between grey, green and soft approaches to adaptation;
- Understand the discussion questions appearing in the final section; and
- Answer correctly all questions in the multiple choice quiz.

The main references utilized for the module include publications of international organizations (IEA, OECD, UNECE, WHO) and international financial institutions (EBRD, World Bank) that are listed in the reference section following the main text.

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## AGRICULTURE

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### CLIMATE ADAPTATION CHALLENGES

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Farming depends on weather conditions to a much greater extent than manufacturing and is highly vulnerable to climate change. In transition economies in Europe and Central Asia warmer and more extreme weather is expected to have uneven impacts across the region. According to a World Bank study, rising temperatures could be beneficial for agricultural output and productivity in parts of the Baltics, Kazakhstan, Russia and Ukraine. Negative effects of warmer climate on agriculture are expected to predominate in most parts of South-Eastern Europe, the Caucasus and Central Asia (with the exception of Kazakhstan).

Thus some countries (especially Kazakhstan, Russia and Ukraine) face the challenge of taking advantage of better conditions for farming (longer growing seasons and more rapid plant growth due to higher CO<sub>2</sub> concentrations). Most countries will have to focus however on improving the capacity for coping with negative climate change impacts (higher temperatures and lower precipitation in summer months, droughts and soil erosion) while making agriculture and food security more resilient to warmer temperatures and extreme weather events (World Bank, 2009). Moderate warming may accelerate plant growth but also reduce the quality of some types of forage for animals. Severe warming is likely to have negative impacts on both crops and livestock (Table 4).

**TABLE 4. CLIMATE CHANGE IMPACTS ON AGRICULTURE**

Activity	Climate driver	Impact
Crops	Moderate warming and higher CO <sub>2</sub> concentration in the atmosphere	Faster plant growth Increased yield potential
Crops	Severe warming, drought and floods	Decrease in yields
Livestock	Severe warming Heat stress Increased prevalence of parasites	Higher mortality Lower fertility Lower meat and milk production
Livestock	Higher CO <sub>2</sub> concentration in the atmosphere	Increased quantity but lower quality of forage for animals
Fisheries	Severe warming and increased acidity of oceans	Increased prevalence of disease and declines in some fish and shellfish populations

Source: US Environmental Protection Agency (<http://www.epa.gov/climatechange/impacts-adaptation/agriculture.html#impacts>).

## ADAPTATION MEASURES

Agriculture is a key economic sector in a number of transition economies in Europe and Central Asia where it provides subsistence and incomes to large rural populations. Warmer and more extreme weather reduces both crop and livestock yields, threatening the livelihood of these populations. A recent World Bank study of agricultural adaptation challenges in four of these economies (Albania, Moldova, The former Yugoslav Republic of Macedonia and Uzbekistan) identified, in cooperation with national institutions responsible for agricultural policies, agricultural research centres and local stakeholders, a number of climate adaptation priorities at national and local levels (Sutton et al, 2013). At the national level, the following were assessed as high priorities in at least three out of the four countries mentioned above:

- Improve farmers' access to adaptation technologies and information;
- Improve provision of relevant hydrometeorological information to farmers through mass media; and
- Encourage private-sector involvement to improve agricultural productivity.

At the local (agro-ecological zone) level, the following were identified as high priority adaptation measures in at least one zone:

- Improve irrigation water infrastructure and efficiency;
- Rehabilitate irrigation infrastructure;
- Rehabilitate/construct water storage infrastructure;
- Improve agricultural practices and techniques;
- Improve availability of irrigation water;
- Rehabilitate and build new small-scale water storage;
- Implement floodplain management measures;
- Improve drainage infrastructure;
- Optimize agronomic inputs (fertilizer application and soil moisture conservation);
- Improve crop varieties; and
- Improve livestock management, nutrition and health.

Local and national priorities in structurally similar countries are likely to resemble the ones listed above. In any case, the priorities for adaptation should reflect specific

national and local conditions. It is important to note that in some cases a relocation of farming activities to areas less affected by adverse weather conditions may be the best adaptation option.

The availability and use of water in the agricultural sector is a particularly important issue in the Caucasus and Central Asia. Agriculture accounts for a large share of water consumption, equal to 55 per cent in Kazakhstan, 69 per cent in Azerbaijan, 84 per cent in Kyrgyzstan and 90 per cent in Uzbekistan (OECD, 2012). Water losses are huge and increasing with warmer temperatures and a slow deterioration of the ageing infrastructure. Unsustainable irrigation schemes, inherited from the Soviet era, are conducive to soil erosion and increasing salinity. Even if the water supply is improved and wasteful use limited, a switch to less water-intensive crops and new farming methods seems to be the most attractive adaptation option in the long term (10-20 years).

The World Bank study mentioned above concludes that unless adaptation measures provide support to farmers with improved water management and irrigation infrastructure, wider access to technology and information, and better land management and farming practices, climate change in parts of Eastern Europe, Caucasus and Central Asia could reduce significantly food production and rural incomes over the next decades. Available techniques and best practices should be used to boost agricultural productivity in today's climate while building resilience to warmer and more variable weather.

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## WATER

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### CLIMATE ADAPTATION CHALLENGES

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Water and other natural resources are already under unsustainable pressure from human activity. In addition they are strongly affected by warmer and increasingly extreme weather. Actual or potential climate change impacts in transition economies in Europe and Central Asia include:

- Changes in the volume, timing and quality of water flows;
- More frequent and severe water shortages;
- Intensified erosion and sedimentation;
- Increased rainfall variability and consequent droughts, floods and storms;
- Reductions in glaciers and snow cover;
- Sea level rise; and
- Damage to water quality and ecosystems.

These impacts have knock-on effects on water-using sectors, including agriculture (irrigation), health, energy (hydroelectricity generation and cooling of thermal plants), water utilities (water services for households and industry) and tourism.

The increased water scarcity in some parts of the Caucasus and Central Asia presents considerable adaptation challenges not only at the local level but also at the international level because transboundary water resources are critical for competing uses (such as hydropower generation and irrigation in water-intensive agriculture) in neighbouring states. This international dimension to climate change adaptation presents a growing potential for conflicts over the use water resources. For instance, unilateral infrastructure investment decisions taken in one country can have negative effects on



riparian countries. Thus, in addition to the uncertainty over climate change impacts, countries are faced with uncertainty about their neighbours' reactions. Therefore, transboundary water management is one of the most important climate adaptation challenges.

Table 5 shows the location of supply of main water resources in Central Asia. Tajikistan and Kyrgyzstan are well endowed with water resources, accounting for over 70 per cent of the regional total. However, Turkmenistan and Uzbekistan tend to experience water shortages due to the irrigation-intensive agricultural system inherited from the Soviet era. The tensions between the main suppliers and users of water could intensify with rising temperatures that have already caused a rapid melting of glaciers in Tajikistan and, to a lesser extent, in Kyrgyzstan. These glaciers contribute significantly to the runoff of major rivers in the subregion (World Bank, 2009).

**TABLE 5. SUPPLY OF WATER RESOURCES IN CENTRAL ASIA**

Country	Amu Darya River basin	Syr Darya River basin	Balkash Lake basin	Issyk-Kul Lake basin	Terim River basin	Total (km <sup>3</sup> per year)	Share in regional total
Kazakhstan	-	-	28	-	-	28	18 per cent
Kyrgyzstan	2	34	0	4	7	47	30 per cent
Tajikistan	63	1	-	-	1	65	41 per cent
Turkmenistan	3**	-	-	-	-	3	2 per cent
Uzbekistan	5	4	-	-	-	9	6 per cent
Total	79*	38	29	4	8	157*	100 per cent*
Contribution to total	50 per cent	24 per cent	19 per cent	2 per cent	5 per cent		100 per cent

*Note:* \* Includes the contribution of Afghanistan to the Amu Darya runoff (6 km<sup>3</sup> per year).

\*\* Includes a small contribution of Iran in Amu Darya runoff.

*Source:* Adapted from World Bank (2009).

## ADAPTATION MEASURES

At the national level, adaptation measures in the water sector depend on the nature of main challenges. A comprehensive overview of such measures is provided in UNECE (2009). In flood-prone areas, they include:

- Restriction of urban development in flood-risk areas;
- Improved dam safety and afforestation to prevent mudflows;
- Construction of dykes and resilient housing;
- Land use management;
- Relocation of people from high-risk areas; and
- Upgrading of transport infrastructure.

In drought-prone areas, adaptation measures include:

- Water conservation techniques (e.g. recycling and reuse of wastewater);
- Water saving (e.g. permits for users);
- Fostering of water-efficient technologies and practices (e.g. irrigation);
- Changing agricultural practice (e.g. switching to drought-tolerant crops);
- Increasing the availability of water (e.g. building up reservoir capacity);
- Improving groundwater management;
- Improving waste water treatment; and
- Increasing protected areas.

With respect to trans-boundary water resources, international cooperation is key. The recent agreement between the governments of Moldova and Ukraine to manage jointly the Dniestr river basin is an interesting example of good practice in this area (Box 3).

**BOX 3. JOINT MANAGEMENT OF THE DNIESTER RIVER BASIN BY UKRAINE AND THE REPUBLIC OF MOLDOVA**

The Dniester River shared by Moldova and Ukraine is likely to be affected by climate change leading to warmer and wetter winters and hotter, drier summers. Flooding is a major trans-boundary problem on the Dniester. Climate impacts on water resources also have a cascading effect on the population of the basin and other sectors such as agriculture, power generation, recreation, fisheries and biodiversity. The bilateral Treaty on Cooperation on the Conservation and Sustainable Development of the Dniester River Basin was signed by representatives of Moldova and Ukraine on 29 November 2012.

Representatives of diverse water users, sectors, regions and authorities along the Dniester River met in July 2013 to discuss the risks and measures that can minimize them and protect the population, infrastructure and natural landscapes of the basin. The participants suggested that climate change impacts on groundwater levels and runoff should be addressed through improved management of water reservoirs in the basin, better information exchange between Ukraine and the Republic of Moldova, especially in situations such as extreme weather events, reforestation and the restoration of critical ecosystems. The stakeholder workshop was held in the framework of the new project “Climate change and security in the Dniester basin” carried out by the UNECE and OSCE, under the Environment and Security Initiative (ENVSEC). The project is supported by the Austrian Development Agency with funds from the Austrian Development Cooperation and the European Commission.

(UNECE press release, 13 July 2013)

Another example of international cooperation is provided by the 1998 inter-governmental agreement between Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan on the use of water and energy resources of the Syr Darya basin. The agreement links cross-border water deliveries from upstream countries (Kyrgyzstan and Tajikistan) to the provision of energy supplies such as coal, natural gas and fuel oil by downstream countries (Kazakhstan and Uzbekistan). If the basin suffers low river flows, the countries can agree to barter water for energy supplies in order to save water for irrigation in the growing season (e.g. in Kazakhstan) which otherwise would have been released in winter for hydro-energy production (e.g. in Kyrgyzstan). This mechanism

could enable the signatory states to adapt to changes in water availability. However, the implementation of the agreement has been ineffective (UNECE, 2009).

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## ENERGY

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### CLIMATE ADAPTATION CHALLENGES

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The energy sector is vulnerable to climate variability and extreme weather events (Table 6). Warmer summers, intense heat waves and unexpected changes in precipitation have negative effects on power generation and transmission as well as transportation of oil and gas. Warmer temperatures may however improve the access to the oil and gas resources in the Arctic, resulting in advantages to energy producers in countries like Canada and Russia. Temperature variations between and within years are likely to increase the vulnerability of energy infrastructure and operations. According to the climate studies reviewed in Ebinger and Vergara (2011), Europe and Central Asia is the only region in the world with large inter-annual temperature variations (up to 5° C). In addition, large changes in the temperature variability projected for the region imply that the vulnerability to climate change may well increase over time even if mitigation policies would achieve the targeted stabilization of greenhouse gas emissions by the mid-century.

High temperatures that reduce the availability of cooling water for power plants affect both nuclear and thermal energy supply. It is interesting to note in Table 6 that energy supply from renewable sources (hydro, wind, biofuels, solar) is also vulnerable to climate change. Therefore the expansion of renewables that is routinely pursued by climate mitigation policies does not improve energy security by itself. However, investment in locally renewable energy sources can improve resilience to climate change if it increases the decentralization and flexibility of the energy system (IEA, 2010).

The experience of advanced industrialized economies suggests that energy demand in transition economies in Europe and Central Asia is likely to be influenced by climate change as follows. Warmer weather is likely to shorten the heating season and thus reduce demand for energy. However, the increase of energy used for cooling in summer months should increase demand and also peak demand during heat waves. These effects are likely to offset the energy-saving effect of warmer winters to some extent and can also overload the transmission system at critical times.

Improvements in energy efficiency can reduce the stress on energy delivery systems, making the adaptation less capital intensive. Table 3, introduced in the first module, shows that a number of transition economies have a huge potential for increasing energy efficiency. Significant energy savings could be achieved in industrial, housing and transport sectors, providing that these economies continue to catch up to energy efficiency levels of leading countries (EBRD, 2011). Energy-efficient building codes and fuel-efficient vehicle standards would be particularly important in this context. The catch up would reduce significantly the household and industrial demand for energy, making the energy system less vulnerable to changing weather conditions.

**TABLE 6. CLIMATE CHANGE IMPACTS ON ENERGY SUPPLY**

Source	Climate driver	Impact
Hydro power	Heat waves Extreme events	Increased uncertainty of energy output Revisions of transmission needs
Wind power	Alteration in wind speed frequency	Increased uncertainty of energy output
Biofuels	High temperatures Extreme events	Reduced thermal generation efficiency
Solar power	High temperatures Extreme events	Reduced solar cell efficiency Increased uncertainty
Thermal power plants	High temperatures Extreme events	Reduced energy generated Increased uncertainty
Nuclear power plants	High temperatures Extreme events	Reduced energy generated Increased uncertainty
Oil and gas	Extreme events	Reduced energy generated Increased uncertainty

*Source:* Adapted from Ebinger and Vergara (2011).

Energy and water systems are closely linked because changes in production or consumption of one resource require the use of other. Warmer and more variable weather affects both sectors and makes the allocation of water for energy, agriculture and other competing uses extremely important within and between countries, especially in Central Asia. This implies that integrated planning is needed, at both national and regional levels.

## ADAPTATION MEASURES

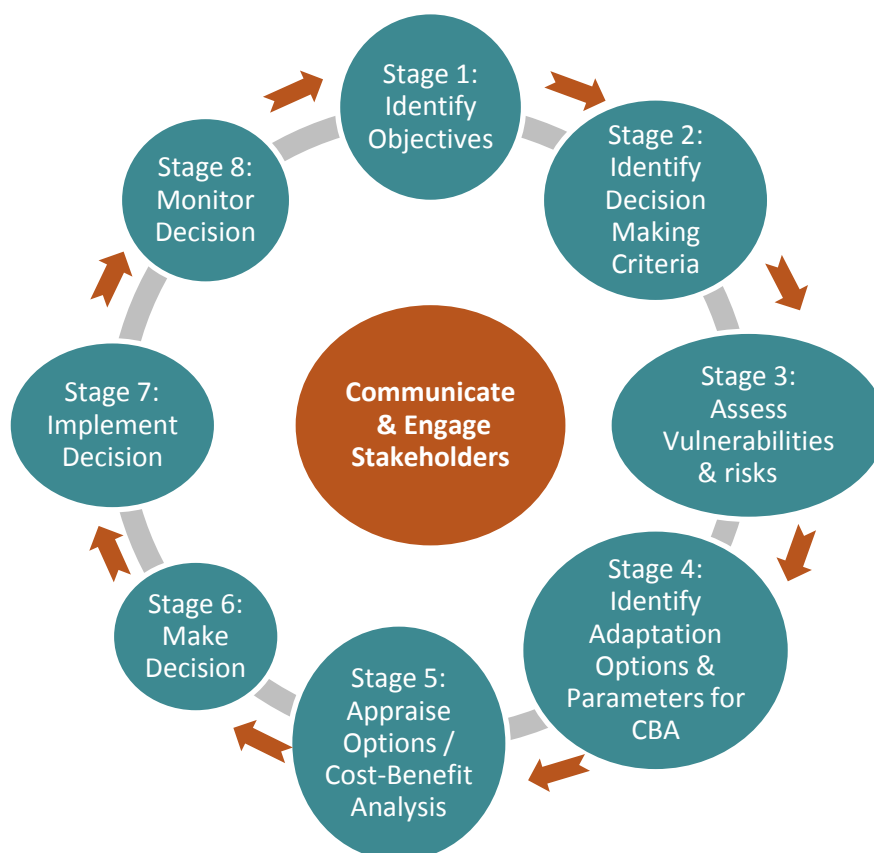
The World Bank has identified a list of near-term actions to support climate change adaptation of the energy sector (Ebinger and Vergara, 2011). The following adaptation measures are particularly relevant for countries of transition economies in Europe and Central Asia:

- Explore interactions between water and energy balances;
- Improve the understanding of climate change impacts on renewable resource potential;
- Explore synergies and tradeoffs between mitigation and adaptation strategies for the energy sector; and
- Identify technological and behavioural options to save cooling energy and reduce peak load demand for electricity.

Given the uncertainty about a precise timing and geographical pattern of future climate change impacts, policy makers have to consider systematically the available options for coping with such impacts. One option is simply to do nothing, wait for such impacts and cope with them subsequently. Alternative options include an adoption of various adaptation measures with associated costs and benefits. But which measures should be adopted? Decision makers need to avoid both under-adaptation (i.e. spending too little on adaptation measures and incurring huge climate change damages) and over-adaptation (i.e. spending too much on measures that prove to be wasteful). Figure 5 provides a schematic illustration of a risk-based approach to climate change adaptation. This approach enables decision makers to choose best adaptation options in uncertain situations with the aid of the cost-benefit analysis (CBA). CBA compares systematically

costs and benefits of various adaptation measures, making the choice of cost-efficient options feasible.

**FIGURE 5. A RISK-BASED APPROACH TO CLIMATE CHANGE ADAPTATION**



Source: ESMAP (2010).

There are eight stages in the risk-based approach:

- Identification of objectives;
- Identification of decision making criteria;
- Assessment of vulnerabilities and risks;
- Identification of adaptation options and criteria for cost-benefit analysis;
- Appraisal of options with the aid of cost-benefit analysis;
- Selection of the best option;
- Implementation of the option selected; and
- Monitoring of outcomes.

The risk-based approach has been used by the World Bank experts and domestic stakeholders in Albania and Uzbekistan to identify adaptation priorities in the energy sector (Box 4). The first five stages of the assessment process depicted in figure 5. took 5 - 8 months while costs per country averaged USD 200,000 (ESMAP, 2010).

**BOX 4. ENERGY ADAPTATION IN ALBANIA AND UZBEKISTAN**

The World Bank has developed a hands-on energy adaptation toolkit (HEAT) that provides a framework for assessing climate change vulnerabilities and adaptation options in the energy sector. The toolkit was used in Albania in 2009 and Uzbekistan in 2010. The assessment helped energy stakeholders in both countries to identify priorities to support climate smart development. The online version of the toolkit is available at <http://www.esmap.org/esmap/heat>.

The following critical adaptation actions were identified in Albania, a transition economy where 90 per cent of electricity is generated in hydro power plants:

- Improve the quality and dissemination of weather and climate forecasts for energy sector planning;
- Improve energy efficiency and demand-side management;
- Diversify energy supply domestically and through trade;
- Ensure that the management and development of water resources integrates energy, agriculture, water supply and sanitation, and cross-border concerns as well as environmental and social concerns; and
- Build climate resilience into all new investments.

Similar priorities may well be relevant for structurally similar economies. In most transition economies, housing accounts for a substantial portion of energy demand and CO<sub>2</sub> emissions. Energy efficient housing would thus contribute to climate change mitigation (through reduced emissions) as well as to adaptation (by reducing the stress on energy supply networks during peak heating and cooling periods).

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## TRANSPORT

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### CLIMATE ADAPTATION CHALLENGES

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Climate change is expected to have major impacts on both freight and passenger transport. Although most impacts are expected to be adverse, some may be beneficial. For instance, warmer weather can open sea-lanes in the Arctic Ocean for large-scale commercial shipping. This would cut the distance and time needed for transport of goods between Europe, America and Asia, reduce costs of trade and contribute to climate change mitigation (through lower greenhouse gas emissions).

However, in most parts of Europe and Central Asia climate change is likely to have predominantly negative impacts on transport infrastructure and operating conditions. This may pose a particular problem for economies of Central Asia that have to overcome extremely long distances to nearest seaports and challenging weather conditions for transport infrastructure maintenance and operations. Potential effects of climate change on transport infrastructure in the road and rail sectors are illustrated in Table 7.

**TABLE 7. CLIMATE CHANGE IMPACTS ON ROAD AND RAIL INFRASTRUCTURE**

Mode	Climate driver	Impact
Road	Heat waves	Melting asphalt Damage to bridges
	Droughts	Degradation of road foundations
	Increased frequency of extreme rainfall	Landslides and subsidence Damage to bridges
	Floods	Loss of road strength and bearing capacity
	Extreme heat and cold variability	Damage to road surfaces and more frequent maintenance
Rail	Increased frequency of extreme rainfall	Increased risk of flooding of rail lines
	Increased winter precipitation, drier summers and higher temperatures	Increased scour of bridges, instability of embankments and rail buckling
	Heat waves	Degradation of power transmission, slope fires and overheating of rolling stock equipment
	Storms, high winds and thunderstorms	Damage to installations, over-voltage and effects on signaling

Source: Adapted from UNECE (2011).

## ADAPTATION MEASURES

The climate change adaptation needs in the transport sector have yet to be assessed systematically in most countries. Some priority adaptation actions for various transport modes have been recommended recently by an intergovernmental group of experts on climate change impacts and adaptation in transport (UNECE, 2013). The recommendations pertaining to the road and rail sectors are presented below in an abbreviated form.

- Road owners should systematically define climate risks and assess consequences at network level (e.g. by identifying flood-prone hotspots and temperature sensitive network sections), and initiate the development of strategies to mitigate such risks in a cost-effective manner;
- The road design, construction and operation should include:
  - risk assessments that evaluate the exposure, sensitivity, vulnerability, resilience and adaptation responses of the road systems,
  - planning of timeframes that consider longer-term climate change effects,
  - adaptation strategies (including implementation procedures);
- National policies for road transport should include awareness raising and good practice sharing schemes, as well as more strategic and long-term approaches to spatial planning;
- In the rail sector, a constructive way forward is to begin quantifying changes related to safety risk and traffic delays that are likely to be induced by unforeseen weather events while taking into account:
  - different types of weather sensitive infrastructure and their spatial distribution (e.g. track, drainage, overhead electrification equipment),
  - historical data on the delays caused by weather-related incidents,
  - current values used in risk models for weather-related precursors to hazardous events and predicted harm to people,

- quantitative estimates of likely changes in the occurrence of extreme events, based on current industry intervention levels (temperature, flood levels, wind gust speeds, etc.),
- common education and awareness improvements, starting within the railway industry staff;
- Studies of impacts of more frequent extreme storms and, in particular, of intense downpours, heat waves, floods and extreme winds on the rail network should not only assess accident risks in the design process (standard practice) but also identify precautionary measures needed to improve resilience to climate change; and
- Rail infrastructure is designed to be used over long periods of time (often > 100 years) and therefore climate adaptation needs should be considered well in advance.

The expert group recommendations pertaining to inland waterways are not listed here, given their limited importance for transport networks in the Caucasus and Central Asia. However, three countries of the subregion (Azerbaijan, Kazakhstan and Turkmenistan) have ports on the climate-sensitive Caspian Sea. Therefore, some of the recommendations of the expert group pertaining to ports might be of interest:

- Facilities that face manageable risks might require mostly risk management and emergency response planning while termination of port facilities should be the last resort only;
- To understand the significance of climate change-induced risks for a given port, it is necessary to analyze the factors affecting the port performance and evaluate weather impacts, taking into account existing vulnerabilities, critical thresholds and climate change assessments/forecasts; and
- The extent of climate change impacts on ports will vary greatly, though there are some key risk areas that all ports should consider.

Similarly as in other sectors, the priority of adaptation measures can be determined with the aid of cost-benefit analysis. Transport decision makers can use guidelines for applying the cost-benefit analysis in countries with transition economies that are available in English, French and Russian versions (UNECE, 2003). These guidelines provide a useful planning tool that can facilitate considerably the appraisal and selection of transport infrastructure projects.

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## HEALTH

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### CLIMATE ADAPTATION CHALLENGES

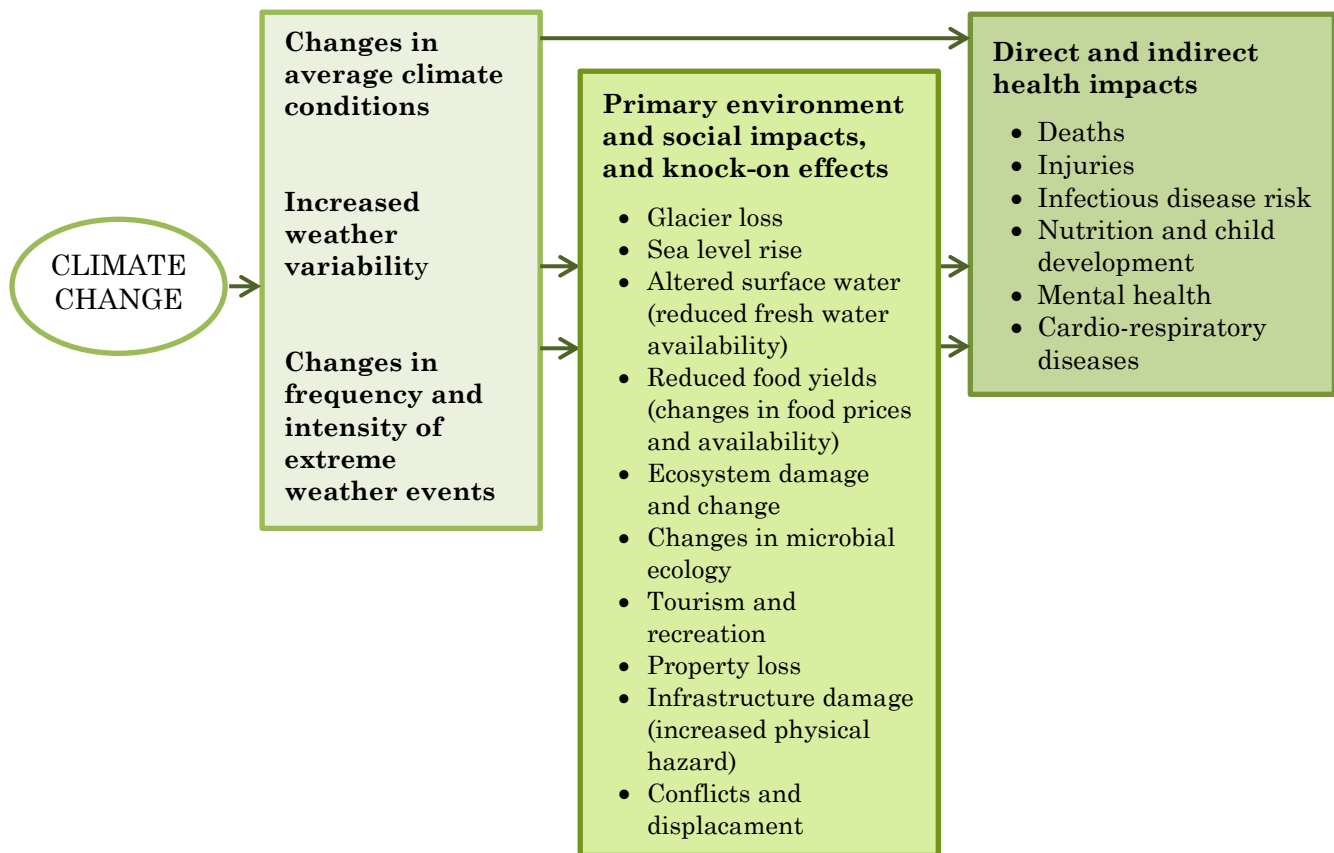
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A number of health experts consider climate change to be the biggest health threat in the 21<sup>st</sup> century (Costello, 2009). Direct health consequences of heat waves, extreme weather events, and temperature-enhanced levels of urban air pollution are well known. Indirect risks are related to climate change effects on food yields, water flows, infectious-disease vectors, and (for zoonotic diseases) intermediate-host ecology. Other indirect impacts manifest themselves as mental health problems in failing farm communities, displaced groups, disadvantaged indigenous and minority ethnic groups (McMichael, 2013).



Warmer and more extreme weather is reflected in an increasing incidence and intensity of floods, heat waves and draughts. Extreme weather events pose a number of direct and indirect public health risks. Direct risks include heat exhaustion and fires caused by heat waves. For instance, the 2003 heat wave caused some 70,000 deaths in Europe and Central Asia. The 2010 heat wave in Russia caused probably some 55,000 premature deaths. Another direct risk is posed by floods that killed hundreds of people since 2000 in Central and Eastern Europe, the Caucasus and Central Asia. Landslides in the Caucasus and Central Asia contributed to the revival of malaria in late 1990s, a disease thought to have been eradicated. Indirect risks result from consequences of extreme weather events such as malnutrition and migration. Figure 6 illustrates both direct and indirect impacts of climate change on health.

**FIGURE 6. CLIMATE CHANGE IMPACTS ON HEALTH**



Source: Adapted from McMichael (2013).

## ADAPTATION MEASURES

According to UN estimates some USD 73 billion per year will be needed globally for adaptation measures by 2030, including USD 5 billion spent directly by the health sector and over USD 25 billion by sectors influencing public health, such as water supply and sanitation. Most governments have however no reliable estimates of climate adaptation expenditures by sector.

Responses to climate change challenges in the health sector in advanced industrialized countries include initiatives that aim to improve:

- Research of links between climate change and disease;
- Training of health professionals;

- Monitoring of emerging health risks;
- Public communication pertaining to specific health risks;
- Identification of vulnerable groups (e.g. children, seniors, marginalized groups); and
- Emergency response plans.

In spite of these initiatives, public health responses to warmer and more unpredictable weather are predominantly reactive rather than anticipatory. The situation tends to be worse in transition economies where the funding for public health systems is relatively modest and the cost of extreme weather events in terms of fatalities and diseases relatively high. An ongoing pilot project in Uzbekistan may produce some interesting lessons for climate change adaptation in the health sector for other countries of the Caucasus and Central Asia (Box 5).

**BOX 5. PILOT ADAPTATION MEASURES TO PROTECT HUMAN HEALTH IN UZBEKISTAN**

Uzbekistan is one of the seven countries participating in the first global climate change and health adaptation project administered by the World Health Organization and United Nations Development Programme. The project seeks to find solutions for the health risks caused by climate change. In Uzbekistan, the project aims to pilot adaptation measures in Tashkent and Syrdarya provinces during the 2011-2014 period. Expected benefits of the project include:

- Reduction of the acute intestinal, cardiovascular and respiratory diseases induced by climate change;
- Improved general health of population;
- Development of skills to monitor climate change and make preventive steps to minimize negative health impacts;
- Enhanced knowledge of the general public about self-protection against climate-sensitive diseases; and
- Development of practical tools to cope with climate variability and change.

Additional information about the project is available at:

<http://www.adaptationlearning.net/project/piloting-climate-change-adaptation-protect-human-health-uzbekistan>.

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## URBAN AREAS

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### CLIMATE ADAPTATION CHALLENGES

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Climate change impacts tend to be most powerful in cities with high concentrations of population and interconnected infrastructure networks. In Europe about 75 per cent of people live in urban areas (EEA, 2012). In Central Asia the share of population living in urban areas is projected to rise from 47 per cent at present (ranging from 27 per cent in Tajikistan to 55 per cent in Kazakhstan) to 55 per cent in 2050 (Center for Economic Research, 2013).

The climate change impacts affecting cities in Europe and Central Asia result mainly from heat waves, floods, water scarcity and droughts (Table 8). Given the economic importance of urban agglomerations, the cost of such impacts in terms of human life and lost income and wealth can be considerable. For instance, the average cost of water scarcity and droughts in the European Union exceeds 6 billion euros per year (EEA, 2012).

**TABLE 8. CLIMATE CHANGE IMPACTS ON URBAN AREAS**

Climate driver	Impact
Heat	Loss of life Energy supply interruptions Water supply problems Deterioration of transport services
Flooding	Loss of life and disease (contamination, post-traumatic stress disorders) Disruption of communications network Damage to infrastructure (energy, transport, water utilities) Damage to private and public property Deterioration of groundwater quality
Water scarcity and droughts	Water-borne infectious diseases Water supply problems Energy supply interruptions Deterioration of groundwater quality Damage to buildings

*Source:* Adapted from EEA (2012).

## ADAPTATION MEASURES

Three basic adaptation approaches can be used to address climate change impacts in urban areas: gray, green and soft (EEA, 2012). The ‘grey’ approach aims to enhance the climate resilience of infrastructure and protect people with the aid of physical interventions and construction measures. The ‘green’ approach aims to improve the resilience of ecosystems and use their services to achieve adaptation solutions. The ‘soft’ approach uses spatial planning, knowledge transfer and economic incentives to reduce vulnerability and encourage adaptive behaviour. Associated with the specific approaches are innovative grey, green and soft technologies for climate change adaptation.

Grey adaptation measures in European cities include:

- Climate proofing of buildings;
- Innovative design of new buildings to enhance resilience;
- Intelligent urban design to improve ventilation;
- Maintenance and upgrades of municipal water, sewage and drainage systems;
- Dams and flood defenses;
- Water saving devices;
- Water recycling systems;
- Rain water harvesting systems;
- Water supply from remote areas (pipelines); and
- Desalination plants.

Green adaptation measures include:

- Expansion of green urban areas (parks, gardens, wetlands, green roofs);
- Allowing the passage of fresh air into urban areas;

- Maintaining green areas inside and outside of cities for flood retention;
- Water storage in wetlands for later use; and
- Use of the plants adapted to drought conditions.

Soft measures include:

- General awareness raising;
- Forecasting and early warning systems;
- Identification of heat islands in cities;
- Improving the preparedness of healthcare and social systems;
- Stricter building codes to improve resilience;
- Insurance for extreme weather events;
- Cost-reflective pricing of municipal water services;
- Restriction of water use; and
- Organization of emergency water supply.

The measures mentioned above have yet to be implemented in many parts of Eastern Europe, Caucasus and Central Asia. The old (Soviet-era) electricity, gas, water, sewage, heating and other utilities have deteriorated to a large extent and massive investment is needed soon to replace them with modern infrastructure systems that would reflect current and expected urban patterns (Center for Economic Research, 2013). This long overdue infrastructure investment upswing presents an opportunity for these countries to leap ahead in climate change adaptation while taking advantage of the available experience in advanced industrialized countries.

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## SUMMARY

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- 1.** Climate change is likely to have significant and mostly negative impacts on various sectors (agriculture, water, energy, transport, health) and in urban areas. Tables 4 – 8 and Figure 6 show such impacts.
- 2.** There are two basic policy options for responding to climate change impacts. One option is to do nothing and cope with such impacts reactively. The other option is to implement protective adaptation measures in advance. Figure 5 illustrates the proactive approach to adaptation, entailing an involvement of stakeholders and choice of cost-effective policy options.
- 3.** Adaptation measures aim to reduce adverse climate change impacts or take advantage of positive impacts. A number of such measures are listed in the sections dealing with specific sectors and urban areas.
- 4.** Adaptation measures entail a number of innovations, consisting of new grey, green and soft technologies. The former consist of improved technical and construction measures while the latter utilize ecosystem services, spatial planning and economic incentives.
- 5.** Adaptation challenges are particularly demanding in countries of Eastern Europe, Caucasus and Central Asia, due to a number of physical and economic factors, including the ageing and inadequate infrastructure inherited from the Soviet era. Policy makers in these countries should ensure that the drive to modernize ageing infrastructure is complemented by an adoption of good adaptation planning practices.

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## GLOSSARY

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**Climate change** refers to a persistent change in the mean and/or the variability of climate properties.

**Climate change adaptation** refers to the adoption of policies and practices to prepare for the effects of climate change.

**Climate change mitigation** refers to the adoption of policies and practices that reduce greenhouse gas emissions of economic activity.

**Cost-benefit analysis** refers to a systematic comparison of the costs and benefits associated with projects or government policies.

**Greenhouse gases** refer to carbon dioxide, nitrous oxide, methane, ozone and chloro-fluorocarbons occurring naturally and resulting from human activities, and contributing to the greenhouse effect (global warming).

**Technology** refers to the state of technical knowledge.

**Sustainable development** is a process that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains two key concepts: the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

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## ADDITIONAL RESOURCES

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The UNECE publication entitled *Guidance on Water and Adaptation to Climate Change* provides advice to decision makers and water managers on how to assess impacts of climate change on the water sector as well as how to design and implement appropriate adaptation strategies (UNECE, 2009). The production of the *Guidance* was based on the collaboration of more than 80 experts from 25 countries of the ECE region and a number of international organizations.

Annex II of the *Guidance* consists of a checklist that is provided as a tool for self-assessment of a country's current position. The checklist was designed to help decision makers and policy makers identify and address bottlenecks in their country's progress to effective climate change adaptation.

The *Guidance* can be downloaded free of charge in English, French and Russian at:

[http://www.unece.org/fileadmin/DAM/env/water/publications/documents/Guidance\\_water\\_climate.pdf](http://www.unece.org/fileadmin/DAM/env/water/publications/documents/Guidance_water_climate.pdf) - in English,

[http://www.unece.org/fileadmin/DAM/env/water/publications/documents/Guidance\\_water\\_climate\\_f.pdf](http://www.unece.org/fileadmin/DAM/env/water/publications/documents/Guidance_water_climate_f.pdf) - in French,

[http://www.unece.org/fileadmin/DAM/env/water/publications/documents/Guidance\\_water\\_climate\\_r.pdf](http://www.unece.org/fileadmin/DAM/env/water/publications/documents/Guidance_water_climate_r.pdf) - in Russian.

## QUESTIONS FOR DISCUSSION AND MULTIPLE CHOICE TEST

### QUESTIONS FOR DISCUSSION

1. Which sectors are most vulnerable to climate change impacts in your country? What would be the best way to enhance their resilience?

.....

.....

2. Which sectors could take advantage of beneficial effects of climate change in your country or region? How?

.....

.....

3. What are the advantages of a risk-based approach to climate change adaptation?

.....

.....

### MULTIPLE CHOICE TEST

**Check the best answer.** (Correct answers can be found on page 144)

#### QUESTION 1

Climate change adaptation in the agricultural sector can include:

- A. Improved irrigation.
- B. Improved provision of hydrometeorological information to farmers.
- C. Relocation of rural population from most sensitive areas.
- D. All of the above.

Your answer:.....

#### QUESTION 2

Weather conditions affect:

- A. Production in all sectors equally.
- B. All countries equally.
- C. Agriculture more than manufacturing.
- D. None of the above.

Your answer:.....

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### QUESTION 3

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Adaptation measures in flood-risk areas do not include:

- A. Improved irrigation.
  - B. Construction of dykes.
  - C. Land use management.
  - D. Upgrading of transport infrastructure.
- Your answer:.....

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### QUESTION 4

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Adaptation measures in drought-prone areas can include:

- A. Improved irrigation.
  - B. Switching to less water-intensive crops.
  - C. Adoption of water-saving technologies.
  - D. All of the above.
- Your answer:.....

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### QUESTION 5

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Climate change adaptation measures in the energy sector aim to:

- A. Make the energy sector more resilient to extreme weather events.
  - B. Increase the centralization of power supply.
  - C. Increase demand for electricity.
  - D. None of the above.
- Your answer:.....

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### QUESTION 6

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Energy and water systems tend to be:

- A. Unrelated.
  - B. Closely linked.
  - C. Both A and B.
  - D. None of the above.
- Your answer:.....



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**QUESTION 7**

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Climate change impacts on health can result in:

- A. Premature deaths.
- B. Injuries.
- C. Infectious diseases.
- D. All of the above.

Your answer:.....

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**QUESTION 8**

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Many health experts consider climate change to be:

- A. The biggest health threat in the 21<sup>st</sup> century.
- B. A relatively unimportant health risk in the 21<sup>st</sup> century.
- C. A predominantly positive health factor in the 21<sup>st</sup> century.
- D. None of the above.

Your answer:.....

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**QUESTION 9**

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Climate change is expected to have major impacts on

- A. Freight transport.
- B. Passenger transport.
- C. Both A and B.
- D. None of the above.

Your answer:.....

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**QUESTION 10**

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Cost-benefit analysis can be used to prioritize adaptation measures in the following sectors:

- A. Energy.
- B. Water.
- C. Transport.
- D. All of the above.

Your answer:.....

# MODULE III

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## POLICY INSTRUMENTS FOR COST-EFFECTIVE ADAPTATION

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## INTRODUCTION

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People adapted to climate change for thousands of years while human behaviour, technologies and social systems evolved in response to its impacts. The previous module describes contemporary climate change challenges and adaptation measures in five major sectors (agriculture, water, energy, transport and health) and urban areas. It also emphasizes that a comparison of costs and benefits is useful for the appraisal of adaptation options. This module considers a number of policy instruments that can be used to encourage cost-effective climate adaptation by businesses, consumers and public institutions.

Upon completion of this module, you should be able to:

- Understand the concept of optimal adaptation;
- Comprehend the use of cost-benefit analysis for evaluating policy options;
- Identify diverse policy tools for cost-effective adaptation;
- Understand obstacles to the use of some policy tools in transition economies;
- Appreciate the importance of innovative approaches to climate adaptation;
- Understand the discussion questions appearing in the final section; and
- Answer correctly all questions in the multiple choice quiz.

The main references utilized for the module include the publications produced or contracted by various international organizations that are listed in the reference section following the main text.

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## PRICE SIGNALS AND ENVIRONMENTAL MARKETS

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### OPTIMAL ADAPTATION

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The basic idea is that economic agents – consumers, firms and government – respond to material incentives. Such incentives facilitate adaptation to actual or expected climate change impacts at the firm, household and government levels. Prices can provide the necessary information for optimal adaptation measures, providing that they reflect all relevant costs. In that case correct price signals encourage the right extent of adaptation at least cost.

How much adaptation would be optimal? In principle, it should increase as long as the additional (marginal) benefit of extra adaptation exceeds its additional (marginal) cost. This condition ensures that net benefits of adaptation are maximized. The following numerical example illustrates adaptation costs, benefits and net benefits in two alternative scenarios (Table 9).

In the baseline adaptation scenario, the cost of standard climate protection measures amounts to CAD 90. If the climate does not change, the cost of climate-related damage equals CAD 50. In the event of climate change, the cost of damage increases by CAD 200 to CAD 250. In the extended adaptation scenario, the cost of standard climate protection (CAD 90) is augmented by the extra cost of additional adaptation measures (CAD 60) to CAD 150. If there is no climate change, the cost of normal climate damage is reduced from CAD 50 to CAD 20, implying an extra benefit of extended adaptation of

CAD 30. In the event of climate change, relative to the baseline the damage decreases from CAD 250 to CAD 140, implying an extra benefit of CAD 110.

**TABLE 9. A HYPOTHETICAL EXAMPLE OF ADAPTATION COSTS AND BENEFITS**

Scenario	Current climate	Changed climate
Baseline adaptation	Adaptation cost = 90 Normal climate damage: 50 Climate change damage: 0	Adaptation cost = 90 Normal climate damage = 50 Climate change damage = 200
Extended adaptation	Adaptation cost = 150 Normal climate damage = 20 Climate change damage = 0	Adaptation cost = 150 Normal climate damage = 20 Climate change damage = 120
Net benefit of extended adaptation	Extra benefit = 30 Extra cost = 60 Net benefit = 30 – 60 = -30	Extra benefit = 30 + 80 = 110 Extra cost = 60 Net benefit = 110 – 60 = +50

Source: Adapted from Agrawala and Fankhauser (2008).

A comparison of the two adaptation scenarios indicates that in the absence of climate change, the cost of extended adaptation measures (CAD 60) exceeds the associated extra benefit of CAD 30. This amounts to a negative net benefit of CAD 30. In the event of climate change, the cost of extended adaptation measures (CAD 60) is lower than the extra benefit of CAD 110. The net benefit, i.e. the difference between the extra benefit of CAD 110 and extra cost of CAD 60, amounts to CAD 50. Thus in the event of climate change, the cost-benefit analysis indicates that extended adaptation is the better choice. And conversely.

### ESTIMATING ADAPTATION COSTS AND BENEFITS

Generally, adaptation costs are easier to estimate than adaptation benefits. For instance, Atamuradova (2010) projects that adaptation costs in the water sector of Turkmenistan over the 2009-2030 time period amount to almost USD 10.5 billion under the current (baseline) adaptation scenario. The baseline scenario assumes that continuous improvements in irrigation techniques, storage and utilization of water resources would reduce the nation's water supply deficit by 4.2 - 4.5 billion m<sup>3</sup> over the period projected.

In an extended adaptation scenario with more efficient irrigation and better storage and utilization of water resources (including wastewater), costs would rise to USD 15.4 billion and water savings to 7.3 - 8.5 billion m<sup>3</sup>. This would practically eliminate the water supply deficit. The extra cost of extended adaptation is about USD 4.9 billion while the extra benefit amounts to some 3 billion m<sup>3</sup> in water savings. The calculation of net benefit of enhanced adaptation is impossible unless we assign a monetary value to water (Table 10). Otherwise the cost-benefit analysis cannot identify the best option.

**TABLE 10. ESTIMATES OF ADAPTATION COSTS AND BENEFITS IN THE WATER SECTOR**

Scenario	Changed climate
Baseline adaptation	Adaptation cost = USD 10,482 million Adaptation benefit = 4.2 – 5.5 billion m <sup>3</sup> (water savings)
Extended adaptation	Adaptation cost = USD 15,424 million Adaptation benefit = 7.3 – 8.5 billion m <sup>3</sup> (water savings)
Net benefit of extended adaptation	Extra benefit = 3 – 3.1 billion m <sup>3</sup> Extra cost = USD 4,942 million Net benefit = ?

Source: Adapted from Atamuradova (2010).

## THE CHOICE OF ADAPTATION STRATEGY AND PRICE SIGNALS

Responses to climate change impacts can be passive (do not adapt and bear losses) or active (reduce or prevent losses). If costs of adaptation exceed its benefits, then a passive strategy makes perfect sense from the economic point of view. If however benefits of adaptation exceed its costs, then a choice of an active strategy is rational. The choice of adaptation strategy in response to climate change impacts is influenced by price signals. For instance, higher relative prices of energy or water would encourage an adoption of energy-saving or water-saving innovations.

The actual prices faced by economic agents are often influenced by various charges, subsidies and taxes imposed by governments with a view to reconciling efficiency and equity. The pricing of water has traditionally been most inefficient in agriculture (due to subsidized irrigation) and most efficient in the industrial sector. Nevertheless, Australia and Canada have been able to develop regional water markets in the agricultural sector that could facilitate adjustments to climate change impacts. It is not clear how such markets could function in transition economies with vastly different institutions and governance standards.

## EFFICIENCY AND EQUITY CONCERNS

Cost-reflective pricing of municipal water supply for households prevails in advanced industrialized economies where water utilities have to be able to recover at least operating costs. In most economies in Eastern Europe and Central Asia the prices of water services for households tend to be heavily subsidized because cost-reflective prices would hurt the poor. Such subsidies are inefficient in the sense that they do not incentivize consumers to use water efficiently and provide highest per capita benefits to people with above-average incomes.

In the energy sector, electricity and natural gas prices for households in Eastern Europe and Central Asia are lower than costs due to government subsidies (these prices are actually equal to zero up to a threshold level in Turkmenistan). By contrast, households in Germany pay a significantly higher price for electricity than industry because government policy subsidizes renewable energy while responding to competitiveness concerns of large exporting firms.

## PAYMENTS FOR ECOSYSTEM SERVICES

In the context of sustainable development, it is important to note that it would be efficient to assign positive (rather than zero) values to various ecological services provided for free by natural capital. Payments for ecosystem services (PES) entail contractual transactions between buyers and sellers of an ecosystem service or a land/management practice likely to secure that service (UNECE, 2011). PES schemes could reduce significantly costs of adaptation in agriculture, forestry and other sectors, if one could overcome the unwillingness to pay for traditionally free services (Agrawala and Fankhauser, 2008).

If there are well-defined property rights and a limited number of interested parties, the problem of externalities can be solved by private negotiations without any government intervention. A successful application of the PES concept can be found in France where a bottled water manufacturer (Vittel) has agreed to compensate upstream farmers for maintaining water quality with the aid of sustainable agricultural practices. Other PES schemes have been used successfully in other parts of Western Europe. E.g. consumers of water pay for sustainable management of the forests belonging to the Swiss city of Basle through an additional charge in their water bills. A similar public-private PES scheme is codified in a contract between the public water utility in the Danish city of Copenhagen and a private forest owner (UNECE, 2011).

But how relevant are PES schemes for transition economies? The use of innovative PES schemes in countries of the Caucasus and Central Asia has been so far limited to projects financed by international donors (OECD, 2012). However, an innovative PES scheme in Kyrgyzstan has demonstrated the usefulness of the concept for the subregion (Box 6).

### **BOX 6. AN INNOVATIVE PES SCHEME IN KYRGYZSTAN**

An innovative PES scheme was initiated in the Chon-Aksu region of Kyrgyzstan in 2009 with the aim to rewarding upstream communities for their environmental services. The process has been facilitated by the CAREC Kyrgyzstan office. Local downstream communities mobilized to form associations of resource users such as mushroom pickers and water user groups. These associations agreed on acceptable rewards for upstream communities (state-owned forestry units and pasture committees) in exchange for safeguarding the water quality. Resource users are thus buyers of ecosystem services while upstream communities are sellers.

Given the shortage of cash and lack of trust in official institutions, labor-in kind has been chosen as a means of payment. Subsequently, 50 thousand seedlings were planted on 4 hectares of land by members of the mushroom pickers association to improve forest ecosystems. In exchange, upstream communities took the measures necessary to preserve the water quality. Although this innovative scheme has proved to be operational and avoided corruption, cash payments for ecosystem services may well be used in next stages of the project.

The innovative use of the PES mechanism in Kyrgyzstan motivated diverse stakeholders in Kazakhstan, Tajikistan and Uzbekistan to request that it be replicated and scaled up in their own countries. Potential sites for such PES schemes have been identified and a new PES pilot project in one of these locations is to be supported by the Norwegian government. A video presentation of the Kyrgyz PES project can be downloaded at <http://youtu.be/tPCJPS55uTM>.

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## REGULATIONS AND STANDARDS

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### REGULATIONS AND STANDARDS FOR RESILIENT INFRASTRUCTURE

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This section is based largely on a report of the Engineering the Future partnership that operates in the United Kingdom (Engineering the Future, 2011). Most adaptation strategies focus on infrastructure with a view to ensuring steady supply of essential services such as communications, energy, housing, transport, water and sanitation. Current regulations, building codes and design standards ensure a certain level of resilience that is however not uniform across sectors.

Adaptation measures that are considered to be appropriate for expected weather patterns should be incorporated in routine infrastructure maintenance. If this is not possible, one should consider advantages of retrofitting existing facilities to improve their climate resilience. Over time new infrastructure will have to be built in compliance with new adaptation requirements. If such norms are too restrictive and rigid, then overinvestment in unnecessary resilience is a likely outcome. And conversely, adaptation standards that are too weak are likely to result in underinvestment.

Innovative adaptation strategies should address shared vulnerabilities and interdependencies of diverse infrastructure systems. Energy, water, ICT and transport infrastructures are often co-located and at risk of being affected simultaneously by extreme weather events. These infrastructures are also interdependent in the sense that a failure in one of them (e.g. ICT) has repercussions throughout the entire infrastructure network. Ideally all infrastructures should be resilient to an equivalent degree. Until now, codes and standards in some infrastructure sectors have been designed to withstand extreme conditions better than in other sectors.

In order to ensure the supply of essential services diverse infrastructure regulators (line ministries or specialized agencies) should cooperate closely and coordinate planning for resilience across the whole system. At present there is a lack of coordination of adaptation investments and emergency procedures. Therefore, governments should elaborate detailed plans for adaptation across the entire networked infrastructure system. Planning regulations should also deter building on flood plains and/or require that buildings be more resilient to flooding.

How can one achieve infrastructure resilience at reasonable cost? If adaptation solutions are to be cost effective, timing is essential. Incorporating better adaptation features into the design of new structures adds between 0 to 15 per cent to the upfront construction cost. Improving resilience through a re-build or retrofit of existing structures is considerably more expensive. E.g. in Canada the cost of installing a backwater valve (a device that stops water from backing up from over-burdened sewer lines) in an urban family home amounts to approximately CAD 200 during construction but increases to 6,000 dollars once the house has been built. The average cost of repairing a flooded basement ranges from CAD 15 to 20 thousand (Feltmate and Thistlethwaite, 2012).



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## REGULATIONS AND STANDARDS FOR BEHAVIOURAL ADAPTATION

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Demand-side adaptation measures such as efficient energy and water use can be encouraged with the aid of regulations and performance standards. Regulatory instruments affect the behaviour of economic agents by redefining the set of available options. Examples in high-income countries include mandatory recycling schemes of household waste, minimum energy performance standards and energy efficiency labels for various household appliances and equipment, and minimum fuel efficiency and emission standards for motor vehicles. These policy instruments provided a major stimulus for the generation and diffusion of resource-saving innovations.

But why should transition economies in Eastern Europe, Caucasus and Central Asia adopt standards for behavioural adaptation? The economic importance of regulatory instruments is non-negligible. Minimum energy performance standards and labels have been widely used in Western economies since the early 1990s, resulting in huge performance improvements. For instance, the average energy consumption of washing machines and refrigerators in the European Union declined by some 40 per cent and 60 percent respectively between 1992 and 2006. The extrapolation of Western results indicates that countries of Eastern Europe, Caucasus and Central Asia could save some 50 TWh and CAD 5 billion per year if they were to implement comparable energy efficiency standards and labels (Energy Charter Secretariat, 2009).

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## FINANCING SCHEMES

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### PUBLIC SECTOR SCHEMES

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Major physical structures for climate protection (e.g. barriers, dykes, equipment of emergency response and disaster relief services, public health facilities) are financed by the government sector. In most countries the bulk of infrastructure investment in key sectors (energy, telecoms, transport, water and sanitation) is also financed by the public sector, either directly or by user charges or both. It is difficult to determine the portion of infrastructure investment that reflects adaptation (climate resilience) requirements but various studies mention that, depending on the structure, improved resilience parameters can increase construction cost by up to 15 per cent.

External financing for investment in climate change mitigation can be accessed by governments of developing countries through the Clean Development Mechanism (CDM). What is it? Most industrialized countries have committed to reduce their greenhouse gas emissions in an international agreement known as the Kyoto Protocol. This agreement provides for the possibility of a country meeting its Kyoto commitments by supporting an emission reduction project in a developing country. Such projects can earn certified emission reduction credits that can be sold in emissions trading markets such as the Emissions Trading System of the EU. Industrialized countries can purchase these credits and use them to meet a part of their emission reduction targets under the Kyoto Protocol. CDM thus stimulates sustainable development and emission reductions while providing industrialized countries with some flexibility in meeting their emission reduction or limitation targets.

Azerbaijan was the first country in the world that was able to use CDM to sell certified emission reduction credits (see Box 16, Module V). A 2 per cent levy on the

credits certified by the CDM is transferred to the Adaptation Fund that was established to finance concrete climate adaptation projects and programmes in developing countries. In addition, a number of industrialized countries provided voluntary contributions. Although the Fund received significant resources to support adaptation (around USD 350 million by the end of 2012), the pace of disbursement has been slow due to the administrative complexity of the scheme. Nevertheless, two countries from the Caucasus and Central Asia submitted successfully grant applications (Box 7).

**BOX 7. ADAPTATION FUND PROJECTS IN GEORGIA AND TURKMENISTAN**

In 2011 the Adaptation Fund approved applications for project grants from Georgia and Turkmenistan. The first grant, amounting to USD 5.3 million, finances the development of climate resilient flood management practices to protect vulnerable communities in Georgia. The second grant, amounting to USD 2.9 million, finances the development of effective water management practices and legislation in Turkmenistan with a view to supporting the adoption of efficient irrigation techniques.

Although most climate related projects financed by development banks target mitigation (i.e. lower CO<sub>2</sub> emissions), the availability of funds for investment in adaptation has improved. For instance, Tajikistan has received recently almost CAD 50 million for adaptation investment (Box 8).

**BOX 8. INVESTMENT PROJECTS FOR CLIMATE RESILIENCE IN TAJIKISTAN**

International financial institutions have recently approved USD 47.8 million in grant financing for adaptation projects in Tajikistan that should be implemented over a 5-year period. These projects will improve water management and hydroelectric infrastructure as well as institutional capacities for integrating climate resilience into national development and investment planning, and supporting land management measures to enhance rural livelihoods through greater resilience to climate-related shocks. Participating institutions include the ADB, EBRD and the World Bank.

(<https://www.climateinvestmentfunds.org/cifnet/?q=country/tajikistan>)

Are grants and budget appropriations sufficient for the financing of adaptation-related investment? No. Given the limits to public financing of climate-proofing investment and growing adaptation needs implied by various climate scenarios, governments are likely to seek alternative sources of finance through public private partnerships.

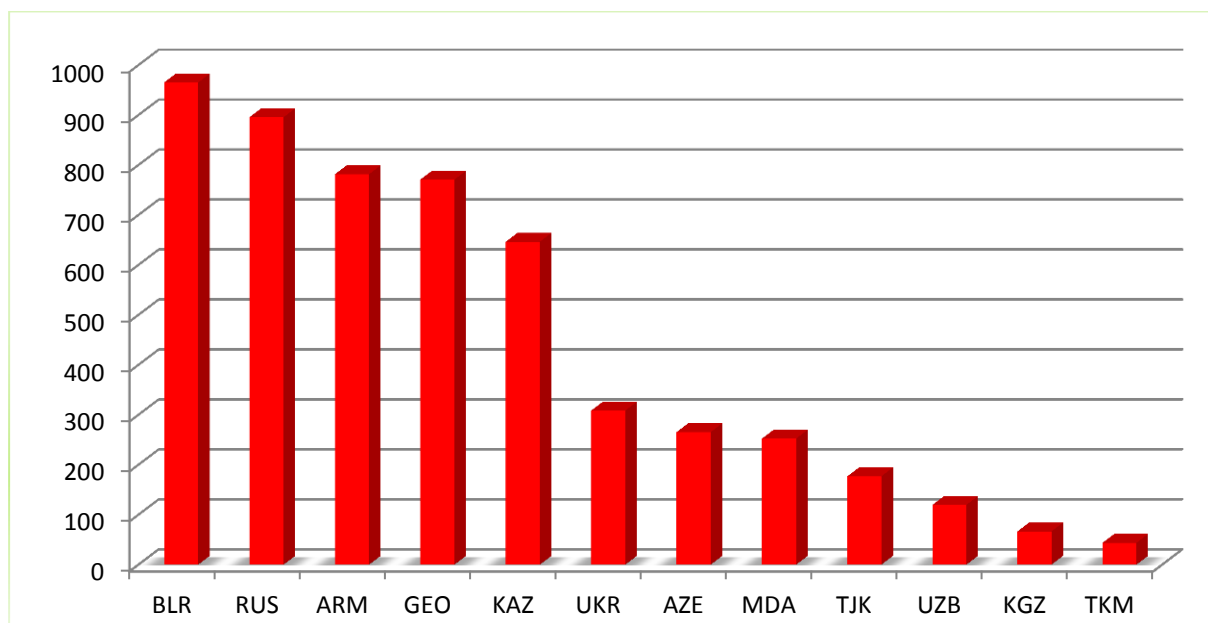
**PUBLIC-PRIVATE PARTNERSHIPS IN THE INFRASTRUCTURE SECTOR**

Public-private partnerships (PPP) are based on a long-term approach to procuring public infrastructure. The private sector shares financing and construction risks with the government and ensures effective delivery of infrastructure services and maintenance for a pre-determined period. In Eastern Europe, Caucasus and Central Asia, the importance of PPP financing varies noticeably across countries. The cumulative

PPP infrastructure investment in per capita terms ranges from USD 965 in Belarus to USD 44 in Turkmenistan (Figure 7).

Given the availability of robust concession schemes for the financing of telecom and energy projects, the bulk of PPP funds in Eastern Europe, Caucasus and Central Asia has been invested in these two sectors. Both sectors are important for green growth and climate change adaptation. The capacity of middle-income countries to attract PPP financing tends to be better than in low-income countries. However, the Pamir energy project in one of the poorest regions of Tajikistan demonstrates that PPP financing can be used successfully in low-income countries with the aid of public and private development institutions, providing that affordability concerns be addressed upfront (Box 9).

**FIGURE 7. PPP INFRASTRUCTURE INVESTMENT IN EASTERN EUROPE, CAUCASUS AND CENTRAL ASIA**



Source: World Bank PPP database, UNECE statistical database.

**BOX 9. THE PAMIR PRIVATE POWER PROJECT IN TAJIKISTAN**

The Pamir Private Power Project has improved the reliability and increased the quantity of electricity supply in the Gorno Badakhshan Autonomous Region of Tajikistan in a financially, environmentally and socially sustainable way. This successful PPP project in the form of a 25-year concession agreement has been initiated in 2002 and implemented by the Aga Khan Fund for Economic Development. The government of Tajikistan owns physical infrastructure while Pamir Private Power is responsible for electricity generation, transmission and distribution. The CAD 26.4 million project has been financed by a mix of equity (45 per cent) provided by the Aga Khan Fund and IFC and debt (55 per cent) provided by IDA and IFC. A social protection scheme ensures that poor households pay reduced tariffs that are consistent with their standard of living.

(UNECE, 2008)

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## PUBLIC-PRIVATE PARTNERSHIPS AND CLIMATE CHANGE ADAPTATION

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How can governments ensure that PPP infrastructure projects are both climate resilient and cost effective? If the project entails a construction of a new facility, the PPP contract could stipulate the expected level of climate resilience. This would be cheaper than retrofits after the completion of construction. In the case of long-term concessions, the PPP agreement should specify minimum performance standards (such as the availability of roads or energy supply). This would provide incentives for the private partner to adopt appropriate maintenance methods and other adaptation measures. Contracts could also stipulate which party is responsible for particular climate risks (Agrawala and Fankhauser, 2008).

The PPP financing of municipal water and sewerage projects could also be important in the adaptation context. However, such projects have been rarely successful in less advanced transition economies and developing countries. The reason is that there seem to be no sustainable business models in this sector for low and middle-income countries. What is needed is an organizational innovation that would recognize the access to clean water as a basic human right and provide a minimum daily amount (specified by WHO norms) for everyone without charge while allocating the remaining quantity of water (i.e. over 95 per cent of total supply) with the aid of a partial or full cost-recovery pricing scheme.

In addition to infrastructure investment, PPP schemes can be used to finance the development and deployment of innovative adaptation technologies. For instance, public-private joint ventures are already financing the development of heat and drought-resistant crops for African countries as well as medical research of neglected diseases that could improve public health adaptation to climate change (Agrawala and Fankhauser, 2008).

In countries with dynamic mandatory pension systems based on individual contributions of employees to their own pension accounts (e.g. Kazakhstan), an innovative financing model could channel a part of pension funds to PPP investment projects in resilient infrastructure or innovative adaptation technologies. This would diversify the financial portfolio of existing pension funds and increase returns that have been relatively low in transition economies with funded pension schemes.

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## INSURANCE SCHEMES

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### TRADITIONAL AND INNOVATIVE INSURANCE PRODUCTS

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Insurance has been used for a long time to address risks related to extreme or unexpected weather events. Even though the vulnerability to extreme weather events has been increasing in transition economies in Europe and Central Asia, insurance coverage of natural hazards is low, especially among homeowners and small and medium-sized enterprises. Innovative insurance schemes that encourage adaptation (e.g. by reducing rates for farmers, firms or households that undertake adaptation investments) are also rarely used in the region. By contrast, weather insurance is used widely by small farmers in developing countries of Asia and Africa.

Most experts agree that lack of affordability is the main reason for low insurance coverage in emerging economies and advocate a mix of private provision with some form of public subsidy. An example of good practice is provided by the comprehensive earthquake insurance in Turkey. The Turkish national insurance pool, established in late 1990s, involves the public and private sectors in different layers of risk coverage to make insurance affordable. According to the World Bank, some 1.8 million earthquake insurance policies for homeowners have been underwritten since 2000. A similar national insurance pool was established in Romania a decade later with coverage for earthquake, flood and landslide risks. Although the Romanian legislation has made this insurance scheme mandatory for all 8.4 million homeowners in the country, only 10 per cent of them bought the insurance during the first year of operation (Bulugea, 2011).

For the time being, hardly any innovative insurance products for climate change adaptation are available in the Caucasus and Central Asia. The “Southeastern Europe and Caucasus Catastrophe Risk Insurance Facility (CRIF)”, implemented by Europa Re (a catastrophe risk reinsurance company) in collaboration with the World Bank, aims to assist participating countries in developing insurance markets for catastrophic risks. Local companies are to be provided with access to web-based catastrophe and weather risk insurance products and claims settlement technologies. So far the project has been implemented in three countries of South-Eastern Europe (World Bank, 2011).

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## INDEX-BASED SCHEMES

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Index-based insurance schemes reduce transaction losses to both the insured and insurers because no verification of losses is required in order to pay insurance claims. Insurance contracts are written against a weather index such as rainfall or temperature. If the chosen weather index exceeds a certain threshold, a payment is triggered. In addition to relatively low costs, this approach to insurance against extreme weather events eliminates the so-called moral hazard problem. This problem results from irresponsible behaviour of insured persons who engage in hidden activities to increase risks and insurance payouts.

An interesting example of good practice is provided by Mongolia. Following huge livestock losses during the extremely cold winter in 2001–2002, the government developed with the assistance of the World Bank an innovative index-based insurance product based on livestock mortality rates. This insurance scheme protects Mongolian farm herders against livestock losses due to harsh weather conditions. Herders are not compensated for the cost of small livestock losses but larger losses in excess of predetermined risk thresholds are transferred to the private insurance industry. In the event of catastrophic losses, the cost is borne by the government. The uptake of the index insurance by small vulnerable herders is limited however by lack of adequate marketing (OECD, 2013).

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## R&D AND INNOVATION INCENTIVES

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### SUPPLY-SIDE (TECHNOLOGY PUSH) INCENTIVES

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Technical progress is the key factor for reducing costs of climate change adaptation. Government can adopt forward-looking policies and programmes that

support research and development of innovative adaptation technologies. Such measures include:

- Equity support (especially for SMEs);
- Micro-financing schemes for innovative start-ups;
- Provision of adequate education and training;
- Subsidized loans and tax incentives for green R&D activities;
- Support for eco-technology innovation centres; and
- Support for renewable energy production.

A number of Western countries and China support generously research and development of green technologies for adaptation and mitigation with a view to supporting exports in the rapidly expanding global market for such technologies. However, transition economies in Europe and Central Asia have not prioritized technology-push in this area.

The business sector should play an important role in innovation activity and investment. While it is difficult to determine what will be the main areas of growth in adaptation technology, the following sectors are likely to be affected (Oxfam, 2009):

- Water management;
- Agriculture;
- Energy supply;
- Disaster preparedness;
- Insurance;
- Natural resource management; and
- Climate change information and consulting services.

### DEMAND-SIDE (TECHNOLOGY PULL) INCENTIVES

Demand-side incentives may be necessary to help develop markets that would otherwise be too small for eco-innovation. The measures aiming to stimulate a market for technological and other innovative solutions to the challenge of climate change adaptation include:

- Green public procurement;
- Introduction of mandatory efficiency standards (e.g. appliances, automobiles, buildings); and
- Sustainable consumption initiatives.

Such measures eventually pull new technologies into widespread use. Examples include a growing demand for fuel-efficient automobiles, energy-efficient appliances, and low-energy and resilient buildings in advanced industrialized economies. Green public procurement requires enabling legislation that provides public agencies with the option to consider sustainability in the choice of suppliers. In addition, reforms are needed to enable SMEs to bid for and win public sector contracts (see also Module IV).

Demand-side incentives for eco-innovation have been relatively weak in most transition economies. However, some of them have achieved good results in the diffusion of green technologies (Box 10).

**BOX 10. A CLIMATE-SMART TECHNOLOGY IMPROVES CROP YIELDS IN KAZAKHSTAN**

In response to climate change, farmers in northern Kazakhstan have increasingly adopted a climate-smart no-till practices that enable them to sustain high yields, cut cultivation costs and reduce soil erosion. The government of Kazakhstan, the World Bank and other international organizations have supported the development and diffusion of no-till technology that requires large investment in machinery and herbicides. With 10 per cent of farmland under no-till practices, Kazakhstan has become the second largest adopter in the world of this climate-smart technology.

More details are available at: <http://www.worldbank.org/en/results/2013/08/08/no-till-climate-smart-agriculture-solution-for-kazakhstan>.

**THE LEGACY OF THE SOVIET RESEARCH AND DEVELOPMENT SYSTEM**

The relatively weak use of R&D and innovation incentives for climate change adaptation in transition economies reflects to some extent the Soviet legacy. The R&D system developed in the Soviet Union served as a model for other Communist countries. The system was characterized by centralized research in state institutes rather than universities or state-owned enterprises (that accounted for the bulk of production). The more prestigious institutes were parts of the Soviet Academy of Sciences while others functioned as specialized academies or research sections of government line ministries such as agriculture, construction, energy, metallurgy, machine building, transport, etc.

The Soviet R&D system achieved remarkable results in theoretical science and military and space applications. It was less successful in the commercialization of scientific discoveries in production of civilian goods in general and consumer goods and services in particular, given the priority of heavy industry (including the military sector) in the Soviet system of central planning. Heavy industry was considered to be essential for economic development and catch-up with leading industrialized countries.

The Soviet R&D system proved to be inadequate in the rapidly changing institutional environment of the 1990s that saw a more or less rapid transition from central planning to markets. The well-developed scientific and engineering educational system continued to produce a large number of competent graduates. However, a large number of them could not find satisfactory employment and decided to emigrate instead. The state research and development institutes were downsized and experienced budget cuts in most transition economies. The slow restructuring and low salaries in the R&D sector in the 1990s coexisted with a continued isolation from enterprises.

Since then a number of transition economies initiated reforms of the R&D system while encouraging more research activity in universities, stronger links between scientists and firms, technology transfer, and the formation of small businesses. However, the tradition of centralized and government-controlled R&D activity remains noticeable while the innovation performance continues to lag behind leading industrialized economies (Goldberg et al, 2011).

**OTHER UNDERLYING FACTORS**

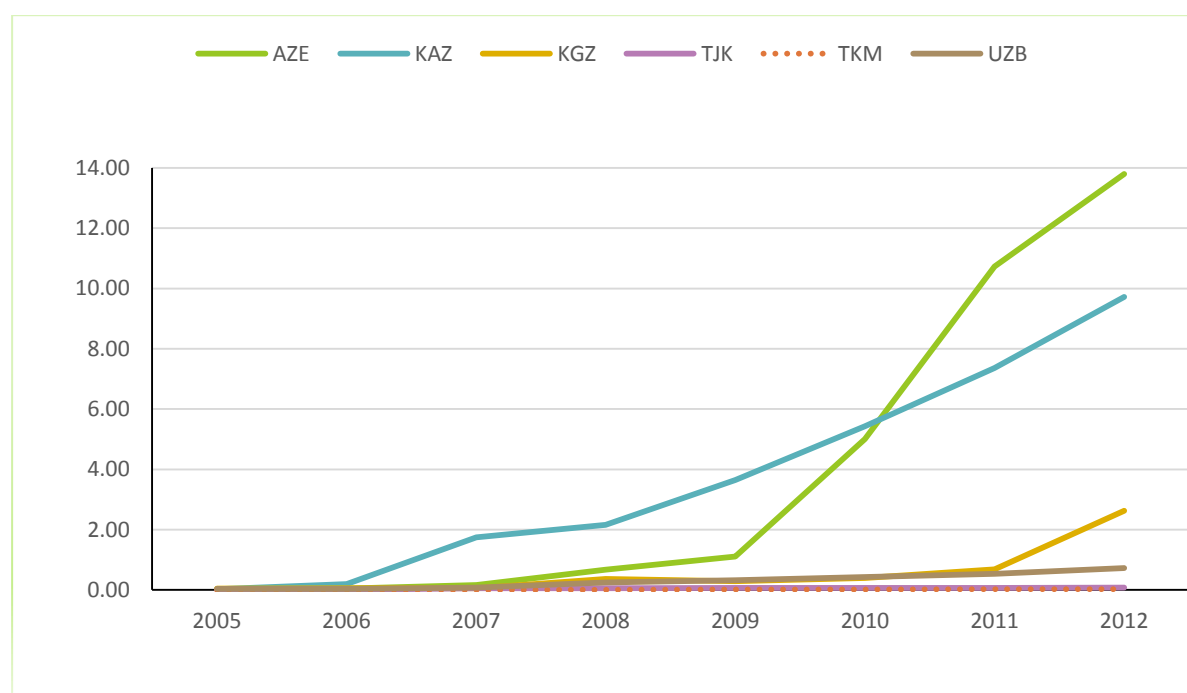
Legacy factors, while important, cannot explain everything. The weak R&D and innovation incentives in transition economies reflect also the quality of new institutions

that have been established during the transition process. The innovation process is market driven in advanced industrialized countries. Clearly, their good practices cannot be simply transplanted into economies that lack well developed legal systems and competitive markets.

Another barrier to the generation, adaptation and diffusion of green innovations for climate change adaptation is posed in some transition economies by a limited access to high speed internet. The availability of high speed internet is a necessary precondition for the use of a number of green innovations. Figure 8 shows that some countries of the Caucasus and Central Asia have made significant progress in this area while others have not.

Underlying factors also include the shortage of relevant skills and competencies for a successful adoption of advanced green technologies as well as the limited availability of finance for the investment needed for their acquisition. These factors will be discussed in more detail in Module IV.

**FIGURE 8. FIXED BROADBAND SUBSCRIPTIONS PER 100 INHABITANTS**



*Source:* World Telecommunication/ICT Database 2013, International Telecommunication Union.

## SUMMARY

1. The policy instruments used to encourage climate change adaptation include price signals and environmental markets, regulations and standards, financing schemes, insurance schemes, and R&D and innovation incentives.
2. It is important to compare costs and benefits of adaptation policies in order to achieve cost-effective outcomes. Table 9 shows a hypothetical cost-benefit analysis of alternative policy options. Table 10 illustrates the estimation of adaptation costs and benefits in the water sector of Turkmenistan.



3. Policy makers should aim to achieve the optimal level of investment in climate resilience. If the adaptation incentives provided by policies are too strong, then wasteful overinvestment in resilience is likely to materialize. If the incentives are too weak, then underinvestment in resilience is likely to result in steep damages from climate change.
4. Organizational innovations are needed in order to assign prices to ecosystem services and allow environmental markets to function. Regulatory instruments can stimulate technological progress that makes development more sustainable. Innovative solutions are needed to develop robust financing models and affordable insurance options for climate change adaptation. Modern infrastructure is also needed for successful adaptation. Figures 7 and 8 illustrate the availability of innovative infrastructure financing and broadband services in selected transition economies.
5. Policies that would enable transition economies to generate, adopt and diffuse green adaptation innovations need to be strengthened. In this context, it is important to overcome the negative legacy of the Soviet R&D system that separated scientific research from commercial applications.

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## GLOSSARY

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**Climate change** refers to a persistent change in the mean and/or the variability of climate properties.

**Climate change adaptation** refers to the adoption of policies and practices to prepare for the effects of climate change.

**Climate change mitigation** refers to the adoption of policies and practices that reduce greenhouse gas emissions of economic activity.

**Cost-benefit analysis** refers to a systematic comparison of the costs and benefits associated with projects or government policies.

**Diffusion of innovations** refers to the way in which innovations spread, through market or non-market channels, to different consumers, countries, regions, sectors and firms.

**Eco-innovation** is an innovation whose use is less environmentally harmful than its alternatives.

**Green innovation** is an innovation whose use is less environmentally harmful than its alternatives.

**Greenhouse gases** refer to carbon dioxide, nitrous oxide, methane, ozone and chloro-fluorocarbons occurring naturally and resulting from human activities, and contributing to the greenhouse effect (global warming).

**Innovation** refers to new or significantly improved products, processes, marketing methods or organizational methods.

**Small and medium-sized enterprises** are independent firms with no more than 250 employees.

**Technology** refers to the state of technical knowledge.

**Sustainable development** is a process that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains two key concepts: the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

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## ADDITIONAL RESOURCES

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An innovative approach to the estimation of health-related adaptation costs has been developed recently by the WHO regional office for 53 countries of Europe and

Central Asia (WHO, 2013). This approach uses an economic analysis tool to support adaptation planning to protect health from the negative effects of climate change. It provides a step-by-step guidance on estimating: (a) the costs associated with damage to health due to climate change; (b) the costs for adaptation in various sectors to protect health from such damage; and (c) the efficiency of adaptation measures that relates the cost of adaptation to expected returns or averted health costs.

The tool is expected to be applied mainly by the ministries and agencies responsible for climate change adaptation in the health sector. It consists of a document describing estimation methods and a manual with an Excel spreadsheet, which provides a visual aid for calculating costs. WHO Europe can provide training in the use of the spreadsheet, if necessary. Requests for the Excel spreadsheet should be sent by e-mail to [climatechange@ecehbonn.euro.who.int](mailto:climatechange@ecehbonn.euro.who.int).

Government officials, researchers or advocacy groups can use the tool developed by WHO to estimate the economic costs of health effects of climate change as well as the costs and benefits of adaptation measures to minimize such effects. In particular, the tool can help strengthen the case for health adaptation in countries such as transition economies that have not yet implemented comprehensive adaptation measures.

Public-private partnerships (PPPs) in the delivery of public services may become increasingly important in the climate adaptation context. PPPs provide a number of advantages but they also present a severe organizational and institutional challenge for the public sector. To address the challenge, the UNECE has elaborated a PPP governance guidebook for policymakers, government officials and the private sector. The good governance principles elaborated in the guidebook are likely to be relevant for PPP-financed adaptation projects.

The English version of the Guidebook on Promoting Good Governance in Public-Private Partnerships is available at:  
<http://www.unece.org/fileadmin/DAM/ceci/publications/ppp.pdf>.

The Russian version is available at:  
[http://www.unece.org/fileadmin/DAM/ceci/publications/ppp\\_r.pdf](http://www.unece.org/fileadmin/DAM/ceci/publications/ppp_r.pdf).

## QUESTIONS FOR DISCUSSION AND MULTIPLE CHOICE TEST

### QUESTIONS FOR DISCUSSION

1. Do you think that cost benefit analysis would be a useful tool for assessing adaptation scenarios in your country? Why (not)?

.....

.....

2. To what extent are the adaptation policy instruments used in high-income economies relevant to countries of the Caucasus and Central Asia? Why?

.....

.....

3. Should an affordable weather risk insurance be subsidized by government and made mandatory for households and/or businesses in your country? Why (not)?

.....

.....

### MULTIPLE-CHOICE TEST

**Check the best answer.** (*Correct answers can be found on page 144*)

#### QUESTION 1

Which item is relatively hard to estimate in monetary terms in the cost-benefit analysis of real-world adaptation scenarios?

- A. Benefits.
- B. Costs.
- C. Net benefits.
- D. Both A and C.

Your answer: .....

#### QUESTION 2

In countries of the Caucasus and Central Asia payments for ecosystem services are:

- A. Widely used.
- B. Never used.
- C. Seldom used.
- D. None of the above.

Your answer: .....

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### QUESTION 3

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Which of the following incentives have not been used as policy instruments for climate change adaptation?

- A. Price incentives.
- B. Regulatory incentives.
- C. R&D and innovation incentives.
- D. Managerial stock incentives.

Your answer: .....

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### QUESTION 4

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PPP schemes are used in Eastern Europe, Caucasus and Central Asia to finance infrastructure investment mainly in:

- A. Telecom and energy sectors.
- B. Water and wastewater sector.
- C. R&D projects.
- D. None of the above.

Your answer: .....

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### QUESTION 5

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Overly strict and rigid regulations and standards for resilience of new infrastructure are likely to result in:

- A. Overinvestment in resilience.
- B. Underinvestment in resilience.
- C. No investment in resilience.
- D. None of the above.

Your answer: .....

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### QUESTION 6

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Which of the following items are examples of regulations and standards for behavioural adaptation?

- A. Mandatory waste recycling.
- B. Energy efficiency standards for household appliances.
- C. Fuel efficiency standards for new cars.
- D. All of the above.

Your answer: .....

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### QUESTION 7

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Innovative insurance products for climate change adaptation:

- A. Are widely available in countries of the Caucasus and Central Asia.
- B. Include index-based insurance products.
- C. Include moral hazard products.
- D. All of the above.

Your answer: .....

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### QUESTION 8

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R&D and innovation incentives include:

- A. Technology-push incentives.
- B. Technology-pull incentives.
- C. Both A and B.
- D. None of the above.

Your answer: .....

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### QUESTION 9

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Technology-pull incentives include:

- A. Green public procurement.
- B. Energy efficiency standards.
- C. Both A and B.
- D. All of the above.

Your answer: .....

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### QUESTION 10

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The Soviet R&D system:

- A. Achieved good results in theoretical science.
- B. Encouraged strong R&D activity in enterprises.
- C. Prioritized the development of innovative consumer goods.
- D. All of the above.

Your answer: .....



# MODULE IV

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## INNOVATION SYSTEMS AND POLICIES IN TRANSITION ECONOMIES IN EUROPE AND CENTRAL ASIA

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## INTRODUCTION

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This module introduces key concepts that will enable you to gain a broad understanding of national innovation systems and policies in transition economies in Europe and Central Asia. The module considers the necessary conditions for vibrant innovation activity and describes main innovation policies. It also introduces the policy measures used to promote eco-innovation. The topics covered include:

- Framework conditions;
- Innovation governance;
- Framework policies;
- Innovation-specific policies; and
- Eco-innovation policy.

Upon completion of the module, you should be able to:

- Appreciate the importance of framework conditions for innovation activity;
- Comprehend the concept of innovation governance;
- Identify innovation-specific policies;
- Identify various eco-innovation measures;
- Understand the discussion questions appearing in the final section; and
- Answer correctly all questions in the multiple choice quiz.

The main references utilized for the module include publications of international organizations (OECD, UNECE, UNIDO) and international financial institutions (EBRD, World Bank) that are listed in the reference page at the end of the module.

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## FRAMEWORK CONDITIONS

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### FRAMEWORK CONDITIONS AND SPECIFIC CONDITIONS

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Framework conditions determine the environment for the development and uptake of new technology and innovation. These conditions include:

- Commercial and financial laws, including intellectual property rights;
- Structure of product and financial markets;
- Openness to international trade and foreign direct investment;
- Availability of human capital; and
- Availability of physical infrastructure.

Specific conditions determine the environment for innovation in particular sectors and can include the following factors:

- The research and development system in a particular sector (e.g. manufacturing);
- Adequate training and skills (e.g. farmers);
- Access to know-how and credit (e.g. logistics companies); and
- Acceptance of innovations (e.g. retail sector).

## TRANSITION FROM CENTRAL PLANNING TO COMPETITIVE MARKETS

One of the key lessons of economic history is that innovation thrives best in competitive market economies. Note that markets are not enough. A poor implementation of legal statutes, heavy burden of taxation and excessive business regulation drive informal (shadow) economic activity. The firms operating in shadow economies have neither the capacity nor incentives to generate innovations and adopt progressive technologies. According to a World Bank study, the average size of informal activity in transition economies in Europe and Central Asia (38 per cent of GDP) is close to that of developing countries (39 per cent) and twice as high as in high-income countries (19 per cent). Switzerland, the United States and Austria have the smallest informal sectors among the 162 countries for which comparable data are available while Azerbaijan and Georgia are among the three countries with largest informal sectors (Schneider et al, 2010).

How far have the countries of transition economies in Europe and Central Asia progressed in their shift from central planning to competitive markets? The economics department of the European Bank for Reconstruction and Development (EBRD) compiles national indicators that illustrate the state of structural transition in key areas such as privatization, enterprise governance, competition policy, trade and foreign exchange regimes, and financial institutions. EBRD economists also estimate national transition indicators for various goods-producing and service sectors. The Bank's legal department compiles assessments of the legal transition pertaining to the extensiveness and implementation of core commercial and financial laws. Most transition economies have made major efforts to upgrade their commercial and financial legislation. However, the quality of implementation of legal provisions is rather uneven. The comparatively good performance of the new EU member states has been driven to some extent by their lengthy accession process, including an establishment of a legal system compatible with EU legislation. The rule of law and progress in transition to competitive markets are positively related (Figure 9).

## INTELLECTUAL PROPERTY RIGHTS

In the context of innovation, effective legal protection of intellectual property rights (IPRs) such as copyright, patents and trademarks is important. Intellectual property protection encourages knowledge creation, invention and innovation in the long run. However, the enforcement of IPRs dampens the diffusion of protected (and thus more expensive) innovations in the short run. Generally the enforcement of IPRs is stricter in countries that are WTO members because WTO rules protect IPRs in international trade.

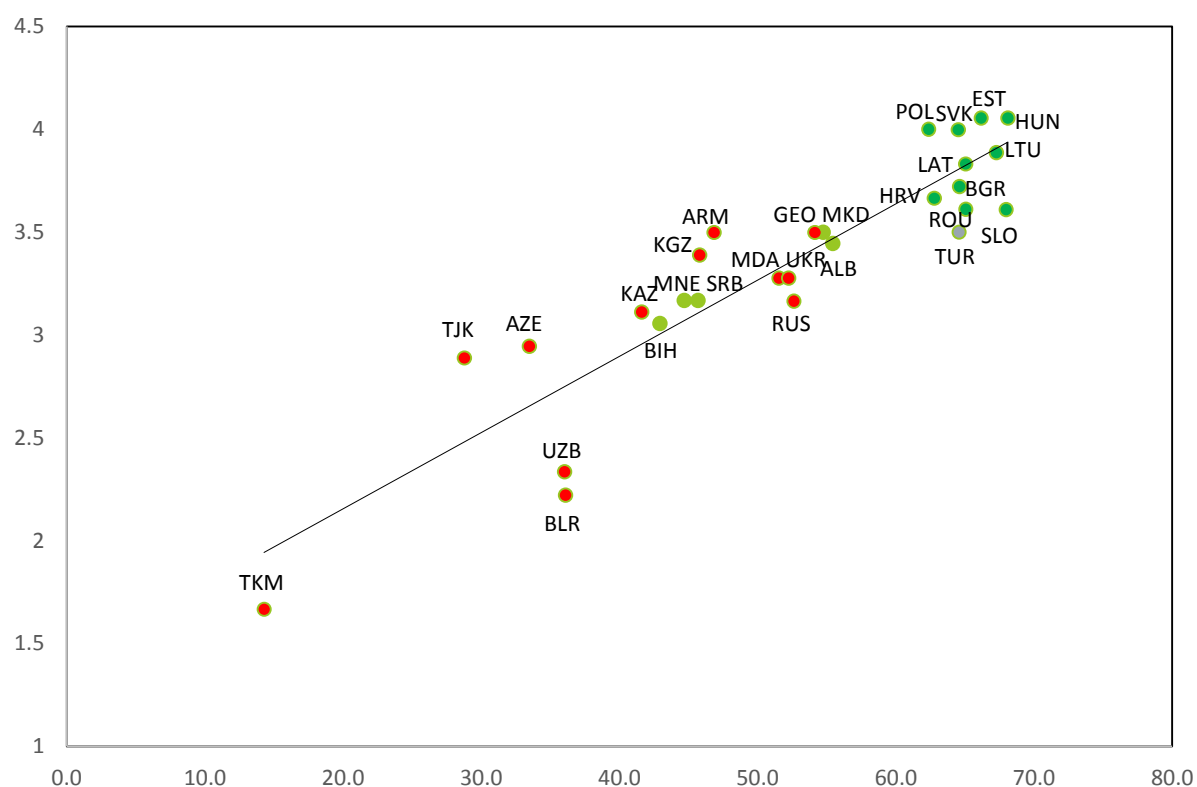
## UNEVEN PROGRESS IN TRANSITION

A snapshot of country transition indicators, in transition economies in Europe and Central Asia is provided in table 11. The indicators range from 1 (rigid centrally planned economy) to 4+ (industrialized market economy). The + (-) sign corresponds to 0.33 (-0.33) on the scale. Market economies cannot function well without competing firms and flexible prices. The table shows that most countries made significant progress with respect to small-scale privatization and liberalization of domestic prices, foreign trade and exchange systems. The progress made in the privatization of large state-owned enterprises has been slower and more uneven. Transition lags in business governance

and enterprise restructuring as well as competition policy remain large in a number of countries. Low transition scores (2 or less) are highlighted in the table.

A snapshot of sector transition indicators is provided in Table 12. Low transition scores (2 or less) are highlighted in the table. The assessment is based on publicly available data or observations of market structure and market-supporting institutions and policies (EBRD, 2012). The institutional evolution of sectors is important because the business environment and market structures determine the competitiveness and productivity of firms. Business firms in competitive markets have incentives to absorb new technology and adapt to various challenges, including those posed by climate change. In contrast, various subsidies (e.g. artificially low prices of electricity, fuel and water) and other state interventions lead to market distortions and inefficiencies. The liberalization of infrastructure services such as telecommunications, energy and transport is particularly important because it is conducive to higher FDI inflows and technology transfer.

**FIGURE 9. THE RULE OF LAW AND PROGRESS IN TRANSITION**



*Note:* Effectiveness of the implementation of commercial and financial laws (ranging from 1 to 100) is assessed on the basis of perception-based surveys. State of transition, measured by the average of transition indicators, ranges from 1 (rigid centrally planned economy) to 4+ (*industrialized market economy*).

*Source:* EBRD country and legal transition indicator databases.

**TABLE 11. THE EBRD COUNTRY TRANSITION INDICATORS  
(TRANSITION ECONOMIES IN EUROPE AND CENTRAL ASIA, 2012)**

	Large scale privatization	Small scale privatization	Governance & enterprise restructuring	Price liberalization	Trade & forex system	Competition policy
<b>EECCA</b>						
Armenia	4-	4	2+	4	4+	2+
Azerbaijan	2	4-	2	4	4	2-
Belarus	2-	2+	2-	3	2+	2
Georgia	4	4	2+	4+	4+	2
Kazakhstan	3	4	2	4-	4-	2
Kyrgyzstan	4-	4	2	4+	4+	2
Moldova	3	4	2	4	4+	2+
Russia	3	4	2+	4	4	3-
Tajikistan	2+	4	2	4	3+	2-
Turkmenistan	1	2+	1	3	2+	1
Ukraine	3	4	2+	4	4	2+
Uzbekistan	3-	3+	2-	3-	2-	2-
<b>SEE</b>						
Albania	4-	4	2+	4+	4+	2+
Bosnia and Herzegovina	3	3	2	4	4	2+
Montenegro	3+	4-	2+	4	4+	2
Serbia	3-	4-	2+	4	4	2+
The FYR of Macedonia	3+	4	3-	4+	4+	3-
Turkey	3+	4	3-	4	4+	3
<b>NMS</b>						
Bulgaria	4	4	3-	4+	4+	3
Croatia	3+	4+	3+	4	4+	3
Estonia	4	4+	4-	4+	4+	4-
Hungary	4	4+	4-	4+	4+	4-
Latvia	4-	4+	3+	4+	4+	4-
Lithuania	4	4+	3	4+	4+	4-
Poland	4-	4+	4-	4+	4+	4-
Romania	4-	4-	3-	4+	4+	3+
Slovakia	4	4+	4-	4+	4+	4-
Slovenia	3	4+	3	4	4+	3-

*Note:* Transition indicators range from 1 (rigid centrally planned economy) to 4+ (industrialized market economy).

*Source:* EBRD transition indicators database.

**TABLE 12. THE EBRD SECTOR TRANSITION INDICATORS  
(TRANSITION ECONOMIES IN EUROPE AND CENTRAL ASIA, 2012)**

	Agri-business	General industry	Telecoms	Natural resources	Sustainable energy	Electric power	Water utilities	Road transport
<b>EECCA</b>								
Armenia	3-	3	3	3-	3-	3+	3-	3-
Azerbaijan	2+	2	2-	2+	2+	2+	2-	2+
Belarus	2+	2	2	1	2	1	2-	2
Georgia	3-	3-	3-	2	3-	3+	2	2+
Kazakhstan	3-	2	3	2-	2-	3	2+	2+
Kyrgyzstan	2+	2	3	2+	2	2+	2-	2-
Moldova	3-	2-	3	3	2+	3	2	3-
Russia	3-	3-	3+	2	2	3+	3	3-
Tajikistan	2	2-	2+	1	2+	2	2	2-
Turkmenistan	1	1	2-	1	1	1	1	1
Ukraine	3-	2+	3-	2-	2+	3	2+	3-
Uzbekistan	2	1	2	1	2-	2+	2-	1
<b>SEE</b>								
Albania	3-	2+	3+	3-	3+	3	2+	3-
Bosnia and Herzegovina	3-	2	2+	2	2	2+	2	3
Montenegro	2+	2+	3+	3+	2	2+	2	2+
Serbia	3-	3-	3	2	2+	2+	2+	3-
The FYR of Macedonia	3-	3	4-	2+	2+	3	2+	3-
Turkey	3-	3	3+	3+	3	3+	3	3-
<b>NMS</b>								
Bulgaria	3	3+	4-	3+	3-	3+	3	3-
Croatia	3	3+	4	4-	3-	3	3+	3+
Estonia	3+	4+	4	4	3-	4	4	3
Hungary	4	4-	4	4-	3	4-	4	4-
Latvia	3	4-	3+	3+	3+	3+	3+	3
Lithuania	3+	4-	4-	3+	3+	3+	3+	3
Poland	3+	4-	4	3	3	3+	4-	4-
Romania	3	3+	3+	4-	3+	3+	3+	3
Slovakia	3+	4+	4-	3+	3	4	3+	3-
Slovenia	4-	3+	3+	3+	3+	3	3+	3

*Note:* Transition indicators range from 1 (rigid centrally planned economy) to 4+ (industrialized market economy).

*Source:* EBRD (2012).

## THE IMPORTANCE OF ENTREPRENEURSHIP, COMPETITION AND FINANCING

Entrepreneurship is the most important driver of innovation. In addition to business-friendly regulation and a good access to finance, social acceptance of both successes and failures of innovative entrepreneurs is essential for the development of a knowledge-based economy (UNECE, 2009). While government can control business regulations and support the formation of new innovative firms, it cannot control societal attitudes to entrepreneurship that tend to be hostile in many transition economies. Given the opaque nature of the privatization process and widespread corruption in some of these countries, such attitudes are understandable. However, a cultural change towards an acceptance of entrepreneurship as a positive innovative force is an important precondition for a vibrant business environment in which innovations thrive.

Why does competition matter? Competition breeds innovation. Firms that don't have to compete have weak incentives to innovate. With respect to competition policy, countries of the Caucasus and Central Asia lag behind other transition economies. However, the comparatively liberal external trade and foreign exchange systems in Azerbaijan, Kazakhstan, Kyrgyzstan and Tajikistan (Table 11) are conducive to competition in the traded sector that could facilitate the absorption and diffusion of innovative products and services.

A healthy development of financial institutions is essential for the financing of innovative firms, especially in the strategic SME sector. Kazakhstan has achieved a remarkably successful transition in banking and capital markets (Table 13). However, bank financing as well as the issuance of bonds and shares are available on reasonable terms only to large established enterprises. Other forms of financing for innovative micro, small and medium-sized enterprises (MSMEs) remain underdeveloped. All other countries of Central Asia and Azerbaijan are still in early stages of financial transition. The insurance sector also remains underdeveloped (recall from Module III that innovative insurance products are important in the climate adaptation context).

**TABLE 13. THE EBRD FINANCIAL TRANSITION INDICATORS  
(TRANSITION ECONOMIES IN EUROPE AND CENTRAL ASIA, 2012)**

	Banking	Insurance and other fin. services	MSME finance	Private equity	Capital markets
<b>EECCA</b>					
Armenia	2+	2	2+	1	2
Azerbaijan	2	2	2	1	2-
Belarus	2	2	2	1	2-
Georgia	3-	2	3-	1	2-
Kazakhstan	3-	2+	2	2-	3
Kyrgyzstan	2	2-	2-	1	2-
Moldova	2+	2+	2	2-	2+
Russia	3-	3-	2	2+	4-
Tajikistan	2	2-	1	1	1
Turkmenistan	1	2-	1	1	1
Ukraine	3-	2+	2	2	3-
Uzbekistan	1	2	1	1	1
<b>SEE</b>					
Albania	3-	2	2+	1	2-
Bosnia and Herzegovina	3-	2+	2+	2-	2-
Montenegro	3-	2+	2+	1	2+
Serbia	3-	3	3	2-	3-
The FYR of Macedonia	3-	3-	2+	1	2-
Turkey	3+	3	3-	3-	4-
<b>NMS</b>					
Bulgaria	3	3+	3-	3-	3
Croatia	3+	3	3-	2+	3
Estonia	4-	3+	3	3-	3
Hungary	3+	3	3	3	3+
Latvia	3+	3+	3	3-	3
Lithuania	3+	3+	3	2+	3
Poland	4-	4-	3	3+	4
Romania	3	3+	3-	3-	3
Slovakia	4-	3+	3+	2+	3
Slovenia	3	3	3	3-	3

*Note:* Transition indicators range from 1 (rigid centrally planned economy) to 4+ (industrialized market economy).

*Source:* EBRD (2012).



## QUALITY EDUCATION AND KNOWLEDGE-BASED ECONOMY

Quality education is a key precondition for the development of any knowledge-based economy. A number of transition economies in Europe and Central Asia have participated in the tests of the reading, mathematics and science literacy of 15-year old students conducted by the Programme for International Student Assessment (PISA). The programme is administered by the Organisation for Economic Co-operation and Development (OECD). Despite some improvements over time, only some transition economies achieved results that are close to the average of OECD countries (Table 14). In contrast to the relatively good performance of the students tested in Russia, those in Kazakhstan, Azerbaijan and Kyrgyzstan achieved less satisfactory results. This can be explained to some extent by lower per capita incomes in Azerbaijan and Kyrgyzstan because up to a threshold level income is the principal determinant of performance in PISA tests. However, comparatively higher income levels alone cannot explain the outstanding performance of students from countries such as Estonia or Poland.

**TABLE 14. PERFORMANCE IN READING, MATHEMATICS AND SCIENCE LITERACY**

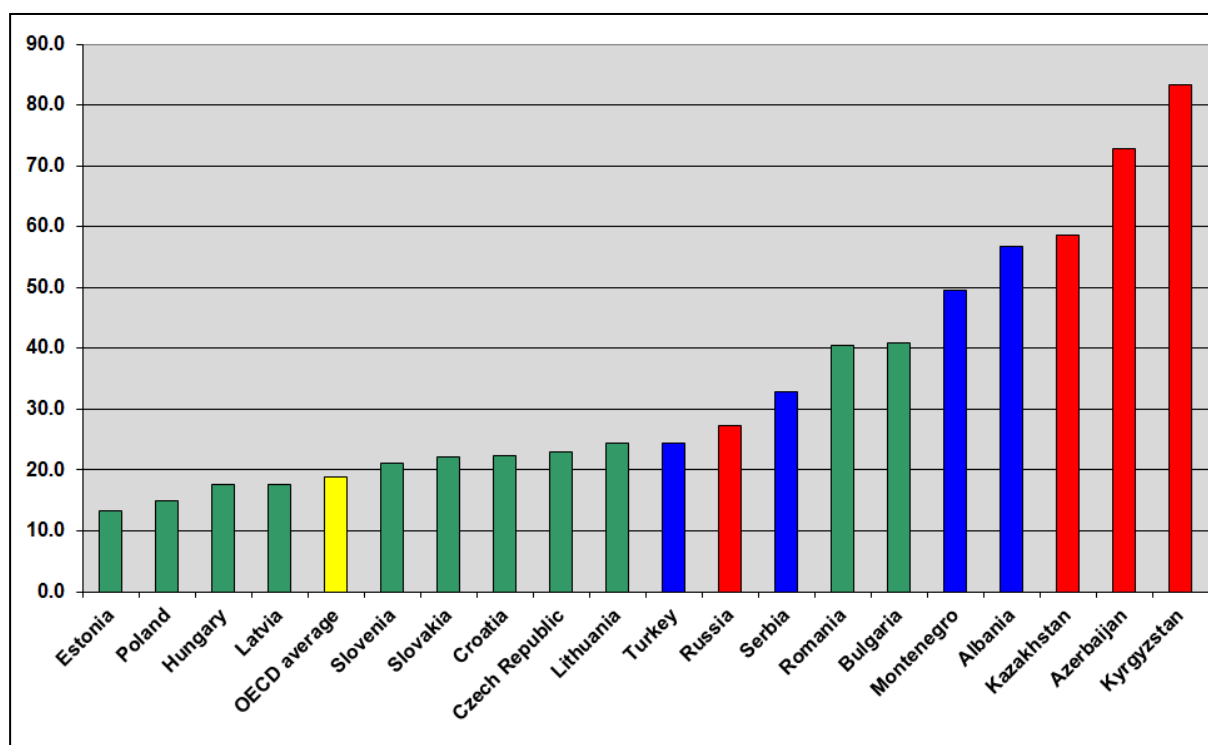
Country	Reading	Mathematics	Science	Average
Estonia	501	512	528	514
Poland	500	495	503	499
Slovenia	483	501	512	499
Hungary	494	490	503	496
Czech Republic	478	493	500	490
Slovakia	477	497	490	488
Latvia	484	482	494	487
Lithuania	468	477	491	479
Croatia	476	460	486	474
Russia	459	468	478	469
Turkey	464	445	454	455
Serbia	464	442	443	450
Bulgaria	429	428	439	432
Romania	424	427	428	427
Montenegro	408	403	401	404
Kazakhstan	390	405	400	399
Azerbaijan	362	431	373	389
Albania	385	377	391	384
Kyrgyzstan	314	331	330	325
OECD average	495	496	501	497
NMS average	474	480	489	481
SEE average	448	449	460	452
EECCA average	381	409	395	395

Source: UNECE calculations based on OECD data.

PISA tests the application of knowledge in normal everyday situations so that it measures competencies and not only knowledge (Bloeme, 2013). What is the baseline proficiency that would enable today's 15-year old students to participate successfully in

tomorrow's labour markets? According to PISA, this baseline is defined as level 2 of proficiency across all three categories (reading, mathematics and science), i.e. a level at which students have sufficient mastery of skills and competencies that are important for participation in a knowledge-based society. Figure 10 shows that more than one-half of 15-year old students in Albania, Kazakhstan, Azerbaijan and Kyrgyzstan have failed to achieve level 2 literacy skills.

**FIGURE 10. THE SHARE OF 15-YEAR OLD STUDENTS BELOW READING LEVEL 2**



Source: OECD.

## EDUCATIONAL EQUITY AND POST-SECONDARY EDUCATION

Recall that in lower income countries the educational outcomes measured by PISA correlate to a large extent with the level of per capita income. Economic growth may well explain improvements in the average performance of students from the participating countries of Eastern Europe, Caucasus and Central Asia in PISA tests between the early and late 2000s. However, this progress was not uniform and some students were left behind. For instance, a detailed analysis of the 2009 PISA test results has revealed that test scores of students from Kyrgyzstan correlate strongly with the school location and language of instruction (Bloem, 2013). This factor, reflecting a large divide in educational quality between major cities and the countryside, matters in most other countries as well. Therefore it is important to improve the educational equity as well as educational quality outside of major cities.

Post-secondary education is important for knowledge-based economies. In most transition economies the proportion of population with access to tertiary education increased since late 1980s. Notable exceptions include four countries in the Caucasus and Central Asia (Azerbaijan, Georgia, Tajikistan and Uzbekistan) where the tertiary enrolment rates are lower than in late 1980s. Tertiary enrolment may have also declined

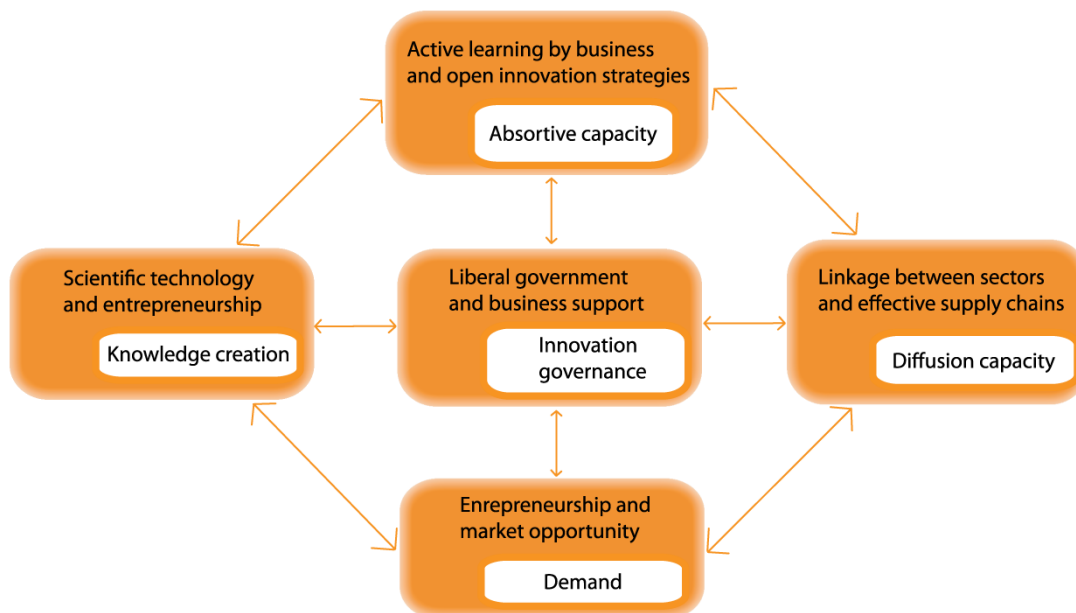
in Turkmenistan, a country for which enrolment data are not available. Moreover, the quality of tertiary education in the region is variable and large numbers of graduates lack employment-relevant skills. In most countries the majority of students in tertiary institutions are women with the exception of Tajikistan and Uzbekistan. Male students continue to predominate in technical disciplines in all countries. This implies an underutilization of human resources that could be costly in the context of innovation.

## INNOVATION GOVERNANCE

### STRUCTURE OF THE NATIONAL INNOVATION SYSTEM

The national innovation system (NIS) is the flow of technology and information among actors of innovation activities. It consists of a complex network of interacting private and public institutions whose activities generate the supply and demand of knowledge as well as its absorption by firms and diffusion throughout the economy. Figure 11 illustrates this complexity by representing principal NIS components (technology supply, demand, absorptive capacity, diffusion capacity, governance) and their interactions. Central to the system is innovation governance, i.e. the capacity of a country to coordinate a large number of policy measures that influence the innovation process. Innovation governance refers to the capacity of public officials to develop and implement policies as well as the organizational setup to facilitate coordination and linkages between system components (UNECE, 2007).

**FIGURE 11. STRUCTURE OF THE NATIONAL INNOVATION SYSTEM**



*Source:* UNECE (2009).

The key point to understand is that innovations unfold through complex processes that governments cannot create or order to be created. Instead these processes are driven by an interplay of various forces – academic institutions, research laboratories,

entrepreneurs, private investors, large and small firms, consumers and public agencies – that can be empowered or influenced but not fully controlled by government policies and programmes. Given the complexity of the NIS, a systemic approach is needed. What does this mean? Such an approach aims to identify principal strengths and weaknesses of the national innovation system and propose coherent policies for better innovation performance.

## THE RATIONALE FOR GOVERNMENT INTERVENTION

Competitive market forces are essential for innovation. However, the business sector is unlikely to spend enough on research and development (R&D) and innovation. Why? First, innovative firms are seldom able to appropriate fully the economic gains resulting from the use of their discoveries. Second, risk-averse banks and private investors have only imperfect information about the true market potential of new R&D and innovation activities which implies funding gaps, especially in early stages of technological development. Third, the business R&D and innovation activity is particularly weak in transition economies due to the legacy of centralized state-controlled research (UNECE, 2007).

Governments can correct such market failures with the aid of innovation policies. It is important to bear in mind that government interventions in this area have been seldom successful in emerging and developing economies. Why? The lack of success reflects policy errors (e.g. unrealistic objectives) as well as governance failures such as corruption or the capture of policy makers by vested interests. Risks of governance failures are significantly higher in transition economies than advanced industrialized countries (Goldberg et al, 2011).

## INNOVATION GOVERNANCE CHALLENGES

Innovation governance reflects the peculiarities of institutional evolutionary patterns and is thus country specific. This implies that there is no optimal model of innovation governance. There are however always two principal innovation governance challenges: policy coordination and policy coherence. Whereas a number of advanced economies have integrated innovation policymaking in diverse forms (ranging from the creation of a new Ministry of Science, Technology and Innovation in Denmark to a coordination of ministerial R&D activities by the Office of Chief Scientist in Israel), a rather more fragmented or sectoral policy approach has persisted in transition economies (UNECE, 2007).

The weak horizontal coordination in most transition economies between the line ministries concerned with various areas of innovation (e.g. Agriculture, Education and Science, Economy, Energy, Environment, Health, Industry and Trade) reflects the legacy of a governance system based on strong vertical command links (described in Module III). For instance, this tradition is not conducive to the mainstreaming of climate change concerns into sectoral innovation policies. However, the problem is not specific to transition economies. Effective policy coordination across various domains remains an important governance challenge in most countries.

What is the difference between innovation strategy and innovation governance? Innovation strategy aligns policy objectives with the means to implement them while innovation governance determines how well the available resources are used. Is innovation governance relevant in transition economies? Yes. Transition economies tend

to spend significantly less on R&D and innovation than advanced countries while the public sector provides the bulk of R&D expenditure. Therefore, good innovation governance is essential for spending the limited resources for R&D and innovation incentives well.

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## FRAMEWORK POLICIES

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### FRAMEWORK POLICIES AND INNOVATION PERFORMANCE

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Innovation policies can be classified into framework policies and innovation-specific policies. Framework policies try to improve the framework conditions discussed above. In principle all governments in transition economies in Europe and Central Asia accept the need to continue the transition to markets and pursue further reforms of the core commercial and financial laws with a view to improving the environment for doing business. Framework policies are active in the following areas:

- Financial, labour and product markets;
- Education;
- Competition;
- Legal (incl. IPR) reforms;
- Infrastructure; and
- Trade and FDI regulations.

But why are framework policies so important? The experience of advanced industrialized countries shows that the quality of framework conditions is essential for a good innovation performance. For instance, good framework policies can encourage the formation of innovative enterprises. Estonia provides an interesting example of a confluence of supportive government policies for the formation of innovative firms and a broad social acceptance of entrepreneurial successes and failures (Box 11)

#### **BOX 11. ESTONIA'S UNEXPECTED ENTREPRENEURIAL RECORD**

According to the World Bank data on new business density (measured by the number of new business registrations over the population aged 15-64), Estonia is the leader in transition economies in Europe and Central Asia and among the best performers in the world. Why Estonia? A part of the puzzle is explained by the fact that Estonia has introduced earlier than other countries a sweeping organizational innovation known as e-government. The electronic online registration of new businesses has been available in Estonia since 2007 (UNECE, 2009). This provides potential entrepreneurs with a convenient way of setting up new limited liability companies. Another factor is a powerful demonstration effect provided by a sweeping success of Skype internet-telephony, an innovation developed by an Estonian start-up (now part of Microsoft). This has increased social acceptance of entrepreneurship, especially among young people.

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### COMPETITION POLICY AND FOREIGN TRADE LIBERALIZATION

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Competition can be enhanced with the aid of competition policy and foreign trade liberalization. The available research shows that the firms exposed to competitive

pressures spend more on R&D and innovate more than the firms operating under less competitive conditions. In the trade sector the firms in the new EU member states have been exposed to strong competition in the huge EU single market (the largest market in the world) and either learned to innovate or went bankrupt. Competitive pressures in a number of transition economies have been less brutal, especially in resource-based economies with well-protected national champions, i.e. large state-controlled enterprises that operate in various strategic sectors.

Most countries of transition economies in Europe and Central Asia joined the World Trade Organization (WTO), opening their economies to more competition from abroad. However, six countries have still not concluded the WTO accession negotiations (Azerbaijan, Belarus, Bosnia and Herzegovina, Kazakhstan, Serbia and Uzbekistan) and one country not initiated such negotiations to date (Turkmenistan). WTO accessions have proved to be advantageous in the sense that benefits of membership exceeded its costs. Aside from the international trade in goods and services, WTO monitors how its members are applying intellectual property rules in the following areas:

- Copyright;
- Trademarks;
- Geographical indications;
- Industrial designs;
- Patents;
- Lay-out designs of integrated circuits; and
- Undisclosed information, including trade secrets.

Governments are allowed to reduce social costs resulting from the adoption of IPRs through various exemptions, for example in the area of public health.

## HUMAN CAPITAL FORMATION

Human capital formation can be supported with the aid of policies that target improvements in the quality of compulsory education. Kazakhstan provides an important example of good practice: a government programme aims to improve the quality of compulsory schooling while using international tests for the monitoring of programme outcomes (Box 12). In addition to international assessments, country reports based on national and sub-national data should be used to analyze specific education issues in greater depth with a view to elaborating forward-looking policy recommendations.

### **BOX 12. USING PISA TESTS TO IMPROVE THE QUALITY OF EDUCATION IN KAZAKHSTAN**

Kazakhstan was one of the 65 countries/economies participating in the 2009 PISA survey, achieving the 59th position in overall ranking. National authorities decided to continue participating in subsequent PISA tests with a view to monitoring the evolution of performance. The State Programme for the Development of Education of the Republic of Kazakhstan targets an improvement in the PISA ranking to 50-55 by 2015 and 40-45 by 2020.

(UNECE, 2012)

What should be done to improve the performance of higher education institutions (HEIs) in transition economies? It is essential to overcome the legacy of weak

cooperation between the HEIs, research institutions and enterprises. In addition to teaching, HEIs should be actively involved in the development of science, technology and innovation policies with a view to improving technology transfer and commercialization of research. Growth of the innovative SME sector could be stimulated by policies that provide a solid legal basis (including effective IPR protection) for the establishment of spin-off companies by research-oriented HEIs (UNECE, 2012).

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## INNOVATION-SPECIFIC POLICIES

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### OBJECTIVES OF INNOVATION-SPECIFIC POLICIES

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Governments use innovation-specific policies to increase:

- Absorptive capacity;
- Generation of knowledge;
- Diffusion of innovation; and
- Demand for innovation.

Innovation-specific policies focus either on the linkages between interacting parts of the national innovation system (Figure 11) or on the improvement of weak parts. If the individual parts of the system are weak, improvements of linkages between them are unlikely to be the best policy option. Nevertheless, innovation policies of most of the new EU member states focus on competitive R&D programmes and industry-science linkages. Only two countries, Hungary and the Czech Republic, target directly business R&D and business innovation with the aid of various measures that include R&D tax incentives (Izsák et al, 2013).

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### ABSORPTIVE CAPACITY

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What is absorptive capacity? In the context of innovation the term refers to the ability of firms to assess, absorb and adapt external technology. Policies can improve absorptive capacity by supporting the process of lifelong learning that entails continuous upgrading of relevant skills of workers and managers. This type of learning helps to reduce human capital mismatches in the labour market and is conducive to the generation of incremental innovations based on existing technologies.

Although new EU member states have access to the EU structural funds to finance various education and training programmes, they spend on average less than advanced economies on this type of human capital formation. In Eastern Europe, Caucasus and Central Asia only Belarus, Kazakhstan and Russia seem to have comprehensive policies that aim to overcome shortages of skilled and qualified employees (UNECE, 2007; UNECE, 2012).

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### TECHNOLOGY TRANSFER AND ECONOMIC DIVERSIFICATION

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In recent years policy makers in resource-based transition economies have increasingly promoted innovation-based diversification while the business environment continued to improve. Cluster initiatives and programmes operate in Kazakhstan and Russia, reflecting specific innovation profiles in various regions and providing support for better links between regional innovation actors (universities, research organizations,

firms and investors). For the time being the innovative start-ups and SMEs seem to be weakly represented in such clusters (Kutsenko and Messner, 2013 and UNECE, 2012).

Technology transfer in transition economies was traditionally provided by centralized industry research institutes that serviced enterprises controlled by line ministries (e.g. chemicals, engineering, energy, metallurgy, etc.). Enterprises seldom had in-house R&D departments (with the exception of Slovenia). During early stages of transition most of these research institutes had been closed or downsized in the countries aspiring to join the EU but continued to operate on a large scale in some countries of Eastern Europe, Caucasus and Central Asia. Subsequently, new institutions such as science and technology parks, innovation advisory services and the competence centres operated jointly by business firms and research institutions or industrial development agencies were tasked with the generation and transfer of knowledge in a growing number of transition economies (UNECE, 2007).

## GENERATION OF KNOWLEDGE

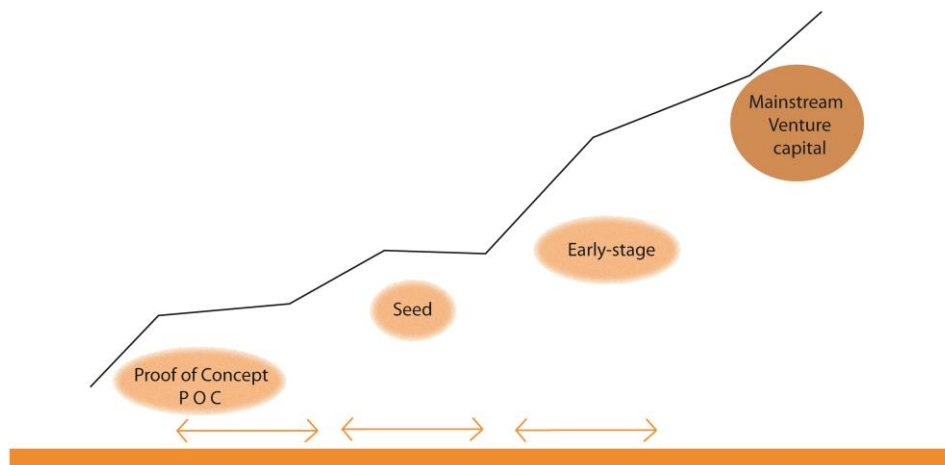
The policies targeting absorptive capacity can achieve near-term improvements while encouraging imitation and incremental innovation based on existing technologies. By contrast, the policies targeting the capability of the NIS to generate and apply new knowledge may well succeed only in the long term. In comparison to innovation leaders, transition economies tend to spend less on R&D and are characterized by weak in-house industrial R&D activity with few links to scientific institutions. This reflects the Soviet legacy of centralized state-controlled research. A number of countries, including the new EU members as well as Russia and Kazakhstan, strive to overcome such weaknesses by providing generous tax incentives for R&D and innovation activities of large firms.

The support for innovative micro, small and medium-sized enterprises remains weak. Given the relatively strong tradition of science and engineering in transition economies, there is no shortage of new ideas that could have commercial applications. However, there are numerous obstacles on the road from new ideas to markets. The biggest obstacle is the limited availability of finance. Governments can address this problem in different stages of innovation activity with the provision of grants and co-investment in venture capital funds. Another obstacle for small firms and individual inventors is the lack of competent business advisory services that would provide them with the logistical support and technical assistance in areas such as international patent protection. In some transition economies publicly funded business incubators have provided such advisory services with mixed results (Goldberg et al, 2011).

## EARLY STAGE FINANCING

Innovative start-ups and SMEs are plagued in many countries by red tape and poor access to finance. Bank lending is practically unavailable without collateral and proven credit record. Figure 12 illustrates the stages of funding requirements of start-up firms. Following a demonstration of the feasibility of a new idea, the early-stage financing is provided by the seed capital injected by the founder or private investors (individuals or specialized funds) or government grants. In the next stage angel investors (known also as business angels) provide additional funding in return for an equity stake and some managerial rights. Business angels tend to make more and smaller investments than venture capital funds in early stages of financing (UNECE, 2009).



**FIGURE 12. STAGES OF FUNDING REQUIREMENTS**

Source: UNECE (2009).

Equity financing for start-ups and innovative SMEs, provided by angel investors, government-controlled and private venture capital funds, is available but scarce in new EU member states (with the exception of Estonia that seems to attract well foreign investors and venture capitalists). In a number of other transition economies governments provide small grants or matching grants for a limited number of innovative SMEs.

### LATER STAGES OF FINANCING

Venture capital is also available in resource-rich transition economies such as Russia or Kazakhstan, where its growth is limited by a lack of investable projects rather than by a shortage of funds (Box 13). The importance of equity financing in the innovative SME sector is likely to increase in the longer term in transition economies that continue to improve framework conditions.

#### BOX 13. VENTURE CAPITAL IN KAZAKHSTAN

The National Investment Fund (NIF) of Kazakhstan has supported the development of domestic venture capital industry, setting up a number of hybrid funds where it holds stakes up to 49 per cent of equity while the remaining portion of capital is provided by private investors. These private partners make investment decisions and run the companies in which the venture capital funds invest. Returns are shared equally between the public and private investors. The main constraint is posed by the scarcity of available projects with an acceptable risk-return profile for private investors.

(UNECE, 2012)

### DIFFUSION OF INNOVATIONS

Innovations are diffused when businesses and consumers adopt them. The policies targeting the diffusion of innovations in the business sector focus on various linkages and supply chains. Policy makers in new EU member states prioritized incentives for foreign direct investment (FDI) that was viewed as a major engine of economic modernization. Such incentives included large tax breaks and preferences for FDI firms.

Some countries also established special economic zones to attract foreign investors and stimulate economic diversification and innovation.

Government investment promotion agencies have also encouraged the development of linkages between industrial FDI firms with superior technology and domestic subcontracting firms with a view to increasing the local content in supply chains. Such initiatives led gradually to the establishment of state-supported regional clusters for various export-oriented industries (e.g. automotive industry) that saw close cooperation between foreign-invested firms and various regional stakeholders (universities, research organizations, investment funds, SMEs and innovative start-ups). Despite the success of this form of diffusion of innovations, the number of innovative SMEs in the new EU member states is still comparatively low while the FDI sector continues to be considerably more productive than the domestic sector.

Foreign direct investment in Eastern Europe, Caucasus and Central Asia has been concentrated in extractive sectors such as mining, oil and gas. The cooperation between foreign-invested firms and local suppliers has been relatively weak. In order to address this problem the authorities in Azerbaijan and Kazakhstan have developed programmes that aim to improve the links between FDI firms in the oil and gas sector and local companies in the service support sector (UNECE, 2007).

## DEMAND FOR INNOVATION

Supply-side (technology push) instruments predominate in innovation policies of transition economies. What about the demand side (technology pull)? The feeble innovation activity of the business sector, weak protection of property rights (incl. IPRs), limited access to finance (especially for SME firms), and lack of internal competition are responsible for weak demand for innovation. To address these shortcomings, governments need to improve the investment climate and accelerate transition in key sectors with a view to increasing indirectly demand for innovation. Public procurement and regulations can be used to increase such demand more directly.

Public procurement can create initial demand for a new product or system, either by choosing a supplier (usually a large firm) directly or issuing a competitive tender. The latter option is mandatory in the EU member states, if the value of contract exceeds €25,000. Government can also initiate 'technology pull' with the aid of more stringent standards or regulations that force industry to innovate. This kind of intervention has induced impressive technological progress in advanced industrialized countries (e.g. stringent emission and fuel efficiency standards have been a powerful driver for innovation in the automotive sector). Note however that more stringent regulations, including environmental standards, tend to increase production costs.

The complexity of the public procurement process continues to be a major barrier for small businesses. However, governments can open public procurement to innovative SMEs by making the process less time consuming and more user friendly with the aid of electronic procurement and reforms that allow small businesses to compete successfully for contracts. Electronic procurement is available in all EU member states and Turkey. Nevertheless, administrative barriers to SME participation in tenders continue to exist in most of these countries.

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## ECO-INNOVATION POLICY

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### POLICY INTEGRATION

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How can governments stimulate eco-innovation? Green growth implies the need for policy integration between environmental and innovation policies. This is easier said than done. Environmental policies usually do not target innovation processes while innovation policies are seldom concerned with sustainable development (UNECE, 2007). Traditionally green or eco-innovations have been driven by government regulations in response to specific market failures known as negative externalities. Such failures result when market prices fail to capture the full cost of economic activity that should include the damage caused by pollution and depletion of natural resources.

How can policy makers bridge the divide between environmental and innovation policies? One possibility is to coordinate environmental and innovation measures by eco-innovation policy that aims to enhance both innovation performance and sustainability while using a number of policy instruments such as:

- Market oriented schemes (e.g. emissions trading system, carbon emissions tax);
- Regulations (e.g. minimum standards, recycling rules, permits and bans);
- Direct support for eco-innovation (e.g. subsidies, seed capital grants);
- Consumer policies (e.g. education for sustainable development, eco-labeling);
- Public procurement (green public procurement); and
- Strategic planning (e.g. spatial planning).

### COORDINATION OF ECO-INNOVATION MEASURES

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The eco-innovation instruments are applied in various countries by the line ministries or public agencies responsible for specific policy areas (UNIDO, 2012). Strong leadership is necessary for an effective implementation of eco-innovation measures in sensitive areas such as energy and water tariffs (discussed in Module III). Note that any of the above measures alone may not deliver targeted results. Given the complexity of innovation processes and sustainable development, integrated policy making is needed to coordinate across various domains. Some examples of eco-innovation policy measures and relevant policy areas are listed in Table 15.

Effective eco-innovation policy can exploit synergies among the policy instruments mentioned above. For instance, in addition to using strict environmental regulations and green public procurement, the authorities can boost eco-innovation by putting a price on GHG emissions. The European Union has launched in 2005 an innovative emissions trading system (ETS) that operates in 31 ECE countries (28 EU members, Iceland, Liechtenstein and Norway). The system limits GHG emissions from more than 11,000 heavy energy-using installations in power generation and manufacturing industry that are responsible for about 45 per cent of such emissions. The government of Kazakhstan plans to introduce its own version of ETS in 2014. However, the government's plan is strongly contested by industrial interests and may well have to be postponed or completely abandoned.

**TABLE 15. EXAMPLES OF ECO-INNOVATION MEASURES**

Type	Examples of measures	Policy fields
Market based instruments	Fiscal measures (e.g. energy tax, resource tax, carbon emissions tax, R&D tax incentives) Emissions trading schemes	Fiscal policy Trade policy
Regulatory and normative framework	Energy regulation standards and norms (including technology regulations, energy saving requirements) Permits and bans Land use regulations Environmental management systems, eco-labels and other soft standardization instruments	Environmental policy Industrial policy Energy policy Trade policy Local development policy
Direct support for innovation activity	Financial schemes (loans and credits) Subsidies (e.g. renewable energy subsidies) Venture capital funds Business incubation programmes Targeted R&D and technology transfer Business advisory services Eco-clusters (involved in development of eco-innovations and support for eco-innovative solutions in existing clusters)	Economic policy Energy policy Innovation policy Entrepreneurship policy Research policy Regional policy
Capacity building and demonstration measures	Professional training (eco-efficiency capacity building for enterprises) Changes in educational programmes	Education and training policy
Public procurement	Green public procurement	All policy fields with public procurement capacity (e.g. transport, construction and housing, national defence)
Strategic planning	Climate change foresight Strategic spatial planning	Foresight is relevant for all policy fields

Source: Adapted from UNIDO (2012).

Strategic planning based on climate change foresight has been widely used by a number of governments, providing an important input for eco-innovation policy. Stringent performance standards have stimulated R&D and innovation in industrial activities such as energy generation and manufacturing (e.g. motor vehicles, electrical appliances). Aside from regulations, a number of governments have utilized widely economic instruments such as excise taxes on fossil fuels or subsidies for renewable energy with a view to enhancing sustainability.

## R&D SPENDING ON ENERGY AND ENVIRONMENTAL RESEARCH

Public R&D expenditures on energy and environmental research increased over the last decade in transition economies in Europe and Central Asia while remaining well below the benchmarks established by the EU-15 economies. Private investment in this area increased somewhat in new EU member states. Its magnitude in other transition economies is unknown. Venture capital investment in renewable energy was reported only for two countries (Czech Republic and Poland). The available information on business investment in clean technology implies that the spending gap between the EU-15 and new EU member states has probably increased (UNIDO, 2012).

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## GREEN PROCUREMENT

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Government procurement is becoming an increasingly important driver of green innovation in new EU member states and candidate countries, reflecting important EU initiatives such as the Europe 2020 strategy and green public procurement. The former is a green growth strategy for all 28 EU members. The latter entails the EU directives enabling green procurement, mandatory green procurement rules in specific areas (energy performance of new buildings and equipment, and the use of environmentally friendly vehicles in the public sector) and a support programme to assist government authorities with the implementation of green procurement.

According to the available information, green procurement has not been introduced yet in countries of Eastern Europe, Caucasus and Central Asia. Two countries, Kazakhstan and Russia, have made innovation a national priority but neither established mechanisms for stimulating demand for eco-innovation.

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## SUMMARY

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1. Framework conditions determine the national innovation performance to a large extent. Figure 9 illustrates the relationship between the rule of law and systemic transition to markets. Figure 10 and Tables 11 – 14 show the state of framework conditions in transition economies.
2. The national innovation system consists of five subsystems: innovation governance, knowledge creation, demand for innovation, absorptive capacity, and diffusion capacity. Figure 11 illustrates how these subsystems interact.
3. Innovation-specific policies aim to support the research and development activity, technology absorption and diffusion, and demand for innovations. They focus either on the linkages between parts of the national innovation system such as industry-science collaboration or on the improvement of weak parts of the system such as feeble business R&D and innovation activity. Good innovation governance enhances the effectiveness of such policies.
4. Eco-innovation policy is a subset of national innovation policy. Table 15 shows the main types of eco-innovation policy instruments and examples of specific measures.
5. Integrated policy making is needed to coordinate eco-innovation measures across various domains. Resultant synergies enhance the effectiveness of individual policy instruments.

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## GLOSSARY

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**Absorptive capacity** (in the context of innovation) refers to the ability to absorb new knowledge and adapt imported technologies.

**Angel investors** (also known as business angels) are affluent individuals who provide initial funds to business start-ups in exchange for an equity stake or convertible bonds (that can be exchanged later for shares) and some managerial rights.

**Climate change** refers to a persistent change in the mean and/or the variability of climate properties.

**Climate change adaptation** refers to the adoption of policies and practices to prepare for the effects of climate change.

**Climate change mitigation** refers to the adoption of policies and practices that reduce greenhouse gas emissions of economic activity.

**Cluster** refers in the innovation context to a regional agglomeration of interconnected business firms, subcontractors, research institutions, and innovative start-ups and SMEs.

**Diffusion of innovations** refers to the way in which innovations spread, through market or non-market channels, to different consumers, countries, regions, sectors, markets and firms.

**Eco-innovation** is an innovation whose use is less environmentally harmful than its alternatives.

**Foreign direct investment** refers to an investment made to acquire lasting interest in enterprises operating outside of the economy of the investor.

**Green innovation** is an innovation whose use is less environmentally harmful than its alternatives.

**Green growth** avoids unsustainable pressure on the quality and quantity of natural assets.

**Greenhouse gases** refer to carbon dioxide, nitrous oxide, methane, ozone and chloro-fluorocarbons occurring naturally and resulting from human activities, and contributing to the greenhouse effect (global warming).

**Innovation** refers to new or significantly improved products, processes, marketing methods or organizational methods

**Invention** refers to a new scientific or technical idea and the means of its embodiment or accomplishment. Most inventions are not economically feasible.

**Micro-enterprises** are small businesses with fewer than 10 employees.

**Private equity** refers to the capital invested by individuals or funds in private (non-traded) firms in order to increase its value later.

**Research and development** refers to three activities: basic research, applied research and experimental development.

**Seed capital** is provided in the initial stage of start-up activity by savings of the founder, his or her family, or outside private investors or funds specializing in early stage financing.

**Small and medium-sized enterprises** are independent firms with no more than 250 employees.

**Technology** refers to the state of technical knowledge.

**Technology transfer** refers to the process by which new technology or knowledge developed in one place is applied or exploited by firms or organizations in another place.

**Venture capital** refers to the capital invested by individuals or funds in innovative high-risk start-ups that have survived the initial phase financed by seed capital or angels investors.

**Sustainable development** is a process that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains two key concepts: the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

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## ADDITIONAL RESOURCES

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The Green Economy Toolbox was launched by the UNECE in August 2013 with a view to providing information and guidance on the green economy. The tools provided include guidelines and policy recommendations for facilitating a transformation to the green economy in the following areas: environmental protection, energy, education, finance, housing, innovation, and transport. The Green Economy Toolbox can be accessed at <http://www.unece.org/fileadmin/DAM/GET/>.

Green growth requires action by various stakeholders to stimulate green investment in different sectors. The choice of instruments should be tailored to the characteristics of different economies and to national priorities. There is therefore no one-size-fits-all solution for a transformation to the green economy. However, the Green Economy Toolbox offers tools for different stakeholders, such as governments, businesses, academia, and non-governmental organizations.

The tools provided for national authorities include a guide for policy options and instruments for financing innovation, and principles and recommendations on the financing and development of clean technologies (<http://www.unece.org/fileadmin/DAM/GET/#!/0/4>).



## QUESTIONS FOR DISCUSSION AND MULTIPLE CHOICE TEST

### QUESTIONS FOR DISCUSSION

1. Which framework conditions are particularly weak in your country? What could be done to improve them?

.....

.....

2. Should innovation policies in your country target weak industry-science linkages or weak business R&D and innovation activity? Why?

.....

.....

3. Government can use a range of measures to support eco-innovation. Which measures would be effective in your country and why?

.....

.....

### MULTIPLE-CHOICE TEST

**Check the best answer.** (*Correct answers can be found on page 144*)

#### QUESTION 1

Which of the following is not a framework condition of the national innovation system?

- A. Competition policy.
- B. Education system.
- C. Business environment.
- D. Climate system.

Your answer:.....

#### QUESTION 2

Chart 4.1 implies that the implementation of commercial and financial laws tends to be most effective in which of the following subregions:

- A. Eastern Europe, Caucasus and Central Asia.
- B. New EU member states.
- C. South-Eastern Europe.
- D. Impossible to answer.

Your answer:.....

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### QUESTION 3

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There is an optimal governance structure of the national innovation system that should be adopted by all transition economies.

- A. True.
- B. False.
- C. Neither true nor false.
- D. Impossible to answer.

Your answer:.....

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### QUESTION 4

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Innovation-specific policies can target:

- A. Absorptive capacity.
- B. Knowledge creation.
- C. Demand for innovation.
- D. All of the above.

Your answer:.....

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### QUESTION 5

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Governments cannot:

- A. Control all factors that shape a vibrant entrepreneurial climate.
  - B. Increase demand for innovation.
  - C. Provide financial support for innovative start-ups.
  - D. Provide incentives for foreign direct investment. Your answer:.....
- 

### QUESTION 6

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Effective protection of intellectual property in transition economies:

- A. Is likely to reduce the diffusion of innovations in the short run.
- B. Is likely to increase the generation and diffusion of innovations in the long run.
- C. Both A and B.
- D. None of the above.

Your answer:.....

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**QUESTION 7**

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Which of the following is most likely to increase demand for eco-innovation?

- A. Green public procurement.
- B. Grants for early financing of start-ups.
- C. Venture capital funds.
- D. None of the above. Your answer:.....

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**QUESTION 8**

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According to Table 15, eco-innovation policy instruments could include:

- A. Carbon emissions tax.
- B. Land use regulations.
- C. Renewable energy subsidies.
- D. All of the above. Your answer:.....

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**QUESTION 9**

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The environmental and innovation policies are:

- A. Well integrated in most transition economies.
- B. Usually implemented by separate line ministries or government agencies.
- C. Irrelevant for climate change adaptation and mitigation.
- D. None of the above. Your answer:.....

---

**QUESTION 10**

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Environmental regulations and standards can:

- A. Stimulate eco-innovation.
- B. Reduce greenhouse gas emissions.
- C. Increase production costs.
- D. All of the above. Your answer:.....

# MODULE V

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ASSESSING INNOVATION  
PERFORMANCE IN  
TRANSITION ECONOMIES  
IN EUROPE AND  
CENTRAL ASIA

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## INTRODUCTION

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This module moves from an investigation of framework conditions, national innovation systems and innovation-specific policies (innovation inputs) in transition economies in Europe and Central Asia to an assessment of innovation performance (innovation outputs). Following a discussion of innovation performance based on global and national studies, the module focuses on eco-innovation benchmarks and trends in transition economies. Topics that are covered include:

- Global innovation index;
- Innovation output comparisons based on global indicators;
- Country reviews of innovation performance;
- Assessments of national eco-innovation policies; and
- Eco-innovation trends.

Upon completion of the module you should be able to:

- Interpret global innovation indices;
- Compare innovation performance across countries;
- Make use of national innovation performance reviews;
- Choose eco-innovation benchmarks;
- Identify eco-innovation trends;
- Understand the discussion questions appearing in the final section; and
- Answer correctly all questions in the multiple choice quiz.

The main references utilized for the module include publications and materials prepared by or for international organizations (OECD, UNECE, UNIDO, WIPO) and international financial institutions (EBRD, World Bank) that are listed in the reference page at the end of the module.

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## FROM INNOVATION INPUTS TO INNOVATION OUTPUTS

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### INNOVATION INPUTS IN TRANSITION ECONOMIES

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Module IV provides a broad overview of innovation inputs in countries of transition economies in Europe and Central Asia. These inputs, i.e. framework conditions, innovation governance and policies, differ across transition economies according to their ability to overcome a number of Soviet legacy handicaps, including:

- Centralized knowledge generation;
- Low priority for civilian R&D;
- Low R&D and innovative capacity of firms;
- Inferior technology;
- Ineffective commercial and financial laws; and
- Neglect of R&D and innovation during the early transition period.

Available innovation studies show that, aside from some notable exceptions, transition economies in Europe and Central Asia are still innovation imitators or followers rather than leaders. This is understandable, given the initial conditions of transition in the late 1980s (a decade earlier in the case of Turkey).

Recall from module IV that framework conditions have improved more rapidly in the new EU member states than in other transition economies while R&D spending has remained comparatively low and dominated by the government sector in most countries of transition economies in Europe and Central Asia. Given the crucial importance of framework conditions, one would expect a better innovation performance in countries with superior innovation inputs. But how can we assess innovation performance?

## THE MEASUREMENT OF INNOVATION

Given the overwhelming importance of qualitative change in technological evolution, the measurement of innovation is inevitably an art rather than a science. One way to measure innovation indirectly (i.e. by its effects) is to look at productivity growth. Using this approach, we could show that all transition economies have been catching-up to the US productivity level since the mid-1990s. That is no mean accomplishment. However, a number of factors other than innovation influence output and productivity growth. These other factors include external shocks that reflect energy price swings, financial crises or geopolitical shifts.

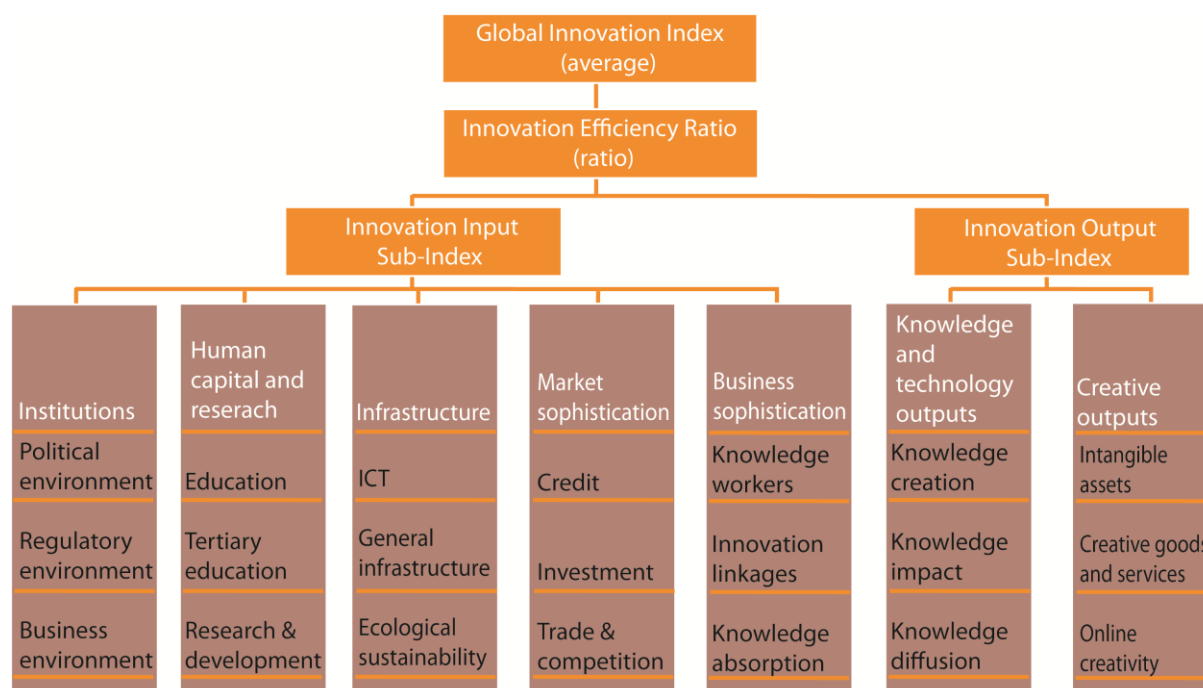
Another measurement approach relies on complex indices of innovation activity such as the Global Innovation Index (GII). GII and similar indices are available for many countries, including most transition economies. However, we should be aware of a limited usefulness of global indices because the historical context and institutions matter (UNECE, 2007). It would be preferable to have a regional innovation index for transition economies in Europe and Central Asia but it is simply not available. Therefore, let us use global indicators for some basic comparisons.

## THE INNOVATION INPUT SUB-INDEX

The latest available version of the global innovation index (GII) provides comparable data on innovation inputs and outputs for 142 countries, including all transition economies with the exception of Turkmenistan (Cornell University, ISEAD and WIPO, 2013). The conceptual structure of the index, based on 84 individual indicators, is illustrated in figure 13.

The GII framework includes an innovation input sub-index that averages evaluation scores of five input pillars: national institutions, human capital and research, infrastructure, market sophistication and business sophistication. Each pillar entails three sub-pillars that consist of three to six indicators. Pillar scores are calculated as weighted averages of sub-pillar scores that, in turn, are weighted averages of individual indicators. The selection of indicators and their weights are based on the judgment of experts and thus subjective. Innovation input scores of transition economies correspond broadly with the assessment of national framework conditions, innovation governance and policies in Module IV.

FIGURE 13. GLOBAL INNOVATION INDEX 2013



Source: Cornell University, INSEAD and WIPO (2013).

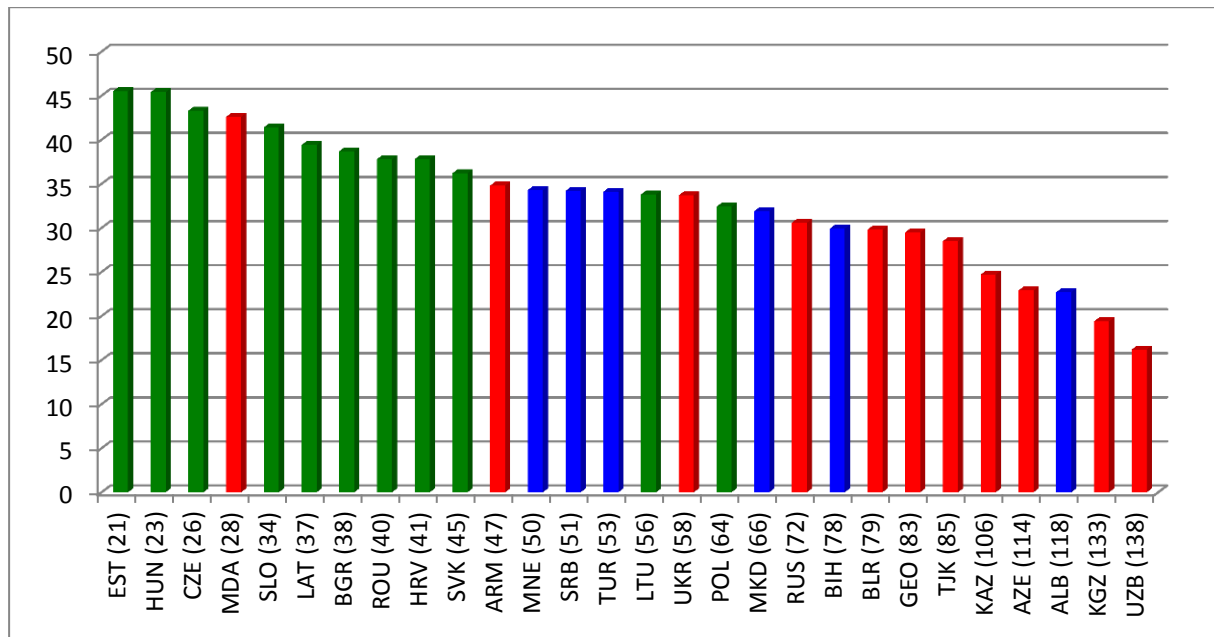
### THE INNOVATION OUTPUT SUB-INDEX

The GII framework includes an innovation output sub-index that averages evaluation scores of two output pillars: knowledge and technology outputs, and creative outputs. The structure is similar to the input index in the sense that each output pillar consists of three sub-pillars that are estimated as weighted averages of the indicators chosen by experts. The innovation output sub-index provides a broad measure of national innovation performance.

A comparison of innovation output scores of 28 transition economies in Europe and Central Asia implies a comparatively good performance of the new EU member states, followed by countries of South-Eastern Europe, Eastern Europe, the Caucasus and Central Asia (Figure 14). Good innovation output rankings of Estonia, Hungary, the Czech Republic and Moldova are noteworthy. These countries placed in the 21<sup>st</sup>, 23<sup>rd</sup>, 26<sup>th</sup> and 28<sup>th</sup> positions respectively out of the 142 countries compared. The relatively good innovation performance of Tajikistan that is ranked higher than other countries of Central Asia and Azerbaijan is impressive.



FIGURE 14. INNOVATION OUTPUT



Source: Cornell University, INSEAD and WIPO (2013).

### COMPARING INNOVATION OUTPUTS OF COUNTRIES WITHIN INCOME GROUPS

Global comparisons can be somewhat misleading in the sense that innovation inputs are superior in high-income countries so that it is hardly surprising that they dominate output rankings. It can be more interesting to compare innovation outputs of countries in the same income group. Such comparisons based on the GII 2013 results reveal that a number of transition economies are among the top 10 performers among:

- Upper-middle income countries (Latvia, Bulgaria, Romania, Montenegro);
- Lower-middle income countries (Moldova, Armenia, Ukraine); and
- Low-income countries (Tajikistan).

The relatively good innovation performance may imply that these countries have implemented policies that improved framework conditions while fostering integration with global markets and linkages between research institutions and business firms. However, the above-par performance may be also due to legacy factors that endowed transition economies with more human capital and research capacity than typical development countries with comparable income levels. By contrast some middle-income countries in transition with below-par innovation output scores in comparison to their middle-income peers (Azerbaijan, Belarus, Kazakhstan and Uzbekistan) had apparently less success with their policies or had to cope with some exceptionally adverse circumstances. Only a country-level analysis can provide convincing explanations for an exceptional innovation output performance.

## OTHER GLOBAL INNOVATION MEASURES

The Global Innovation Index 2013 is a simple average of the input and output sub-indices (Figure 13). Its meaning is not obvious. It is as if we were comparing football teams by adding their respective inputs (e.g. the amount of money spent on coaching, players, etc.) and outputs (e.g. the number of matches won or goals scored).

The Innovation Efficiency Ratio is obtained by dividing the output sub-index by input sub-index. If innovation outputs are related directly to inputs, the efficiency ratio should be close to unity. However, in some cases the meaning of the ratio is unclear. For instance, if the increased innovation input this year results in innovation output next year, then the efficiency ratio is inaccurate for both years.

Another weakness of the global innovation index is the changing methodology that makes clear comparisons of outcomes over time impossible. Nevertheless, global innovation measures provide international benchmarks that could be of interest to analysts and policy makers. The numerical values of the global innovation indices and efficiency ratios as well as the detailed explanation of the underlying methodology are available free of charge (Cornell University, INSEAD, and WIPO, 2013).

## COUNTRY REVIEWS OF INNOVATION PERFORMANCE

Although global innovation indices can be used for interesting comparisons of national innovation inputs and outputs, they are not sufficiently detailed for an explanation of underlying factors or specific policy recommendations. Independent country reviews of innovation systems, policies and performance are more useful in this respect. The OECD and UNECE developed such advisory assessments for governments of countries with transition economies that requested them and agreed to support the review process by providing relevant information and other support.

So far the OECD reviewed innovation policies in Hungary (OECD, 2008), Slovenia (OECD, 2011) and Russia (OECD, 2012) while the UNECE reviewed Belarus (UNECE, 2011), Kazakhstan (UNECE, 2012) and Ukraine (UNECE, 2013). Following a comprehensive assessment of the national innovation system, policies and outcomes in each country assessed, these reviews proposed evidence-based innovation policy recommendations to national authorities. The recommendations emphasize the need to:

- Strengthen the rule of law and IPRs;
- Strengthen human capital for innovation;
- Strengthen internal competition;
- Strengthen governance of the NIS;
- Foster knowledge generation and transfer;
- Strengthen system linkages between universities and industry;
- Encourage a commercial orientation of publicly funded research;
- Increase public R&D expenditure;
- Provide or enhance incentives for business R&D expenditure;
- Support innovation in the SME sector;
- Support innovative start-ups and spin-offs;
- Foster financing of innovative entrepreneurs;
- Maximize benefits from the internationalization of R&D; and
- Expand innovation-oriented public procurement.

Note that the OECD and UNECE reviews examined so far innovation policies and performance in relatively advanced transition economies that have developed comprehensive national innovation strategies. All of the countries reviewed have a large portfolio of innovation actors and supporting institutions. Therefore, the recommendations listed above may not be applicable to transition economies that have not yet developed national innovation strategies and key institutions.

For instance, if a country has a weak research capacity and inefficient state-controlled enterprises, a strengthening of linkages between research and industry is unlikely to enhance innovation performance. Or if the administrative capacity is a limiting factor, it is hard to see how competition policy can be implemented effectively.

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## ASSESSMENTS OF NATIONAL ECO-INNOVATION POLICIES

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### OBJECTIVES OF NATIONAL ASSESSMENTS

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This section is based on the UNECE expert assessments of eco-innovation policies in Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan. These studies provide an overview of:

- The national innovation system and innovation governance;
- Framework conditions;
- Innovation policies and instruments with reference to the mainstreaming of climate change considerations;
- Knowledge generation and transfer;
- Industry-science linkages and collaboration in the innovation process; and
- Innovation and international economic integration.

The assessments also contain some policy recommendations on how to improve the enabling policy framework for the absorption and diffusion of green technologies.

All countries assessed are vulnerable to climate change but differ with respect to particular vulnerabilities, natural endowments and income levels. Azerbaijan, Kazakhstan and Turkmenistan are richly endowed with hydrocarbons and classified by the World Bank as upper middle-income countries. Kyrgyzstan and Tajikistan have abundant water resources and are classified as low-income countries. All five countries share the institutional legacy of Soviet rule.

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### RESPONSES TO CLIMATE CHANGE CHALLENGES

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How did these countries respond to climate change concerns? Turkmenistan has developed a National Climate Change Strategy (Box 14). The climate change issues are embedded less clearly in policy frameworks and strategies in the other four countries assessed.

How important are green or eco-innovations? According to the assessment reports, the development, absorption and diffusion of green technologies is key to effective adaptation to climate change impacts in all of them.

**BOX 14. TURKMENISTAN'S CLIMATE CHANGE STRATEGY**

The government of Turkmenistan adopted a National Climate Change Strategy in June 2012. It is to be financed from a National Clean Climate Fund. The Strategy aims to mainstream mitigation and adaptation measures in policies in key sectors such as water, agriculture, energy, engineering and construction. It also aims to promote climate related research and development. An integrated coordination mechanism for implementing the Strategy will involve a number of ministries and state agencies. The pattern and sequence of implementing actions has not been disclosed to date.

(UNECE, 2013c)

**INNOVATION POLICY FRAMEWORKS**

How developed are the innovation policy frameworks and institutions in the countries assessed? Kazakhstan has a comprehensive national innovation strategy and a relatively well-developed national innovation system. In the other countries assessed the innovation strategies and systems are either not well defined or obscured by the lack of available information. Framework conditions are somewhat better in Kazakhstan than in the other four countries.

The protection of intellectual property rights is incorporated in legal codes of the countries assessed but shortcomings in the implementation of relevant legal statutes persist. With respect to the quality of education, Kazakhstan and Azerbaijan lead while Turkmenistan lags due to radical reforms that were abandoned in late 2000s. Both Kyrgyzstan and Turkmenistan are facing a brain-drain problem with large numbers of students and graduates staying abroad. Authorities in Turkmenistan have reacted to this by introducing administrative restrictions on the number of students allowed to study abroad. The ICT infrastructure and use of internet are more extensive in Azerbaijan and Kazakhstan than in Kyrgyzstan, Tajikistan and Turkmenistan.

**R&D SPENDING AND COORDINATION OF PUBLIC RESEARCH**

R&D spending is relatively low in Azerbaijan (0.2 per cent of GDP), Kazakhstan (0.2 per cent of GDP), Kyrgyzstan (0.1 per cent of GDP) and Tajikistan (less than 0.1 per cent of GDP), and dominated by the government sector. The level of R&D expenditure in Turkmenistan is unknown. All five countries have established good research cooperation with CIS countries and the European Union.

The Ministries of Science and Industry coordinate public research activity in Kazakhstan. In the other four countries the research coordination is the responsibility of the National Academy of Sciences (NAS). Despite some progress in recent years the linkages between research and industry are still generally weak. In Kyrgyzstan industry contributes to the financing of some NAS activities while the NAS facilitates industry-science linkages (Box 15).

**BOX 15. INDUSTRY-SCIENCE LINKAGES IN KYRGYZSTAN**

The National Academy of Sciences of the Kyrgyz Republic promotes actively cooperation between academic scientists and industry. For instance, it has facilitated the establishment of business-oriented research networks in areas ranging from cattle breeding to pharmaceuticals and a laboratory for the certification of ISO standards. NAS also facilitates the adaptation and diffusion of green technologies in Kyrgyzstan.

(UNECE, 2013a)

**FINANCING OF GREEN PROJECTS AND INNOVATIVE FIRMS**

The financing of green projects and eco-innovation by the public sector is comparatively generous in Azerbaijan, Kazakhstan and Turkmenistan. This reflects to some extent the robust financial position of these countries, based on massive revenue windfalls from the exports of hydrocarbons. Azerbaijan has been able to take advantage of external financing and imported technology to implement a number of successful green projects in the energy sector (Box 16).

**BOX 16. ENERGY-EFFICIENCY PROJECTS IN AZERBAIJAN**

Taking advantage of the Clean Development Mechanism, Azerbaijan was the first country in the world that sold carbon credits earned through an energy-efficiency project. The project, financed by an EBRD loan, increased significantly efficiency and reduced GHG emissions of the country's largest thermal power station. Other examples of green energy projects with external assistance include the Sumgait Technologies Park for the development of renewable energy sources and a new hydro power station.

(UNECE, 2013e)

The micro, small and medium-sized enterprises (MSME) sector is weak in all countries assessed. Early stage financing for start-ups and SMEs is not available in Azerbaijan, Kyrgyzstan and Tajikistan but provided in some cases by government grants in Kazakhstan and Turkmenistan. A public ICT development fund for start-ups and innovative firms has been established in Azerbaijan.

**TECHNOLOGY TRANSFER**

Technology parks in Azerbaijan, Kazakhstan and Kyrgyzstan foster knowledge transfer. FDI inflows are concentrated in mining (Kyrgyzstan) or oil and gas sector (Azerbaijan, Kazakhstan and Turkmenistan). Links between the foreign-invested and domestic enterprises as well as technology spillovers are generally weak.

**DEMAND FOR ECO-INNOVATION**

Demand for eco-innovation is weak in all five countries, reflecting the absence of green procurement, subsidized energy and water prices, and weak regulatory norms and standards. The absence of energy-saving building codes is another factor inhibiting

demand for eco-innovation. Last but not least, consumer demand for green products seems to be limited by the lack of public awareness of sustainable development issues.

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## STATISTICAL INDICATORS

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The unavailability of internationally comparable statistical indicators on R&D spending, innovation and sustainable development complicates the process of policy making and evaluation in all five countries. National innovation indicators for Azerbaijan, Kazakhstan and Kyrgyzstan are more widely available than those for Tajikistan and Turkmenistan.

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## ECO-INNOVATION TRENDS

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### ECO-INNOVATION POLICY IN TRANSITION ECONOMIES

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The remaining part of this module focuses on green innovations. Note that eco-innovation policy can be viewed as a sub-set of national innovation policies. Recall from Module IV that eco-innovation policy instruments are relatively important in the new EU member states, which reflects to some extent the priority of sustainable development in the strategies and regulations adopted by the European Union. Such policies have been apparently somewhat less important in other transition economies.

But how good is the eco-innovation performance in transition economies in Europe and Central Asia? To answer this question, it is necessary to consider eco-innovation outputs that include knowledge, capability and innovative green technologies. The following discussion of eco-innovation outcomes is based mainly on findings of a recent UNIDO study on sustainable development in transition economies in Europe and Central Asia (UNIDO, 2012).

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### ENVIRONMENT-RELATED RESEARCH PUBLICATIONS

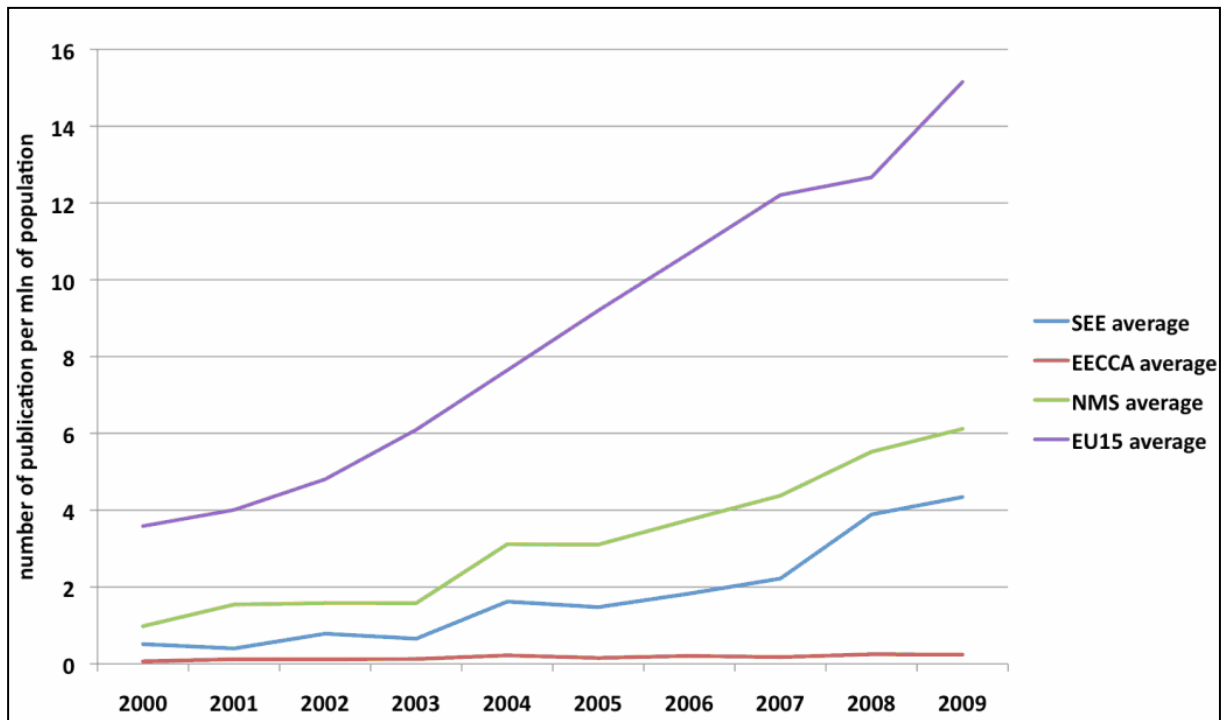
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How can we assess the development of new knowledge in the area of eco-innovation? The increasing importance of environment-related research is reflected in the growing number of scientific publications in this area. In transition economies in Europe and Central Asia the new EU member states lead in the number of such publications followed by countries of South-Eastern Europe and Eastern Europe, Caucasus and Central Asia. Over the last decade the new member states and countries of South-Eastern Europe have registered a substantial growth of research publications on environment and technology while the countries of Eastern Europe, Caucasus and Central Asia have seen little change in this area. However, the environmentally related research output in leading countries (United States, China, United Kingdom, Germany and Japan) has grown more rapidly so that the knowledge gap between them and the transition economies increased (Figure 15).

The gap in environment and technology-related publications between the new EU members and countries of South-Eastern Europe and Eastern Europe, Caucasus and Central Asia has also increased. It is important to note that such research publications originate mainly in Russia and Ukraine in Eastern Europe while three countries of

Central Asia (Kyrgyzstan, Tajikistan and Turkmenistan) had only one or no publications.

**FIGURE 15. TRENDS IN ENVIRONMENT AND TECHNOLOGY-RELATED PUBLICATIONS**

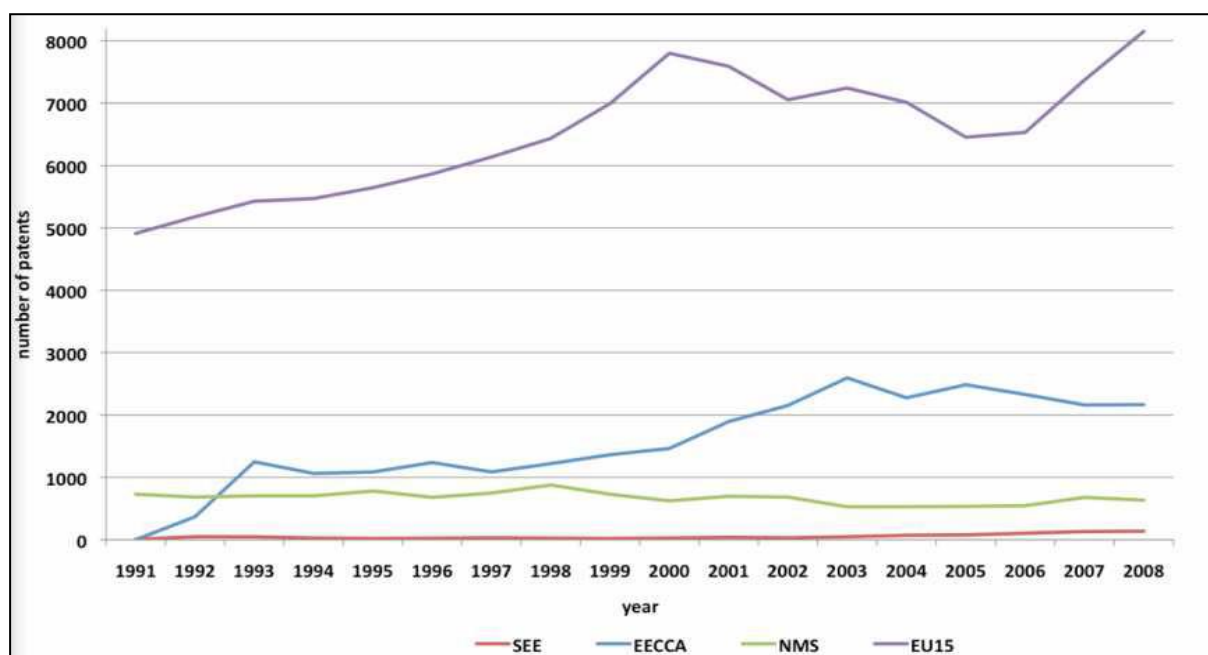


Source: UNIDO (2012).

## ENVIRONMENT-RELATED TECHNOLOGY PATENTS

Another possibility to measure the increase of knowledge is to look at the number of environmental patents, bearing in mind that most patents do not reach the stage of commercial application. With respect to the number of new patents in environment-related technologies, the Eastern Europe, Caucasus and Central Asia subregion leads (mainly due to the prolific output of Russia), followed by the new EU member states and South-Eastern Europe (Figure 16).

The patenting gap to the EU-15 countries remains substantial. When the environmental patenting activity is scaled to population, relative to the EU-15 benchmark the per capita environmental patent activity is 2-times weaker in Eastern Europe, Caucasus and Central Asia, 3-times weaker in the new EU member states and 5-times weaker in South-Eastern Europe.

**FIGURE 16. PATENTS IN ENVIRONMENT-RELATED TECHNOLOGIES**

Source: UNIDO (2012).

## THE USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY

The use of computers, mobile phones and internet has grown rapidly over the last decade in the new EU member states and South-Eastern Europe and somewhat more slowly in Eastern Europe, Caucasus and Central Asia. A convergence of the intensity of use of information and communication technologies (ICT) to the EU-15 level is apparent in all subregions of transition economies in Europe and Central Asia. This is an important precondition for knowledge diffusion because many eco-innovations cannot work without computer software and other ICT systems.

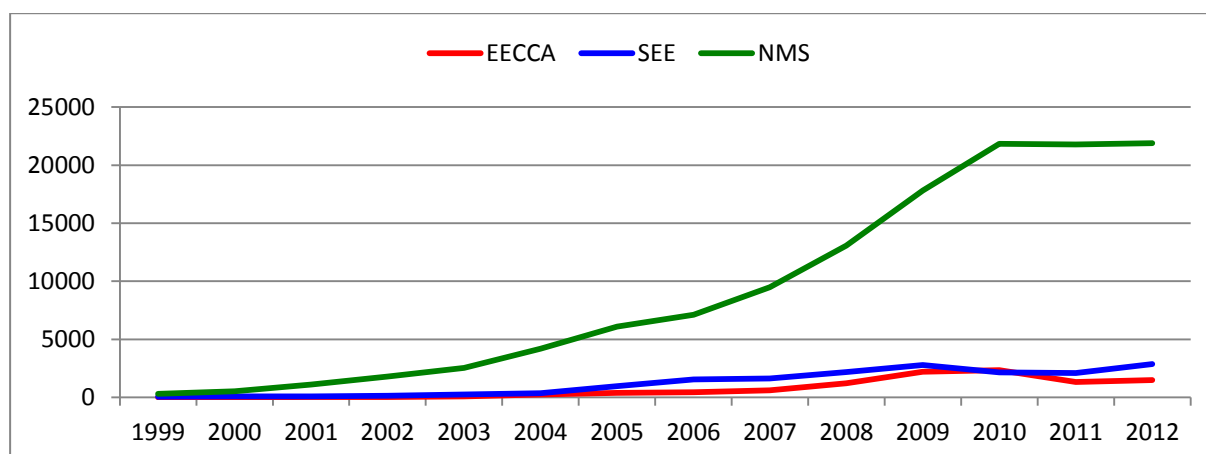
In spite of positive regional growth trends, the availability and use of ICT infrastructure remains comparatively low in some late transition economies. For instance, the availability of high speed internet is still severely limited in Tajikistan, Turkmenistan and Uzbekistan (see Figure 8, in Module III).

## ISO 14001 CERTIFICATION

The diffusion of eco-innovation is hard to measure due to the lack of clear metrics. We know however that good environmental management standards tend to promote the adoption of innovative techniques that use energy and materials more efficiently while reducing waste and harmful emissions. Good environmental management has been institutionalized by the ISO 14001 standard that is used by more than 285,000 firms and organizations in over 150 countries. The diffusion of eco-innovation should correlate with the use of environmental management ISO 14001 certificates. According to this proxy, the diffusion of green innovations has increased rapidly in the new EU member states and Russia and less spectacularly in other transition economies. Subregional trends are illustrated in Figure 17.



FIGURE 17. ISO 14001 CERTIFICATION TRENDS



Source: UNECE calculations based on ISO survey data.

Although the ISO 14001 certification gap to the EU-15 is closing in advanced transition economies and Russia, the use of the standard remains extremely limited in some countries of Eastern Europe, Caucasus and Central Asia. Russia accounts for the bulk of the ISO 14001 certificates issued in the region, followed by Belarus, Ukraine, Kazakhstan and Azerbaijan. However, the progress of ISO 14001 certification has been minimal or non-existent in Kyrgyzstan, Turkmenistan and Tajikistan (Table 16).

TABLE 16. CUMULATIVE NUMBER OF ISO 14001 CERTIFICATES

Year	2001	2005	2012
<b>EECCA</b>	<b>19</b>	<b>1,169</b>	<b>10,351</b>
Armenia	0	5	38
Azerbaijan	0	90	242
Belarus	2	258	928
Georgia	0	0	17
Kazakhstan	1	55	945
Kyrgyzstan	0	0	9
Moldova	0	2	26
Russia	15	612	7,063
Tajikistan	0	0	0
Turkmenistan	0	3	7
Ukraine	1	140	1,011
Uzbekistan	0	4	65
<b>SEE</b>	<b>249</b>	<b>3,474</b>	<b>17,162</b>
<b>NMS</b>	<b>1,931</b>	<b>23,656</b>	<b>129,542</b>
<b>EU-15</b>	<b>31,223</b>	<b>193,492</b>	<b>586,198</b>

Source: UNECE calculations based on ISO survey data.

## ENERGY INTENSITY, NON-HYDRO RENEWABLES AND WASTE MANAGEMENT

Energy intensity trends provide another useful proxy for the diffusion of eco-innovation. In this respect the new EU member states lead, followed by countries of South-Eastern Europe, Eastern Europe, Caucasus and Central Asia. This is not

surprising because private and foreign-invested firms tend to be more energy efficient than state-owned enterprises (EBRD, 2011).

Another indicator of the diffusion of eco-innovation is growth in the use of non-hydro renewable technologies (wind, solar, tidal, biomass, geothermal) that has been strong in the EU and South-Eastern Europe, and relatively weak in CIS countries. However, due to the resource endowment and past investment the share of renewables in the energy mix is highest in the CIS countries, followed by countries of South-Eastern Europe and new EU members.

Waste management is another important eco-industry. Waste recycling has increased over the last decade in the new EU member states and some countries of South-Eastern Europe. Nevertheless, big gaps persist to good practices in the EU-15 countries where up to 70 per cent of municipal waste is recycled. Waste recycling schemes have yet to be introduced in Eastern Europe, Caucasus and Central Asia.

## EXPORT AND IMPORTS OF ENVIRONMENTAL PRODUCTS

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Exports and imports of environmental products (e.g. air pollution control and environmental technologies) provide another measure of green technology diffusion. In per capita terms, such exports and imports are highest in Western Europe, followed by the new EU member states, and then countries of South-Eastern Europe, Eastern Europe, Caucasus and Central Asia.

The share of environmental exports and imports in total trade has been relatively stable over the last decade in the new EU member states and countries of South-Eastern Europe. In the CIS countries the share of environmental exports has decreased while that of imports increased over the same time period.

## ECO-INNOVATION TRENDS BY SUBREGION AND UNDERLYING FACTORS

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On the whole, the available indicators indicate positive eco-innovation output and diffusion trends in all subregions of transition economies in Europe and Central Asia. Improvements appear to have been stronger in the new EU member states than in other transition economies since the early 2000s. Within Eastern Europe, Caucasus and Central Asia, Russia has achieved best results, followed by Ukraine, Kazakhstan and Belarus while the performance of Kyrgyzstan, Tajikistan and Turkmenistan has been exceptionally weak. The gap between transition economies and best performers in Western Europe remains wide or is still growing.

Why is the eco-innovation performance better in some transition economies than others? The new EU member states benefited from relatively good initial conditions for systemic transition from central planning to markets, due to their proximity to Western Europe, absence of disruptive armed conflicts, large inflows of Western know-how and direct investment, and a comprehensive approximation of legal and governance norms to EU standards. In turn, the relatively good eco-innovation performance of Russia probably reflects the country's inheritance of the bulk of Soviet industrial base and research capacity as well as the policy emphasis on innovation and economic diversification since the early 2000s.

## ECO-INNOVATION AND CLIMATE CHANGE

It would be interesting to assess trends in eco-innovation for climate change adaptation and mitigation. Unfortunately the available time-series data on eco-innovation do not differentiate between the adaptation and mitigation technologies. Comprehensive empirical studies of both advanced and transition economies have focused on mitigation rather than adaptation (see e.g. EBRD, 2011). This may reflect the concern with GHG emissions as well as the fact that mitigation is easier to define and measure than adaptation. The goodness of mitigation technology can be judged by the reduction in GHG emissions or energy intensity associated with its use. No comparable yardstick is available for the measurement of the improved resilience provided by adaptation technology.

But why should we worry about the measurement of effects of adaptation technologies? Indeed this may seem like a moot point but we shall see in the next module that the measurement of results associated with particular actions is important for policy evaluation.

### SUMMARY

1. The innovation performance measured by innovation outputs is highly uneven but tends to be better in the new EU member states than in other transition economies. Figure 13 illustrates the structure of the Global Innovation Index used for cross-country comparisons of innovation activity while Figure 14 shows innovation output and international ranking of transition economies.
2. Innovation outputs seem to be broadly consistent with innovation inputs. A number of transition economies have achieved an exceptionally good innovation performance relative to their per capita income levels.
3. Country reviews of innovation performance provide more reliable assessments and policy recommendations than studies based on global innovation indicators. Comprehensive innovation performance reviews were prepared by the OECD and UNECE for a number of transition economies, including Belarus, Hungary, Kazakhstan, Russia, Slovenia and Ukraine.
4. Assessments of eco-innovation policy in five countries of the Caucasus and Central Asia examine the obstacles and opportunities for the uptake of green innovations. R&D expenditure is generally low in the region. However, resource-rich economies provide relatively generous funding for eco-innovation initiatives. Demand for eco-innovation is weak in all countries assessed.
5. The generation and uptake of eco-innovation in transition economies can be monitored with a number of indicators and compared with EU-15 benchmarks. The eco-innovation gap between the leading countries and transition economies is large and still increasing in some areas. Figures 15, 16 and 17 and Table 16 illustrate eco-innovation trends. Within transition economies in Europe and Central Asia the eco-innovation performance of the new EU member states is better than in other transition economies. This is probably due to better initial conditions for systemic transition the adoption of EU norms, strategies and good practices. The relatively good eco-innovation performance of Russia seems to reflect its inheritance of the bulk of Soviet research capacity and economic modernization drive since the early 2000s.

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## GLOSSARY

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**Absorptive capacity** (in the context of innovation) refers to the ability to absorb new knowledge and adapt imported technologies.

**Climate change** refers to a persistent change in the mean and/or the variability of climate properties.

**Climate change adaptation** refers to the adoption of policies and practices to prepare for the effects of climate change.

**Climate change mitigation** refers to the adoption of policies and practices that reduce greenhouse gas emissions of economic activity.

**Diffusion of innovations** refers to the way in which innovations spread, through market or non market-channels, to different consumers, countries, regions, sectors, markets and firms.

**Eco-innovation** is an innovation whose use is less environmentally harmful than its alternatives.

**Foreign direct investment** refers to an investment made to acquire lasting interest in enterprises operating outside of the economy of the investor.

**Green innovation** is an innovation whose use is less environmentally harmful than its alternatives.

**Green growth** avoids unsustainable pressure on the quality and quantity of natural assets.

**Greenhouse gases** refer to carbon dioxide, nitrous oxide, methane, ozone and chloro-fluorocarbons occurring naturally and resulting from human activities, and contributing to the greenhouse effect (global warming).

**Income groups of countries** are defined by the World Bank according to the 2012 GNI per capita as follows. Low income: USD 1,035 or less; lower middle income: USD 1,036 - USD 4,085; upper middle income: USD 4,086 - USD 12,615; and high income: USD 12,616 or more.

**Innovation** refers to new or significantly improved products, processes, marketing methods or organizational methods.

**ISO 14001** refers to a certified management standard that provides practical tools for companies and organizations to identify and control their environmental impact and constantly improve their environmental performance. It can be used in any activity or sector.

**Small and medium-sized enterprises** are independent firms with no more than 250 employees.

**Technology** refers to the state of technical knowledge.

**Technology transfer** refers to the process by which new technology or knowledge developed in one place is applied or exploited by firms or organizations in another place.

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## ADDITIONAL RESOURCES

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The OECD and World Bank are developing a web-based Innovation Policy Platform (IPP).

IPP should provide user-friendly access to data and learning materials about the design, implementation, monitoring, and evaluation of locally appropriate innovation policies. The IPP project aims to enable users learn how innovation systems operate, identify good practices, and apply effective solutions. The content includes policy briefs, case studies, country profiles and operational guidance notes. It is expected that IPP will be used by policy makers who are responsible for innovation policy, advisors, analysts as well as business firms engaged in the innovation process.

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You might want to have a look at the temporary IPP website to get acquainted with the structure of the platform, look at available indicators, complete a survey or provide comments. The temporary website can be accessed at <http://www.oecd.org/innovation/policyplatform/>.

## QUESTIONS FOR DISCUSSION AND MULTIPLE CHOICE TEST

### QUESTIONS FOR DISCUSSION

1. How would you assess the innovation performance of your country? Why?  
.....  
.....
2. How would you assess the eco-innovation performance of your country? Why?  
.....  
.....
3. Which policies could improve the generation and uptake of eco-innovation in your country? Why (not)?  
.....  
.....

### MULTIPLE-CHOICE TEST

**Check the best answer.** (*Correct answers can be found on page 144*)

#### QUESTION 1

The global innovation output index depicted in Figure 13 is:

- A. An average of innovation input and innovation output sub-indices.
- B. A ratio of innovation output and input sub-indices.
- C. Both A and B.
- D. None of the above. Your answer:.....

#### QUESTION 2

The OECD and UNECE country innovation reviews can provide policy makers with:

- A. A comprehensive assessment of the national innovation system.
- B. Examples of good practice from other countries.
- C. Evidence-based policy recommendations.
- D. All of the above. Your answer:.....

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**QUESTION 3**

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UNECE assessments of national eco-innovation performance consider:

- A. Innovation governance.
- B. Financing of innovative firms.
- C. Demand for eco-innovation.
- D. All of the above.

Your answer:.....

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**QUESTION 4**

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Patents in environment-related technologies are related to:

- A. The generation of eco-innovation.
- B. The average age of researchers.
- C. Neither A nor B.
- D. Impossible to answer due to insufficient information.

Your answer:.....

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**QUESTION 5**

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Growth of environment-related research publications implies:

- A. Development of knowledge that is relevant to eco-innovation.
- B. Strong industrial policy.
- C. High revenues from export of energy.
- D. Impossible to answer due to insufficient information.....

Your answer:.....

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**QUESTION 6**

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The increasing use of ISO14001 management standard:

- A. Is likely to promote the diffusion of eco-innovations.
- B. Is inconsistent with energy-saving measures.
- C. Is unrelated to eco-innovation.
- D. None of the above.

Your answer:.....



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**QUESTION 7**

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There are more empirical studies about the climate change mitigation than adaptation:

- A. True.
- B. False.
- C. Neither true nor false.
- D. Impossible to answer due to insufficient information.

Your answer:.....

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**QUESTION 8**

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Waste management and recycling should be viewed as:

- A. An important eco-industry.
- B. An activity unrelated to eco-innovation.
- C. A waste of time and money.
- D. None of the above.

Your answer:.....

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**QUESTION 9**

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The share of non-hydro renewables in the energy mix is:

- A. Positively related with the diffusion of eco-innovation.
- B. Unrelated to the diffusion of eco-innovation.
- C. Neither A nor B.
- D. Impossible to answer due to insufficient information.

Your answer:.....

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**QUESTION 10**

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Growth of imports of environment-related technologies probably indicates:

- A. A decreasing diffusion of eco-innovation in the importing country.
- B. A decreasing diffusion of eco-innovation in the exporting country.
- C. An increasing diffusion of eco-innovation in the importing country.
- D. None of the above.

Your answer:.....

# MODULE VI

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## POLICY OPTIONS AND RECOMMENDATIONS

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## My Notes

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## INTRODUCTION

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This module discusses climate adaptation priorities, proposed adaptation measures and technologies, and some issues related to their adoption. Further, the module outlines the rationale for coherent and coordinated policies fostering the generation, adoption and diffusion of eco-innovation for climate change adaptation. Last but not least, it presents conclusions and recommendations based on the material covered in all modules. Topics that are covered in this module include:

- Priority setting;
- Barriers to adopting progressive adaptation technologies;
- Enabling measures for adopting progressive adaptation technologies;
- Policy integration;
- The policy mix for eco-innovation; and
- Policy options and recommendations.

Upon completion of the module, you should be able to:

- Appreciate the importance of involving multiple stakeholders in the priority setting process;
- Identify the main barriers and enabling measures for the uptake of progressive adaptation technologies;
- Provide a rationale for eco-innovation policy;
- Describe integrated policy making;
- Identify policy options for climate change adaptation; and
- Understand the discussion questions appearing in the final section and answer correctly all questions in the multiple choice quiz.

The main references utilized for the module include publications of international organizations (OECD, UNECE, UNIDO) and international financial institutions (EBRD, World Bank) that are listed in the reference page at the end of the module.

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## PRIORITY SETTING

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### THE IMPORTANCE OF A BROAD SOCIAL CONSENSUS

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As we have seen in module II, climate change impacts present major challenges in various countries and sectors. How a particular society responds to such threats and opportunities depends on the choice of priorities. An authentic priority-setting process requires a serious involvement and voluntary cooperation of key stakeholders – academy, business, civil society and government. An example of good practice in this area is provided by the selection of climate adaptation priorities in Canada, a country that lags the EU and United States in the development of climate adaptation policies and operational measures (Box 17).

In contrast to Canada, the climate adaptation agenda in transition economies has been initiated mainly by external factors such as the European Union climate policies in the new EU member states or the UN Framework Convention for Climate Change (UNFCCC) in some countries of Eastern Europe, Caucasus and Central Asia. Ideally the determination of national priorities should be home made and achieved through a

bottom-up process. Why is this so important? Cost-effective adaptation measures cannot be implemented unless they are broadly supported by all parts of society. For instance, an introduction of economic incentives such as cost-reflective pricing of energy and water services cannot work without a broad social consensus that is unlikely to materialize without an adequate compensation of the poor who are injured most by higher prices.

**BOX 17. EMERGING PRIORITIES FOR CLIMATE CHANGE ADAPTATION IN CANADA**

The Canadian Climate Change Adaptation Project is a non-government initiative that seeks to find and operationalize cost-effective adaptation solutions to most serious climate change impacts facing the nation. It aims to do this with the aid of an advisory committee consisting of 80 Canadian leaders who represent industry, finance, government, academy, youth, aboriginal communities and NGOs. Based on the collective voice of the advisory committee, the following adaptation priorities for Canada have been chosen in 2012:

- City infrastructure;
- Biodiversity;
- Freshwater;
- Aboriginal communities;
- Agriculture; and
- Insurance.

The project aims to operationalize the climate adaptation recommendations for these sectors in 2015 (Feltmate and Thistlethwaite, 2012).

## CLIMATE ADAPTATION PRIORITIES IN CENTRAL ASIA AND AZERBAIJAN

Which adaptation priorities have been identified by countries of Central Asia and Azerbaijan in national communications under the UN Framework Convention for Climate Change? All six countries identified agriculture, water and health as vulnerable sectors. Two countries (Kazakhstan and Tajikistan) identified forestry as another sector vulnerable to climate change. One country (Uzbekistan) also identified city infrastructure, energy and transport as vulnerable sectors (Table 17).

This selection of adaptation priorities seems to reflect the socio-economic importance of the agricultural sector that provides livelihood for large rural populations, accounting for 40-70 per cent of national population. However, we have seen in Module II that in addition to agriculture and water there are other sectors – e.g. energy and transport – where innovative adaptation solutions are urgently needed. Table 18 lists adaptation measures and technologies for the agricultural and water sectors that have been proposed in national communications submitted by countries of Central Asia to the UNFCCC secretariat.

TABLE 17. VULNERABILITY TO CLIMATE CHANGE BY SECTOR

	Agriculture	Water	Health	Forestry	City infrastructure	Energy	Transport
Azerbaijan	✓	✓	✓				
Kazakhstan	✓	✓	✓	✓			
Kyrgyzstan	✓	✓	✓				
Tajikistan	✓	✓	✓	✓			
Turkmenistan	✓	✓	✓				
Uzbekistan	✓	✓	✓	✓	✓	✓	✓

Source: Second national communications under the UN Framework Convention on Climate Change. [http://unfccc.int/national\\_reports/non-annex\\_i\\_natcom/items/2979.php](http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php).

TABLE 18. PROPOSED ADAPTATION MEASURES AND TECHNOLOGIES IN CENTRAL ASIA

	Proposed measures	Hard technologies	Soft technologies	Organizational technologies
WATER SECTOR	Development and introduction of the monitoring and early warning systems	Meteo stations, equipment for the snow and glaciers monitoring	Enhanced climate and water forecast models, use of GIS and RS	Research and extension services to enhance the capacity and delivery of information to the agricultural sector
		Hydroposts, water volume measurement in the irrigation network, water measuring devices at the farm level		
	Improve regulation of annual river discharge	Water reservoirs		Subregional and basin-level water sharing coordination
AGRICULTURE	Increasing water use efficiency in agriculture	Microirrigation technologies, laser leveling	New irrigation practices, e.g. alternative furrow irrigation	Introduction of IWRM at the national level
		Rehabilitation of the water irrigation networks for reduction of water loss	Regulation of groundwater use for agricultural purposes	Water Users Association (WUAs), introduction of payment system/scheme for irrigation water delivery
	Optimization of crop structure		Research and Promotion of drought-resistant crop varieties	Crop diversification, switch to less water intensive crops
	Adapting the agricultural practices to the anticipated climate fluctuations		Introduction of climate-specific insurance schemes	Expansion of the winter crops to take advantage of increased water availability
	Promotion of the sustainable agricultural practices	Zero-tillage	Nutrient management, crop rotation	

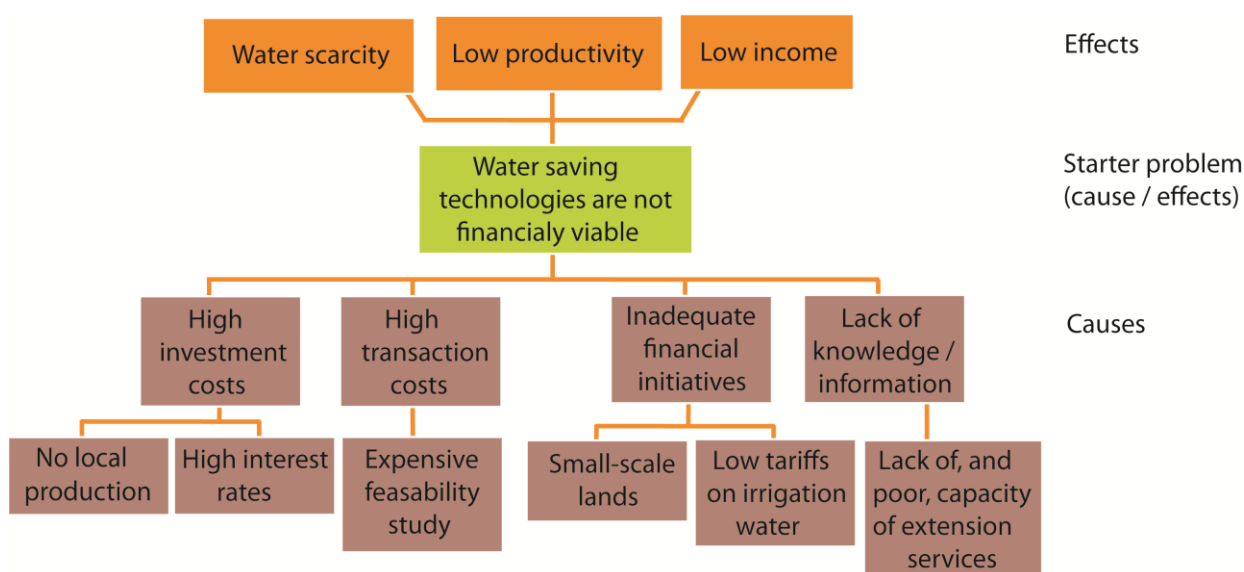
Source: IGES and CAREC (2012).

## BARRIERS TO ADOPTING NEW ADAPTATION TECHNOLOGIES

Once the adaptation priorities and associated technologies have been determined, the question is how to move from priority goals to priority actions. In the real world there are numerous barriers to adopting progressive adaptation technologies, including financial constraints, lack of incentives, lack of information, and non-existent or ineffective advisory services. Figure 18 illustrates this issue with an example from the agricultural sector in Azerbaijan where farmers fail to adopt available water-saving technologies due to such constraints. Barriers to technology transfer and diffusion in countries of Central Asia are similar.

The reluctance of farmers to adopt water-saving technologies is caused mainly by low prices of irrigation water, the relatively high cost of such technologies that have to be imported from abroad as well as prohibitive financing costs. Additional factors include a lack of information about the use and advantages of water-saving technologies. A number of enabling measures were proposed in Azerbaijan after a consultation with a group of stakeholders, including representatives of the Ministries of Agriculture, Economic Development, Ecology and Natural Resources, National Academy of Sciences, State Land and Cartography Committee, State Water Agency, two water enterprises, and NGOs (Ministry of Ecology and Natural Resources, 2012).

**FIGURE 18. BARRIERS TO ADOPTING WATER-SAVING TECHNOLOGIES**



Source: Ministry of Ecology and Natural Resources of the Republic of Azerbaijan (2012).

## ENABLING MEASURES FOR ADOPTING NEW ADAPTATION TECHNOLOGIES

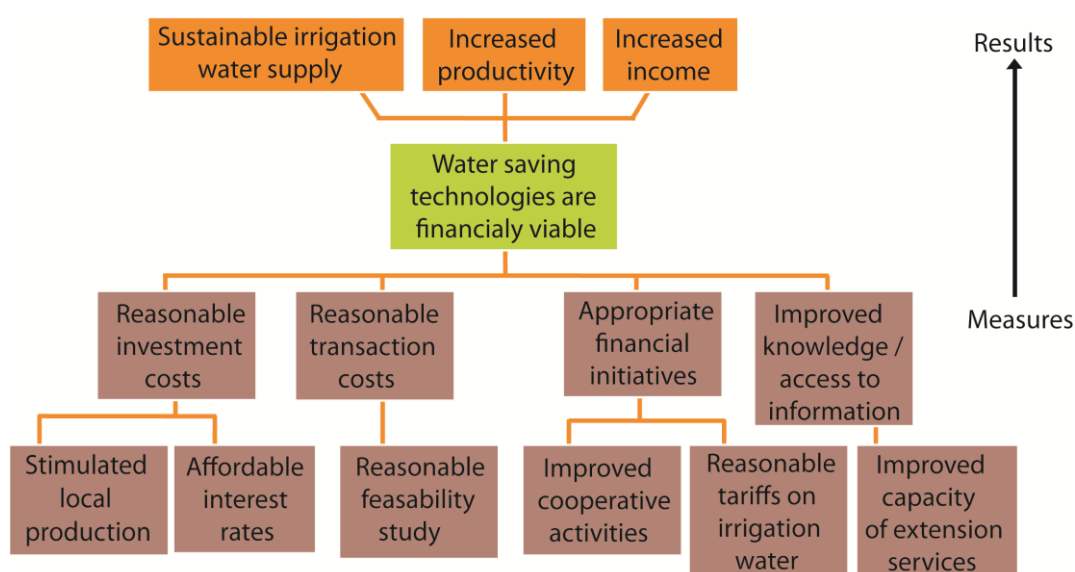
The proposed enabling measures include (see also Figure 19):

- Simplified import procedures for water-saving technologies;
- Tax incentives for local production of such technologies;
- Higher irrigation water tariffs;
- Subsidies for farmers using water-saving technologies;
- Long-term and low-interest loans by the state, IFIs and private banks;
- Implementation subsidies for pilot projects;

- Information campaigns on advantages of new technology and cooperation forms; and
- Improvements of agricultural extension services.

Similar exercises have been carried out in Azerbaijan to assess barriers and enabling measures for the adoption of other progressive technologies in the agricultural and water sectors. In some cases it has been recommended to increase funding for domestic R&D activities with a view to improving the local capacity to provide adaptation solutions and support services. In all cases the enabling measures identified by stakeholders imply the need for additional financing.

**FIGURE 19. ENABLING MEASURES FOR ADOPTING WATER-SAVING TECHNOLOGIES**



Source: Ministry of Ecology and Natural Resources of the Republic of Azerbaijan (2012).

## INFRASTRUCTURE FINANCING DEFICITS

The financing needs for climate adaptation are multiplied by low investment in infrastructure maintenance and new infrastructure. For instance, hydrometeorological observations and forecasts are of critical importance in the context of climate adaptation. However, the number of meteorological and hydrological stations in some countries of Central Asia (Kyrgyzstan, Tajikistan and Turkmenistan) decreased dramatically since the mid-1980s while state hydrometeorological services were not modernized even though progressive low-cost technologies such as automated stations and remote sensing became available (IGES and CAREC, 2012). Even in Kazakhstan where the number of hydromet stations increased, according to the national communication under the UNFCCC their density remains too low for a country of that size.

In addition to agriculture, water and hydromet services, the infrastructure financing deficits in other vulnerable sectors such as energy and transport are also considerable. Although the government and financial institutions can provide financing to a certain extent, some infrastructure investment needed for climate adaptation could be provided by PPP projects based on long-term concessions (see Module III).



## DEVELOPING AN INTEGRATED POLICY FRAMEWORK

### THE ROLE OF INNOVATION IN A GREEN GROWTH STRATEGY

We have seen in module I that green growth is a necessary precondition for sustainable development. Green growth cannot be achieved without innovation. Otherwise major sacrifices in terms of consumption would be needed to achieve a lighter ecological footprint of economic activity. Innovation should be embedded in a green growth strategy. An example of good practice is provided by the Europe 2020 strategy that can be viewed as the first comprehensive green growth strategy.

#### BOX 18. THE EUROPE 2020 STRATEGY

The Europe 2020 Strategy was adopted by the EU in 2010. It has the following measurable targets:

- 75 per cent employment rate for the 20-64 years-old age group;
- 3 per cent of the EU's GDP to be invested in research and development;
- 20/20/20 climate and energy targets (reduce GHG emissions by at least 20 per cent below the 1990 level, increase the share of renewable energy in final energy consumption by 20 per cent, increase energy efficiency by at least 20 per cent);
- An improvement of education levels (reduce school drop-out rates below 10 per cent and increase the share of the 30-34 years-old age group with tertiary education to at least 40 per cent); and
- Reduce social exclusion and poverty (by at least 20 million people).

In addition to measurable targets, the 2020 strategy also introduces a series of actions and policies grouped under three main headings: smart growth, green growth, and inclusive growth.

The R&D expenditure target of 3 per cent of the EU's GDP is ambitious (given the current level of 2 per cent of GDP) and significantly exceeds the current average of about 1 per cent of GDP for transition economies. Within transition economies, the share of R&D expenditure in GDP ranges from about 0.2 per cent in the Caucasus and Central Asia to 1.1 per cent in Russia and 2.5 per cent in Slovenia.

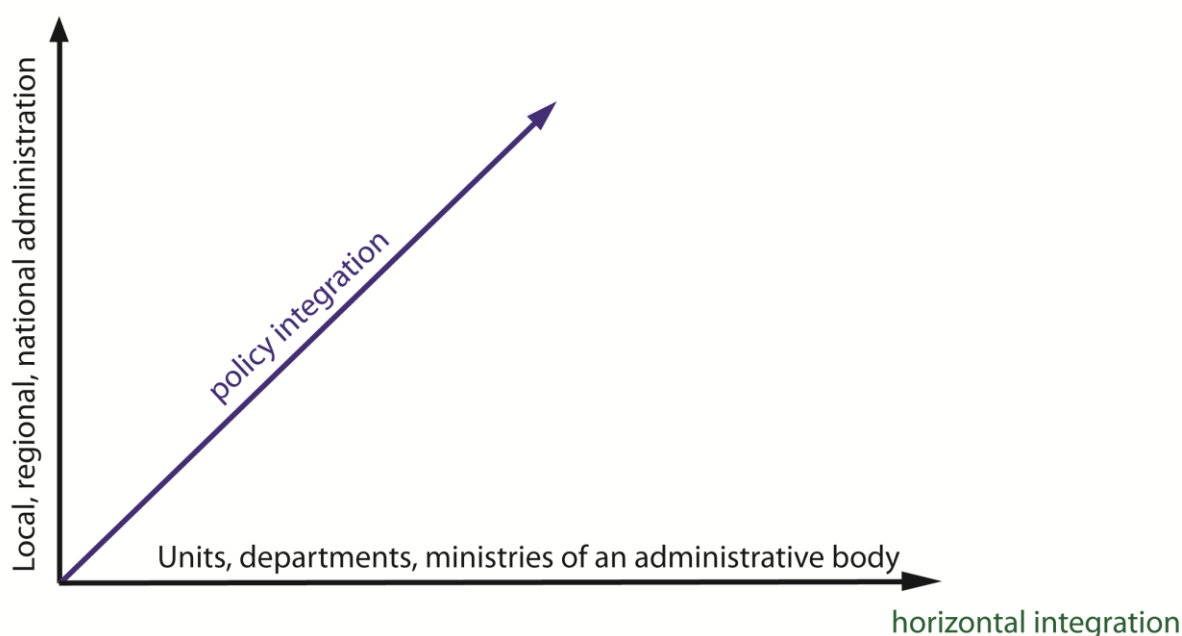
In addition to the new EU member states that follow the Europe 2020 strategy guidelines in their own national strategies, some countries of South-Eastern Europe have articulated national sustainable development strategies under the impact of EU approximation. Belarus is one of the few countries in Eastern Europe and Central Asia that has articulated a national strategy for sustainable development with an emphasis on innovation (UNECE, 2012).

## TOWARDS INTEGRATED POLICY MAKING

The path-breaking Brundtland report on sustainable development identified fragmented policy making as a major obstacle to its pursuit (World Commission on Environment and Development, 1987). The same is true for climate change adaptation. Multiple government levels (local, regional, national) and line ministries as well as specialized agencies implement various policies that have impacts on climate resilience. The current fragmentation of the policy-making process should be replaced by policy integration. Both horizontal integration (between departments and ministries at any government level) and vertical integration (between local, regional and national governments) are essential (Figure 20). An integrated policy framework is needed to coordinate and implement priority actions for green growth and climate change adaptation.

**FIGURE 20. POLICY INTEGRATION**

vertical integration



Source: UNECE (2008).

Following UNECE and WHO (2008), we can enumerate a number of barriers to and advantages of policy integration. The barriers include the following factors:

- Most administrations function in hierarchical organizations that resist innovative changes;
- Incentives in government organizations are usually adapted to narrow administrative goals rather than cross-sector results;
- Some line ministries and specialized agencies are considered more important and thus better funded than other ministries or agencies;
- Professional administrators are often trained in narrow technical fields;
- Sectoral administrative mechanisms and instruments are much better developed than multi-sectoral tools; and
- The legal framework reflects often sectoral concerns and is not conducive to inter-sectoral cooperation.

The benefits of policy integration in the management of cross-cutting issues such as climate change adaptation are important. Policy integration can:

- Encourage balanced decision making by reducing conflicts between different policy fields as well as between policies and citizens;
- Achieve complex goals and objectives better than fragmented policy making;
- Promote synergies and win-win solutions between sectors;
- Reduce duplications and promote consistency in policy-making processes in sectors;
- Promote innovation in policy development and implementation;
- Improve the understanding of effects of policies in one sector on other sectors; and
- Help overcome financial constraints.

The implementation of integrated policy making should reflect the country-specific institutional system and traditions. Thus one cannot simply transfer good practices in this area from one country to another but has to adapt them to local circumstances. However, some organizational arrangements are typical for integrated policy making (Figure 21).

**FIGURE 21. TOWARDS INTEGRATED POLICY MAKING**



Source: UNECE and WHO (2008).

The success of integrated policy depends inter alia on financial incentives provided by budgets for cross-sector activities, specific targets for such activities and effective monitoring with the aid of quantitative indicators. This is admittedly easier said than done if one targets climate adaptation rather than mitigation. Whereas the success of mitigation measures can be measured directly by the associated reduction of CO<sub>2</sub> or GHG emissions, there is no comparable metric for adaptation or resilience. Nevertheless, some adaptation process indicators (e.g. investment in R&D activities related to adaptation) and outcome indicators (e.g. the percentage of farmers or homeowners insured for weather-related disasters) should be relatively easy to calculate.

## EXAMPLES OF ADAPTATION STRATEGIES IN ADVANCED INDUSTRIAL ECONOMIES

Policy integration has been used successfully in a number of countries of Western Europe, including Finland and Germany. The Finnish government approved a national climate adaptation strategy already in 2005. It aims to improve the nation's capacity to adapt to climate change and reduce its social costs (Box 19). The strategy specifies potential adaptation measures for 15 vulnerable sectors until 2080. The Ministry of Agriculture and Forestry is responsible for the coordination of climate change adaptation at the national level. The implementation of the strategy is steered by the Coordination Group for Adaptation to Climate Change, which is run by the Ministry of Agriculture and Forestry, and also contains representatives from other ministries, research institutes, research financiers and regional actors.

### BOX 19. THE FINNISH CLIMATE ADAPTATION STRATEGY

The priorities for increasing the adaptation capacity in Finland include:

- Mainstreaming climate change impacts and adaptation into sectoral policies;
- Addressing long-term infrastructure investment needs;
- Coping with extreme weather events;
- Improving observation systems;
- Strengthening the research and development base; and
- International cooperation.

The key measures to be implemented by 2015 include:

- The integration of climate change adaptation into routine planning, implementation and development processes;
- Preparations for extreme events and the incorporation of assessments of the impacts of climate change into the long-term investment planning;
- Improvement of existing observation and warning systems;
- Implementation of the Climate Change Adaptation Research Programme; and
- Preparations for changes in the international operating environment.

([http://www.mmm.fi/en/index/frontpage/climate\\_change\\_energy/adaption.html](http://www.mmm.fi/en/index/frontpage/climate_change_energy/adaption.html)).

In Germany the federal government adopted a national adaptation strategy in 2008 and an adaptation action plan in 2011. The national adaptation measures are implemented by the federal government in cooperation with regional governments and other stakeholders such as local authorities, businesses, associations and research institutes. The action plan specifies the activities to be carried out by the federal government and links adaptation with other national strategic processes, including the High-Tech Strategy 2020 (Box 20.).

#### **BOX 20. THE GERMAN ADAPTATION ACTION PLAN**

Apart from the projects undertaken by federal authorities in cooperation with regional governments, the German adaptation action plan covers activities in the following areas:

- Knowledge, information, and enabling measures;
- Framework setting (incl. government programmes that provide incentives and fundamentals for adaptation in various fields);
- Activities for which the federal government is directly responsible (taking climate change into consideration as an owner of land, properties and infrastructure, and a builder of infrastructure); and
- International responsibilities (including R&D cooperation and links to activities undertaken at the EU level).

The German adaptation strategy and action plan follow an integrated approach that considers interactions between sectoral and regional activities and mainstreams the consideration of climate change impacts into all relevant sectoral activities. An inter-ministerial working group is to present by the end of 2014 an evaluation of the adaptation strategy and action plan, and provide proposals for their further development.

More details are available at: [http://www.bmu.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/aktionsplan\\_anpassung\\_klimawandel\\_en\\_bf.pdf](http://www.bmu.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/aktionsplan_anpassung_klimawandel_en_bf.pdf).

### **CLIMATE ADAPTATION STRATEGIES IN TRANSITION ECONOMIES**

So far only two European transition economies have adopted national adaptation strategies: Hungary and Lithuania. The development of comprehensive adaptation strategies is also under way in the other new EU member states. Outside Europe, Turkmenistan seems to be the only transition economy with a national climate change strategy that includes adaptation measures (see Module V).

The national adaptation strategy of Lithuania provides an example of good practice because it includes both policy integration and research components. It could be probably emulated by other former Soviet republics more easily than the more elaborate adaptation strategies of Finland and Germany.

**BOX 21. THE LITHUANIAN CLIMATE ADAPTATION STRATEGY**

The recently adopted Strategy for National Climate Management Policy 2013-2050 replaces the earlier national climate strategy for the period 2008-2012. The new strategy includes both climate change adaptation and mitigation goals. Priority sectors and areas for climate change adaptation include agriculture, forestry, biodiversity conservation, water, energy, transport, industry and public health.

The Ministry of Environment coordinates the implementation of adaptation actions in cooperation with Ministries of Energy, Finance, Transport and Communications, Health, Education and Science, Economy, Agriculture and other institutions. The adaptation measures include:

- Effective monitoring of climate change;
- Assessment of vulnerabilities and planning of adaptation options;
- Reduction of the impact of climate change on human health;
- Support for agrarian environmental programmes;
- Support for afforestation of unproductive land; and
- Research and awareness raising.

More details are available at <http://climate-adapt.eea.europa.eu/countries/lithuania>.

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## THE POLICY MIX FOR ECO-INNOVATION

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### THE RATIONALE FOR GOVERNMENT ACTION

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The previous section considers a policy framework that could integrate climate change concerns into relevant horizontal and sectoral policies at local, regional and national levels. This framework can be viewed as an organizational innovation with applications in a number of areas, including eco-innovation policy. But what are the ingredients (policy mix) needed for the uptake of green innovations by the industry, public and household sectors?

In advanced industrialized economies the integrated framework for eco-innovation includes a mix of policies and implementation mechanisms. The business sector generates most innovations while government action is necessary to create incentives for green innovations. Why? Policies are needed to correct market failures (prices may not capture all costs of production and consumption) and neutralize market power of established firms with traditional technologies that prevent market entry of innovative firms. According to OECD (2011), such policies include:

- Creation of clear and stable market signals (e.g. carbon pricing);
- Public investment in basic research;
- Support for private investment in eco-innovation (R&D and commercialization);
- Support for general-purpose technologies (e.g. ICT);
- Fostering the growth of new entrepreneurial firms;
- Facilitating the adoption of green innovations by SMEs;
- Fostering diffusion of green technologies;

- Strengthening markets for eco-innovation; and
- Consumer policy and education to encourage the uptake of green innovations.

## THE IMPORTANCE OF NATIONAL CONDITIONS

Each advanced industrialized country adopts a policy mix that reflects its competitive advantages and institutional traditions. Therefore, policy makers in catching-up economies cannot adopt such models wholesale. Instead they should establish realistic goals and measurable targets (e.g. energy efficiency) based on the benchmarks set by advanced economies (e.g. EU-15 countries). Then a coordinated set of country-specific policies and programmes should be developed and used to provide economic and regulatory incentives for the generation, adoption and diffusion of green innovations (UNIDO, 2012).

Effective eco-innovation measures are needed to implement such policies and programs. While it is important to learn from the experience of leading knowledge-based economies, their innovation models are unlikely to work in transition economies without further improvements of framework conditions and innovation governance (for details, see Module IV). Without such improvements, public funds for the support of eco-innovation could be wasted. Moreover, all transition countries have to focus on increasing the participation of the business sector in R&D and innovation activities (Goldberg et al, 2011).

## CONCLUSIONS AND RECOMMENDATIONS

### CONCLUSIONS

Climate change impacts pose significant adaptation challenges for all countries. Given the costs associated with enhanced climate resilience measures, catching-up economies would benefit significantly from the adoption and diffusion of cost-effective adaptation technologies. Although a number of progressive adaptation technologies have been developed and used successfully by business firms, households and public agencies in high-income countries, their adoption has been hindered in low and middle-income transition economies by an insufficient protection of property rights, inadequate regulatory and price incentives, weak competition, unavailability of finance, and other barriers.

Governments can overcome such obstacles by adopting policies that support innovation in general and eco-innovation in particular while improving the environment for doing business. Why? This would enable the business sector to deploy its technology, managerial know-how and finance productively. Under the right framework conditions, innovative firms and investors will be in a position to deliver the services needed by society effectively and efficiently.

Based on the analysis and inputs of relevant stakeholders, policy makers should prioritize sectors, actions and investment. Priority actions should:

- Promote awareness of sustainable development issues (Module I);
- Promote adaptation in key sectors and areas (Module II);

- Collect data and develop local, regional and national adaptation models to estimate relevant costs and benefits (Module III);
- Mainstream adaptation into land use planning and national resource management (Module III);
- Improve framework conditions and innovation governance (Module IV);
- Adopt appropriate innovation-specific policies (Module IV);
- Initiate innovation performance peer reviews (Module V); and
- Monitor systematically the eco-innovation performance (Module V).

In response to the challenges presented by warmer and more unpredictable weather, governments should support demonstration projects in areas such as climate resilient infrastructure, ecosystem-based approaches to adaptation, and the promotion of progressive adaptation technologies. These comprise hard, soft and organizational technologies, such as more resilient construction materials, climate-risk insurance, the greening of cities and integrated management of water resources.

## RECOMMENDATIONS

On the basis of the materials covered in thematic modules, a number of policy recommendations have been developed. These recommendations focus on the improvement of the functioning of national innovation systems and uptake of green innovations for climate change adaptation. General recommendations for transition economies in Eastern Europe, Caucasus and Central Asia are presented below.

## FRAMEWORK POLICIES

### Recommendation 1.

Reform further framework conditions in the following areas in order to improve the environment for doing business and support knowledge-based development:

- Implementation of commercial and financial laws;
- Human capital formation;
- Competition; and
- Financial markets.

Legal reforms in two areas are particularly relevant. An effective protection of property rights, including intellectual property rights, is conducive to private and foreign investment, entrepreneurship and innovation. Moreover, a solid legal basis for long-term concession agreements is an important precondition for the participation of foreign investors in climate-resilient infrastructure projects (and the associated technology transfer) within the PPP framework.

Human capital formation needs to be improved in the following areas: compulsory education, vocational training, and tertiary education. There is also a need to upgrade the capacity of human resources in the government sector in order to integrate climate adaptation into the planning of government activities, including the building of expertise and skills for climate projections and impact assessments.

Competition breeds innovation. Given the slow restructuring of large state-owned enterprises and their continued dominance in large parts of the economy, it is essential to reduce their market power with the aid of effective competition policy, especially in



the sectors not exposed to foreign competition. Under competitive conditions, firms have strong incentives to introduce innovations.

Given the importance of financing for innovative start-ups and SMEs and the relevance of innovative insurance schemes for climate change adaptation, the development of healthy financial markets with adequate supervision should be among structural policy priorities. Before financial markets operate efficiently, authorities should supplement the financing of start-ups and SMEs with grants disbursed by specialized non-profit agencies. Such agencies should operate at arm's length in allocating the funds received from the government.

Without a qualitative improvement of the framework conditions mentioned above, the innovation and eco-innovation performance is unlikely to improve significantly. In this sense the recommendation 1 is a basic precondition for a successful innovation policy.

## INNOVATION GOVERNANCE

### Recommendation 2.

Complete the process of establishing a coherent national innovation system. This calls for targeted policy efforts in the following directions:

- Undertake a critical assessment of the NIS with a view to identifying missing components and linkages;
- Undertake a public awareness campaign to build ownership for the needed changes among key innovation stakeholders;
- Promote institution building in consultation with key stakeholders;
- Enhance the connectivity within the NIS;
- Set up a public body (agency, committee or ministry) with strategic functional responsibilities for the development and implementation of innovation policy, including the related inter-agency coordination; and
- National data on R&D and innovation should be significantly improved and aligned with internationally agreed statistical standards and methodologies.

### Recommendation 3.

Policies targeting green growth and eco-innovation should be a subset of policies within a national innovation strategy. The development and adoption of a workable national innovation strategy requires a range of supplementary actions by the authorities:

- The national innovation and eco-innovation strategy should be developed as part of the ongoing policy initiatives for economic modernization and diversification;
- Raising the awareness among the business and academic communities and civil society about innovation issues and the national innovation strategy is another prerequisite for success;
- Initiate the establishment of a national innovation council for green technologies with the involvement of the research and business communities and civil society; and

- In view of the current dispersion of functional responsibilities in the area of green growth and eco-innovation, the authorities also need to improve coordination in policy design and implementation.

## INNOVATION-SPECIFIC POLICIES

### Recommendation 4.

Target higher levels of national R&D spending to invest in research capacity and skills development, as green growth and eco-innovation are particularly research intensive:

- Target higher public and private R&D expenditure, with a focus on green growth and eco-innovation;
- Research in priority areas, including climate change, should be encouraged by competitive grants for academic and private researchers;
- Private R&D spending should be supported by tax incentives;
- Governments of resource-rich economies could establish or expand national funds to support R&D and eco-innovation activities;
- Governments of low income countries could tap additional financing from international climate funds;
- Support cooperation between national and foreign R&D institutes;
- Introduce or improve education about climate change, green growth and sustainable development in schools and universities; and
- Support vocational training programmes to ensure the acquisition of relevant skills for the green economy and climate adaptation.

### Recommendation 5.

The authorities should stimulate the demand for eco-innovation:

- Green public procurement mechanisms need to be developed and used widely to increase demand for green products and eco-innovation;
- Simplify the public procurement process in order to enable SMEs to compete for state contracts on a level playing field;
- Introduce modern energy-efficiency and fuel-efficiency standards as well as building codes and infrastructure resilience parameters in order to improve sustainability; and
- Move towards the cost-reflective pricing of energy and water services with adequate social protection for the poor in order to enhance incentives for the adoption of progressive adaptation technologies and sustainable use of natural resources.

### Recommendation 6.

Enrich the innovation policy mix. Given the multifaceted nature of eco-innovation – which brings together multiple stakeholders – the government has a role in facilitating partnerships and cooperation.

- Catch up with good practices in mature economies where the policy mix encompasses broader areas such as the generation of knowledge, absorptive capacity of the economy, the diffusion of innovation and demand for innovation;

- Given the complexity of eco-innovation, there is a need for better and more efficient policy coordination both in design and implementation in this area; and
- As instruments for facilitating partnerships and the cooperation among eco-innovation stakeholders are still practically non-existent, the authorities should support capacity building in these areas of public policy.

### **Recommendation 7.**

The innovation policy mix should assign high priority to policies that support and facilitate the diffusion of innovations. Moreover, given the systemic nature of eco-innovation, linkages within the NIS play a key role for the process of diffusion.

- The authorities should consider introducing specific mechanisms and instruments that encourage and facilitate linkages among stakeholders, especially along the eco-innovation cycle;
- Create organizational structures to support innovation, such as technology business incubators and technology transfer agencies;
- Promote stronger linkages between FDI firms and local subcontractors; and
- Foster market mechanisms that generate incentives for market participants to engage in a cooperation leading to the adoption of green innovations.

### **Recommendation 8.**

Increase the use of financial instruments supporting eco-innovation:

- Governments of resource-rich countries should expand public financing of innovation in general and of eco-innovation in particular;
- Introduce grant schemes to support R&D on eco-innovation;
- Establish project-based eco-innovation financing instruments that encourage the development of industry-science cooperation and inter-firm linkages;
- Develop schemes for alternative financing of climate-resilient infrastructure through public-private partnerships; and
- Target stronger international cooperation in climate-related R&D and innovation activities.

### **Recommendation 9.**

Address the underdevelopment or absence of institutions of early stage financing (such as business angels and venture capital firms) by targeted policy measures. In particular:

- Expand public support for pre-commercialization stages of eco-innovation projects;
- Provide targeted public support for the development of financial institutions that specialize in early stage financing of start-ups and SMEs; and
- Establish new or strengthen existing support mechanisms for the establishment of private non-bank financial institutions that provide early stage financing.

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## SUMMARY

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1. The selection process of national priorities for climate change adaptation should be home based and involve all relevant stakeholders. This could ensure a broad social support for the policies needed for achieving effective adaptation solutions. Table 17 shows adaptation priorities of countries of Central Asia and Azerbaijan.
2. Government should identify, in cooperation with key stakeholders, the barriers and enabling measures for the uptake of cost-effective adaptation technologies in vulnerable sectors. Figure 18 illustrates such barriers while Figure 19 and Table 18 show selected enabling measures and examples of the adaptation measures proposed in Central Asia.
3. Green growth can hardly be achieved without innovation. National green-growth strategies should therefore include innovation policy targets.
4. Integrated policy making is needed for an effective mainstreaming of climate change concerns into relevant policies at local, regional and national levels. Figures 20 and 21 illustrate the main principles of policy integration.
5. The policy mix for eco-innovation in Western countries includes a broad range of policies that stimulate R&D and innovation activities that take place mainly in the business sector. The choice of policy mix in transition economies should reflect national comparative advantages and institutional conditions.

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## GLOSSARY

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**Carbon pricing** refers to pricing of carbon dioxide emissions through taxes or traded emission permits.

**Climate change** refers to a persistent change in the mean and/or the variability of climate properties.

**Climate change adaptation** refers to the adoption of policies and practices to prepare for the effects of climate change.

**Climate change mitigation** refers to the adoption of policies and practices that reduce greenhouse gas emissions of economic activity.

**Diffusion of innovations** refers to the way in which innovations spread, through market or non-market channels, to different consumers, countries, regions, sectors and firms.

**Eco-innovation** is an innovation whose use is less environmentally harmful than its alternatives.

**General-purpose technologies** such as ICT, biotechnology or nanotechnology support all economic sectors rather than particular industries.

**Green innovation** is an innovation whose use is less environmentally harmful than its alternatives.

**Green growth** is a type of economic growth that avoids unsustainable pressure on the quality and quantity of natural assets.

**Greenhouse gases** refer to carbon dioxide, nitrous oxide, methane, ozone and chloro-fluorocarbons occurring naturally and resulting from human activities, and contributing to the greenhouse effect (global warming).

**Innovation** refers to new or significantly improved products, processes, marketing methods or organizational methods.

**Invention** refers to a new scientific or technical idea and the means of its embodiment or accomplishment. Most inventions are not economically feasible.

**Micro-enterprises** are small businesses with fewer than 10 employees.

**Small and medium-sized enterprises** are independent firms with no more than 250 employees.

**Technology** refers to the state of technical knowledge.

**Sustainable development** is a process is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains two key concepts: the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations

imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

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## ADDITIONAL RESOURCES

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Indicators are important for the evaluation of both adaptation and innovation policies. With respect to adaptation, you might want to consult a report on international experience with adaptation indicators that has been prepared for the UK Adaptation Sub-Committee (Horrocks et al, 2012). This report reviews three widely used global adaptation indicators that can be accessed on the internet and used for national assessments and cross-country comparisons:

- Global adaptation index (<http://gain.org/>),
- Climate vulnerability monitor (<http://daraint.org/climate-vulnerability-monitor/climate-vulnerability-monitor-2012/>),
- Climate change vulnerability index (<http://www.cgdev.org/publication/quantifying-vulnerability-climate-change-implications-adaptation-assistance-working>).

In addition, the report reviews national initiatives pertaining to the development of climate adaptation indicators in Australia and Germany. The main conclusion is that there is no optimal framework for the development of vulnerability or adaptation indicators but some common concepts such as process and outcome indicators are useful. The report can be downloaded at [http://hmccc.s3.amazonaws.com/ASC/2012\\_per cent20report/AEA\\_per cent20Global\\_per cent20adaptation\\_per cent20indicators\\_per cent20review\\_per cent20- per cent20final.pdf](http://hmccc.s3.amazonaws.com/ASC/2012_per cent20report/AEA_per cent20Global_per cent20adaptation_per cent20indicators_per cent20review_per cent20- per cent20final.pdf).

With respect to innovation, you might be interested in the new EU innovation output indicator that was launched in September 2013. The indicator compares innovation outputs in 28 EU member states, Iceland, Japan, Norway, Switzerland, Turkey and the United States. The indicator is based on 4 components that provide metrics for an evaluation of innovation policy:

- Technological innovation measured by patents,
- Employment in knowledge-intensive activities,
- Competitiveness of knowledge-intensive goods and services,
- Employment in fast-growing firms in innovative sectors.

A chart showing the new output indicator scores is available at [http://europa.eu/rapid/press-release\\_IP-13-831\\_en.htm](http://europa.eu/rapid/press-release_IP-13-831_en.htm).

The new indicator complements the EU innovation scoreboard that can be accessed at <http://ec.europa.eu/enterprise/policies/innovation/facts-figures-analysis/innovation-scoreboard/>.

## QUESTIONS FOR DISCUSSION AND MULTIPLE CHOICE TEST

### QUESTIONS FOR DISCUSSION

1. Which barriers to adopting of new adaptation technologies are important in your country? Why?

.....

.....

2. Which enabling measures for adopting of new adaptation technologies are important in your country? Why?

.....

.....

3. How can government enable the business sector to invest in green innovations for climate change adaptation? Discuss realistic policy options to achieve this objective.

.....

.....

### MULTIPLE-CHOICE TEST

**Check the best answer.** (*Correct answers can be found on page 144*)

#### QUESTION 1

Which of the following stakeholders should be involved in the process of setting priorities for climate change adaptation?

- A. Government.
- B. Business.
- C. Civil society.
- D. All of the above.

Your answer:.....

#### QUESTION 2

Barriers to the adoption of imported adaptation technologies can include:

- A. Lack of funds for investment.
- B. Subsidized prices of inputs.
- C. Both A and B.
- D. Impossible to answer due to insufficient information.

Your answer:.....

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**QUESTION 3**

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Enabling measures for the adoption of imported adaptation technologies can include:

- A. Simplified import procedures for such technologies.
- B. Subsidized loans for investment in such technologies.
- C. Both A and B.
- D. Impossible to answer due to insufficient information.

Your answer:.....

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**QUESTION 4**

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Adaptation technologies include:

- A. Hard technologies.
- B. Soft technologies.
- C. Organizational technologies.
- D. All of the above.

Your answer:.....

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**QUESTION 5**

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Policy integration includes:

- A. Horizontal integration.
- B. Vertical integration.
- C. Both A and B.
- D. None of the above.

Your answer:.....

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**QUESTION 6**

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Uncoordinated decision making by government departments and ministries is consistent with:

- A. Fragmented policy.
- B. Integrated policy.
- C. Both A and B.
- D. None of the above.

Your answer:.....



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**QUESTION 7**

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Framework policies can improve:

- A. The environment for doing business.
- B. Human capital formation.
- C. Competition in protected sectors.
- D. All of the above.

Your answer:.....

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**QUESTION 8**

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The policy mix for eco-innovation can include:

- A. Public support of basic research.
- B. Fostering the growth of new entrepreneurial firms.
- C. Consumer policy and education.
- D. All of the above.

Your answer:.....

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**QUESTION 9**

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Innovation policies can:

- A. Target the level of R&D.
- B. Demand for eco-innovation.
- C. Provide early stage financing for innovative start-ups.
- D. All of the above.

Your answer:.....

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**QUESTION 10**

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Innovation policies:

- A. Should be consistent with climate policies.
- B. Could help lower the costs of climate change adaptation.
- C. Both A and B.
- D. None of the above.

Your answer:.....







# ANSWERS TO MULTIPLE CHOICE TESTS

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## MODULE I

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1-D, 2-D, 3-B, 4-D, 5-C, 6-A, 7-A, 8-A, 9-D, 10-C

## MODULE II

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1-D, 2-C, 3-A, 4-D, 5-A, 6-B, 7-D, 8-A, 9-C, 10-D

## MODULE III

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1-D, 2-C, 3-D, 4-A, 5-A, 6-D, 7-B, 8-C, 9-C, 10-A

## MODULE IV

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1-D, 2-B, 3-B, 4-D, 5-A, 6-C, 7-A, 8-D, 9-B, 10-D

## MODULE V

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1-A, 2-D, 3-D, 4-A, 5-A, 6-A, 7-A, 8-A, 9-A, 10-C

## MODULE VI

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1-D, 2-C, 3-C, 4-D, 5-C, 6-A, 7-D, 8-D, 9-D, 10-C

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Information Service  
United Nations Economic Commission for Europe

Palais des Nations  
CH - 1211 Geneva 10, Switzerland  
Telephone: +41(0)22 917 44 44  
Fax: +41(0)22 917 05 05  
E-mail: [info.ece@unece.org](mailto:info.ece@unece.org)  
Website: <http://www.unece.org>