Environment and Climate Regional Accession Network ECRAN

Environment and Climate Regional Accession Network (ECRAN)

Report on the Fourth Multi-beneficiary Workshop on Modelling

20-22 April 2016, Tirana

ENVIRONMENT AND CLIMATE REGIONAL NETWORK FOR ACCESSION - ECRAN

WORKSHOP REPORT

Activity 3.2 (Sub-Task 1.4 – A: Practical hands on assistance on quantitative models and scenario development to be used to assess climate and energy policy options and to set emission targets)

REPORT ON THE FOURTH MULTI-BENEFICIARY WORKSHOP ON MODELLING

Tirana, 20-22 April 2016

This Project is funded by the European Union

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LIST OF ABREVIATIONS	
ACER	Agency for the Cooperation of Regional Regulators
APA	Ad-Hoc Working Group on Paris Agreement
BAU	Business-as-usual
BECCS	Bio-energy with carbon capture and storage
CHP	Combined heat and power
COP	Conference of the Parties
CRF	Common reporting format
CCS	Carbon capture and storage
CNG	Compressed natural gas
CMA	The meeting of the Parties to the Paris Agreement
ECRAN	Environment and Climate Change Regional Accession Network
EU	European Union
EU ETS	European Union Emission Trading System
GDP	Gross domestic product
GHG	Greenhouse gases
GWP	Global warming potential
HAM	High ambition mitigation scenario
IEA	International Energy Agency
INDCs	Intended nationally-determined contributions
IPA	Pre-Accession Assistance
IPCC	Intergovernmental Panel on Climate Change
LEAP	Long-range Energy Alternatives Planning System
LED lights	Light-emitting diode lights
LEDs	Low emission strategies
LPG	Liquefied petroleum gas
MRV	Monitoring, reporting and certification
NDCs	nationally determined contributions
REDD+	Actions beyond Reducing Emissions from Deforestation and Forest Degradation
SLED	Support for Low-Emission Development in South Eastern Europe
UN	United Nations

I. Background/Rationale/Legislation covered

There is a need to start developing concrete climate policies based on full alignment with the EU Climate acquis and greenhouse gas (GHG) emission reduction target setting. At present the absence of national or regional targets and roadmaps towards implementation of these targets hamper the development of robust climate policies in the region and thus low emission development. ECRAN could provide the platform to start a regional work on this topic.

Climate policy related strategy development as well as fulfilling the reporting requirements of Annex I countries towards the UNFCCC, similarly to the EU acquis requires detailed modelling of emission scenarios on country level.

In most ECRAN beneficiaries there is experience in modelling aided scenario work, especially in the framework of the preparations of National Communications. However, in many cases this work has been designed and outsourced by international organizations or other external organizations without adequate involvement or ownership of the results by the countries. As such, the knowledge base within the administrations on modelling aided scenario work is limited.

In terms of technical requirements, the focus of the training will be on one specific modelling platform, the Long-range Energy Alternatives Planning System (LEAP*)* which has been developed by the Stockholm Environmental Institute. Of the 8 beneficiaries 6 are already using LEAP, and one (Kosovo*[1]) has expressed interest in using it.

The training program is organized into four modules to be conducted during one year.

[1] *This designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo Declaration of Independence.

II. Objectives of the Training

Objectives

The specific objective of the training program is to increase technical capacities in the countries to allow them to carry out modelling of emission scenarios. The modelling aided scenario work will benefit countries by helping them meet their future EU and UNFCCC reporting requirements, and to form a rational position on national efforts contributing to the EU 2050 roadmap and the 2030 Framework, and may assist them by promoting evidence based planning in energy policy, including in the development of an energy strategy, energy efficiency action plan and renewable energy action plan.

Modelling of emission scenarios is part of the EU member state reporting obligations under the current MRV legislative framework.[2]

Depending on the circumstances of the national public administration and future plans of the public administrations to build modelling capacity inside or outside the public administration, the technical modelling skills can be used in one of two ways. If the chosen option is to carry out modelling work within the public administration the exercise will help to build technical capacity and provide a basis for future work. If the chosen option is to outsource modelling work, the exercise can help beneficiaries gain a better understanding of modelling work which will enable better communication with consultants, thereby ensuring that modelling is relevant to policymakers and that policymakers understand the limits of the work and are able to better interpret the results.

Expected Results

The following results are expected from the regional exercise:

- Enhanced technical capacity within the relevant ministries and institutions (in particular ministries responsible for climate, energy, transport, as well as national statistical offices) to implement specific policies and measures to converge with the EU climate change policy and selected EU legislation;
- Strengthened regional network of experts.
- Enhanced understanding of the EU Monitoring Mechanism Regulation in connection with reporting on Policies and Measures as well as Emission Projections

To ensure active participation, ECRAN beneficiaries were asked to commit that the experts nominated for the training course are allowed sufficient time for carrying out the work required under the different tasks, including attending seminars and conducting the follow-up activities. Experts from the beneficiaries are expected to spend 12 days participating in workshops, and a minimum of 15 days in follow-up activities implementing the regional pilot modelling exercise. The ECRAN team will be

[2] 30/06/2014 - Commission Implementing Regulation (EU) No 749/2014 of 30 June 2014 on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) No 525/2013 of the European Parliament and of the Council; 21/05/2013 - Regulation (EU) No 525/2013 of the European Parliament and of the Council on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change

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monitoring work progress to ensure that the exercise, which requires a significant commitment, is advancing as foreseen.

The first four-day long meeting was organized in Skopje in November 2014 and aimed to give an introduction to the participants to the policy environment, give an introductory training on LEAP as well as provide initial steps in filling the LEAP structure with country relevant data, building up the basic model.

The training part of the second and third Module was focused on definition of scenario types, definition and reporting on policies and measures, projections of drivers of future emissions, costs of technologies and the building of baseline scenario. In Module 3 countries were requested to prepare a **high ambition scenario (HAM-scenario)** of their choice for training purposes, including the identification of technologies, associated costs and definition of the CO2 reduction potential associated with that HAM scenario.

This **fourth and final module** of the training will wrap up the Module 3 homework and will connect the theoretical modelling practices with the recent policy developments where modelling was important, especially connecting INDCs and high ambition decarbonisation scenarios. It will also overview the lessons learned in the previous three modules.

The beneficiaries of the training are the Ministries of Environment of the beneficiary countries who participated in all 3 Modules, including the additional catch up training courses held in Tirana in March 2015 as well as the participants of the national training in Belgrade in April 2015.

Participants of the training are required to bring a portable computer where they have administrator privileges in order to allow the installation of the LEAP software environment for the exercises.

Participants completing all four modules will receive a certificate regarding completion of the training.

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III. Highlights from the Training

Below only the main elements are highlighted. The presentations are presented in Annex III.

Highlights Day 1: Recap previous Modules and the discussion of the Module 3 homework

20 April 2016, Tirana International Hotel, Tirana, Albania

Introduction to Module 4 – Jozsef Feiler, ECRAN

Mr. Feiler started the Module 4 communicating the news about the 21st yearly session of the Conference of the Parties (COP) to the 1992 United Nations Framework Convention on Climate Change (UNFCCC), which took place in Paris in December 2015. The COP21 adopted a historic agreement that forms the cornerstone for continued international cooperation on climate change, and initiatives in the framework of the Environment and Climate Change Regional Accession Network (ECRAN) and bilateral cooperation in particular through Pre-Accession Assistance (IPA). All this demonstrates an unprecedented political determination from around the world.

The aim of the Paris Agreement is described in Article 2 of the Convention, "enhancing the implementation" of the UNFCCC through:

- Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;
- Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low GHG emissions development, in a manner that does not threaten food production;
- Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.

In preparation for the COP21, the parties of the UNFCCC were encouraged to submit their intended nationally-determined contributions (INDCs), which outline what post-2030 actions they intend to commit in the new international climate regime. For many of the ECRAN countries the preparation of INDCs in 2015 represented the first comprehensive attempt to set out a national vision for transitioning to a low emission and climate resilient economy, thereby creating new economic opportunities in renewable energy, energy efficiency, urban development, sustainable farming systems, etc.

The Paris Agreement calls to the equity in its implementation and relies on the principle of common but differentiated responsibilities and respective capacities. The contribution that each individual country should make in order to achieve the worldwide goal are determined by all countries individually and called "nationally determined contributions" (NDCs). The INDCs pledged during the 2015 Climate Conference serve—unless provided otherwise—as the NDCs. The Module 4 aims to discuss and practice the construction of High Ambitious Mitigation Scenarios (HAM) to mitigate national GHG emissions that may to help the policy-makers of beneficiary countries to understand and use better the results of methodologies and models used in INDCs and NDCs.

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Policy update: COP21 outcomes – Jozsef Feiler, ECRAN

In his presentation, Mr. Feiler focused on the discussion of the COP21 outcomes.

During the 1980s, scientists warned that changes were occurring in global climate patterns owing largely to changes in the composition of gases that constitute the atmosphere. In May 1992 the UNFCCC was adopted as one of the Rio Conventions and it entered into force in 1994. **The objective of the UNFCCC is (Article 2 of the Convention) is** "*stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame that allows ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner".*

Initially, the top-down approach was applied to the international climate policy. For instance, the Kyoto Protocol, which regulated the global climate mitigation commitments in 2008-2012 had a very high degree of the international oversight and was based on legally binding commitments for GHG emission reductions for many countries. This approach as well as the main features of the Kyoto Protocol, including however a broader world coverage, was supported by the EU and Australia in the negotiations at COPs in Copenhagen and Cancun. It did not receive however broader support by other governments due to reluctance to legally commit for stringent mitigation targets. Instead, reliance on bottom-up approaches with some top-down elements is becoming more popular. These include different actions inside and outside the UNFCCC including unilateral pledges and coordinated approaches among several jurisdictions.

The Paris COP could be characterized as the event of the decade enjoying the largest number of participants in the UNFCCC history. Overall, there have been 30,372 participants; of them 19,210 from governments, 2,008 from intergovernmental organizations, 6 306 from nongovernmental organizations, and 2,798 from media. The event housed the largest number of heads of state (150) under one roof in the world history.

After its slow start, the event enjoyed the meticulous French preparation including high level involvement, four ministerial meetings, high level events for scientists, business and religious leaders. The event was very strongly supposed by the work of the countries to prepare INDCs: out of 196 UNFCCC parties 189 provided these submissions. The Paris COP relied, among others, on the broad use of new negotiation groups such as High Ambition Coalition and Climate Vulnerable Forum. Overall, the event was characterized by a high degree of transparency having Communiques of all meetings. Having learnt from previous, less successful negotiations, the opinions of small countries have been taken more seriously into account. A principal difference from the previous negotiations was also having the heads of state meeting at the beginning of COP instead of moving it to the end of COP that gave some guidance to officials. The presidency provided an exceptionally tight timetable well in advance. It aimed to focus on the agreement text instead of the country positions and it aimed to be polite but firm in the handling of „troublemaking" countries.

The Paris outcome came in two parts: a 20-page decision, which describes a work plan what countries have to do before the Paris Agreement enters into force in 2020, and a 12-page "Paris Agreement" itself, which defines the commitments for international climate policy after 2020. Having the agreement as an annex allowed the US President to approve it without requiring Congressional ratification (which would be very unlikely).

The Paris Agreement adopted is very ambitious. Its goal is to keep the global warming between 2 and 1.5 degrees Celsius by above the preindustrial levels (Article 2), to reach the global peaking „as soon as possible” (Article 4.1), to achieve the balance of emissions and sinks (excluding solar radiation management) by second half of century (Article 4.1), and to have the global stocktake progressed towards these goals every 5 years from 2023 (Article 14.1 and 14.2).

Such goals represent a massive challenge for decarbonisation. The remaining emission budget to reach the 2 degree Celsius target is 1000-1200 billion tCO_2 and 1.5 degree target - 500-600 billion tCO_2 respectively. The current annual global emissions are ca. 50 billion tCO_2. Only 20-25 years are left to reach the 2 degree Celsius target given the current rate of GHG emission trends and only a decade is left to reach the 1.5 degree Celsius target.

The Paris Agreement assumes that the mitigation efforts should be pursued by everyone. All countries have to participate in mitigation according to their Nationally Determined Contributions (NDCs) (Article 4.2), which define domestic mitigation measures and which are ratcheted upwards every 5 years (Articles 4.3 and 4.9). The industrialized countries should have absolute targets (Article 4.4), whereas the developing countries should „move over time” towards an economy-wide reduction or limitation targets (Article 4.4). Article 3 requires NDCs to be "ambitious", "represent a progression over time" and set "with the view to achieving the purpose of this Agreement". The contributions should be reported every five years and are to be registered by the UNFCCC Secretariat. Each further ambition should be more ambitious than the previous one, known as the principle of 'progression'. Countries can cooperate and pool their nationally determined contributions (Article 4.16-18).

All countries must account for their emissions (Article 4.13) taking into account environmental integrity, transparency, accuracy, completeness, comparability, and consistency of inventories. The countries should take REDD+ actions (Reducing Emissions from Deforestation and Forest Degradation)[3] (Article 5); for this, the countries are encouraged to go for result-based payments (Article 5.2).

Countries can strengthen their INDCs even before their signature that creates a self-reinforcing circle. Countries do not put forward strong NDCs and try to hide “do nothing” behind fake actions of the business-as-usual case.

The Paris Agreement establishes a new market mechanism (Article 6), which envisions the participation of authorized by Party public and private entities (Article 6.4b). The mechanism will be supervised by a body to be designed by countries who have signed the agreement. Rules to be developed by the meeting of the Parties to the Paris Agreement (CMA) based on the following principles: real, measurable and long-term reduction (38b decision), the definition of scopes of activities (38c decision), additionality (38d decision), verification and certification by Designated Operational Entities (DoEs) (38e decision), and the application of experience from Kyoto Mechanisms (38f decision).

The Paris agreement pays special attention to the transparency of the international climate policy (Article 13). This includes the provisions on the clarity and progress of NDCs (Article 13.5), achievements of NDCs (Article 13.12), and mandatory inventory as per IPCC good practice guidance

[3] Reducing Emissions from Deforestation and Forest Degradation (REDD) is an effort to create a financial value for the carbon stored in forests, offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development. "REDD+" goes beyond deforestation and forest degradation, and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks.

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(Article 13.7a). This also includes the support provided-finance, technology transfer and capacity building (Art 13.9). The Agreements builds on the UNFCCC approaches used to date (Article 13.4).

The Agreement is characterized however by somewhat weak principles of non-intrusive, non-punitive, national sovereignty (Art 13.3) as well as the technical expert review, not defined in sufficient detail (Article 13.11). Furthermore, the flexibility for developing countries (Article 13.2) in light of their capacities are however difficult to operationalize.

The Paris Agreement regulates the provision of climate finance (Article 9). The Agreement defined that industrialized countries shall provide finance (Article 9.1) specified in biennial communication of volumes and forecasts (Articles 9.5 and 9.7). Developing countries can provide climate finance voluntarily and report on it (Articles 9.2 and 9.5). The text contains however unclear and vague wording saying that the finance should aim for balance of mitigation and adaptation (Article 9.4) and industrialized countries should „continue to take the lead", progressing beyond current efforts (Article 9.3).

The Agreement established a new goal for adaptation (Article 7.1), which is viewed by many as rather fluffy. It formally recognizes the efforts of developing country in adaptation (Article 7.3). It requires more cooperation efforts (Article 7.7), improved effectiveness and durability (Article 7.7e), and adaptation plans by each party (Article 7.9) with nationally determined prioritized actions (Article 7.9c), which have to be periodically communicated (Articles 7.10 and 11).

The Ad-Hoc Working Group on Paris Agreement (APA) was set up to prepare for the entry into force of the Paris Agreement. The "workplan" invites the IPCC to prepare a special report in 2018 on the impacts of global warming by 1.5 degrees Celsius and the related GHG emission paths by 2018. The "workplan" urges the parties, which INDCs contain the targets up to 2025, to replace them with new NDCs by 2020 and to do so thereafter every five years. It also requests the parties, which INDCs contained the targets up to 2030, to update them and to do so thereafter every five years. The updated INDC synthesis (NDCs) will be prepared by the Secretariat by 2 May 2016, given the cut-off of information as of 4 April 2016. The INDCs can be converted to NDCs immediately upon signature of the Paris Agreement. The APA will develop rules for NDC features and information. The NDC registry will be created by UNFCCC from 2016.

The APA will work to develop the accounting rules for Parties' NDCs (§31) applicable from the second NDC (32§). The accounting methodologies and metrics should be in accordance with those assessed by the IPCC (§31a). The Parties should ensure the methodological consistency between communication and implementation of NDCs, including the consistency of baselines (§31b). The Parties should include all categories of GHG in NDCs; once a category is included, it should remain there (§31c). Otherwise, an explanation on reasons for exclusion of categories is required (§31d). The "workplan" called to avoid double counting (§35). Further, the "workplan" invites the Parties to communicate by 2020 the long-term low emission strategies (LEDs) (§36). The APA is required to design a framework for non-market approaches to sustainable development (§40). Finally, the "workpan" requests from the APA to consider methodologies for assessing adaptation needs (§43b) and to review the adequacy and effectiveness of adaptation methods (§46b). Figure 1 presents the timeline of international climate policy milestones.

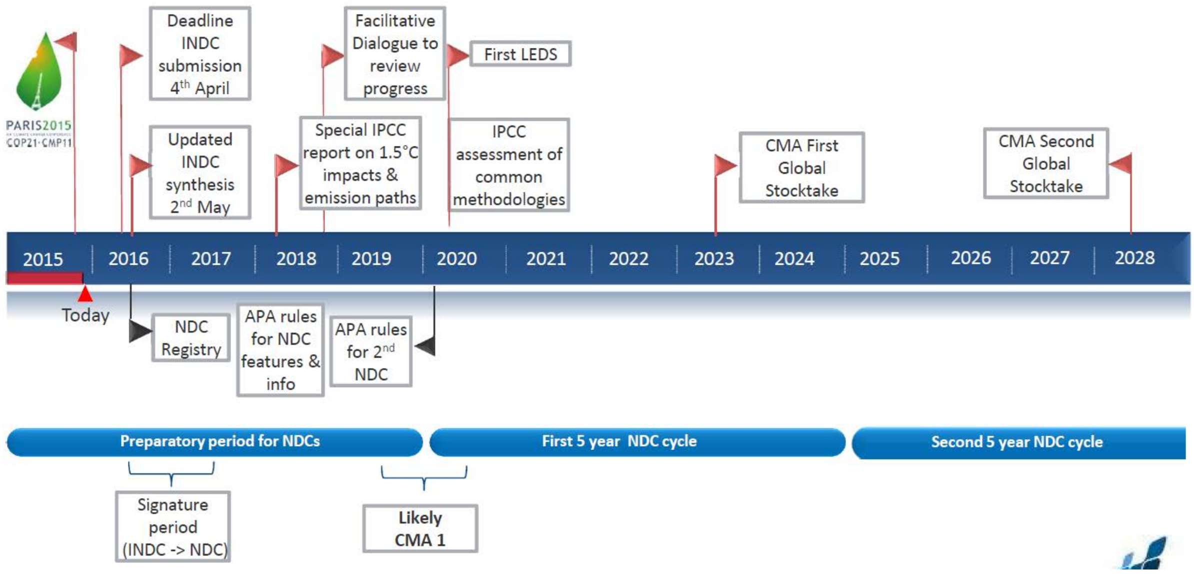

Figure 1: The timeline of international climate policy following the Paris Agreement

<u>EU policy agenda towards the long-term climate goal –Agnes Kelemen, ECRAN</u>

Ms Kelemen started her presentation brainstorming with the workshop participants on the elements required to design a decarbonisation plan for their countries. Together with the participants, she identified that above all, it is important to identify GHG emission reduction targets in the long-term. In order to understand how to get to the long-term target, the countries have to set intermediary targets and calculate the trajectory linking them. In order to achieve the targets, the policy-makers have to design and adopt a comprehensive package of policy instruments. This includes legislative framework, regulatory tools, financial incentives, market-based instruments, and others. Designing these policy tools, policy-makers have to consider the supportive environment for their implementation such as research and innovation, training of experts, etc.

The EU medium and long-term agenda includes the 2020 climate and energy package, the 2030 climate framework, and the 2050 low carbon roadmap. The 2020 climate and energy package introduced three targets: 20% cut in GHG emissions (from 1990 levels), 20% of EU energy from renewables, and 20% improvement in energy efficiency. The package required to introduce multiple energy and climate policy instruments in order to achieve these targets. Overall, the package demanded strong economy-wide efforts to meet climate target.

To achieve the targets of the 2020 climate and energy package, a complex set of legislation was introduced. Thus, the EU Directive establishing the Emission Trading Scheme (ETS) required achieving an emission reduction in the electricity production sector, heat production sector and large industry through the establishment of EU-wide emission trading. The Effort Sharing Decision established the cumulative for the EU and individual targets for EU member states to reduce emissions in transport, buildings, agriculture, and waste sectors. The Renewable Energy Directive establishes an overall policy for the production and promotion of energy from renewable sources in the EU and requires achieving at least 20% of its total energy needs with renewables by 2020 with the help of individual national targets. A set of legislation addressing energy efficiency includes the Energy Efficiency Directive, the European Performance Buildings Directive, the Energy Labelling Directive, and the Ecodesign Directive. Other legislation, which helps to achieve the targets include emission standards for cars and vans, the

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Carbon Capture and Storage Directive, the Energy Taxation Directive, the Third energy package and Trans-European Network infrastructure planning for more integrated energy markets, and others.

Past experience and modelling have confirmed that the impact of the 2020 climate and energy package on both GDP and employment can be positive. At the same time, low carbon pathway requires economic transition. Therefore, there is a need to harmonize economic policies with low carbon policies. For instance, the carbon policies are linked to the EU 2020 Strategy for smart, sustainable and inclusive growth, which promote green growth, innovation, reduce dependence on imports and vulnerability to oil price shocks, etc. Climate policies should be integrated into other EU policy documents, e.g. agenda for new skills and jobs, Innovation Union, etc. Further, the EU allocates 20% of its 2013-2030 funding, totalling more than EUR 1 trillion, for climate change (including regional policy, Horizon 2020, Connecting Europe Facility, LIFE, etc.) There is also other funding which will be directed to climate change actions, e.g. from ETS NER300, national EU ETS auctioning revenue, etc.

The 2030 climate framework includes 40-27-27 targets for GHG emission reduction, renewable energy in the energy balance, and energy efficiency. The EU ETS is required to reduce emissions in the sectors covered by 43% whereas the Effort Sharing Decision requires emission reduction in the sectors covered by 30%. The recent establishment of the Energy Union policy requires more coordination of capacities at regional level, storage and more flexibility in demand response, reinforcement of ACER (Agency for the Cooperation of Regional Regulators), and diversification of energy sources.

The 2030 framework does not introduce specific policy instruments for 2020-2030, but these will be developed later. The accompanying assessment of the 2030 framework highlights its very positive impact on the EU economy. For instance, it found that the implementation of the framework will contribute to the long-term growth, employment, and competitiveness of the EU clean energy sectors. The additional annual investments are estimated to be EUR 38 billion between 2011 and 2030, but fuel savings will compensate these costs to a large extent. The total cost of the energy system in 2030 is projected to increase by 0.15%. More than half of the investments are needed in the residential and tertiary sectors. The energy system costs do not differ substantially from the baseline scenario costs associated with maintenance and replacement. Lower-income countries need to make relatively larger efforts compared to their GDP.

The EU Low Carbon Roadmap requires a reduction of GHG emissions by ca. 80% in 2050 vs 1990 (Figure 2). The roadmap shows that there are multiple ways of reaching decarbonisation in the energy sector by modelling different scenarios. The high energy efficiency scenario requires very high energy savings that would result in a decrease in energy demand of 41% by 2050 as compared to the peaks in 2005-2006. The scenario with diversified supply technologies requires all energy sources to compete on market with no specific support measures, in addition to RES also nuclear and CCS. The high renewable sources scenario requires strong support measures for RES leading 75% in 2050 as share of gross final consumption and 97% in electricity sector. The scenario with delayed carbon capture and storage (CCS) is similar to diversified supply technologies scenario but assumes higher shares for nuclear energy. Finally, the low nuclear scenario is similar to the diversified supply technologies scenario but no new nuclear and higher penetration of CCS (around 32% in power generation).

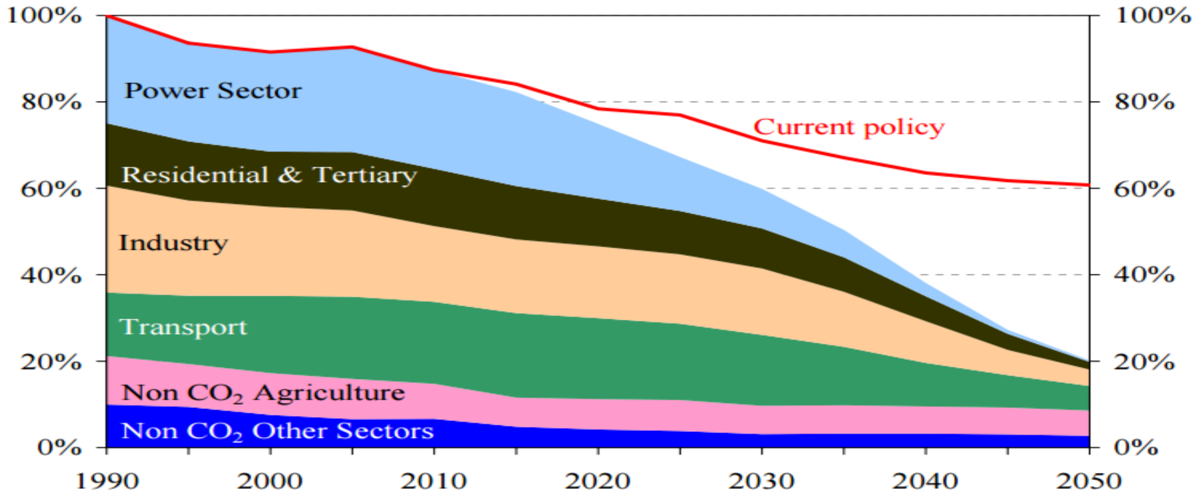

Figure 2: The GHG emission trajectories of the EU Low Carbon Roadmap 2050

In order to achieve the targets set by the EU Low Carbon Roadmap, the public and private sector have to increase their investments by 300-400% by 2050 vs their level in 2005. At the same time, the implementation of the Roadmap will help create new jobs. In the future, 250-750 thousand additional jobs are expected from annual EUR 20 billion investment required by the roadmap. The realization of the package also contributes to better air quality, health benefits, and reduced ecosystem impacts.

<u>The homework assignments of Modules 1-3 - Aleksandra Novikova, IKEM</u>

Ms Novikova reminded about the homework assignments given at the previous training modules. There were two such assignments. The assignments were to be understood in connection with the LEAP exercises introduced at the training and they were based on the data sets provided by Charlie Heaps. The participants were requested to complete assignments and report on their progress to the ECRAN team by the deadlines indicated.

The 1st homework assignment consisted of two tasks. Task 1 was to work with the participant country in the LEAP model distributed by Charlie Heaps. More specifically, the participants had to check the input data populated for the variables in the base year. These variables were filled with Heaps' data sets gathered from the IEA balances and other sources. The data was compiled until the base year 2011 and included key social and economic data, historical energy balances for the energy demand sectors and the transformation sector, and GHG emission factors. The participants had to identify locally available input data for these variables in their countries and compare them to Heaps' data. Then, the participants had to compare the levels of GHG emissions calculated by Heap's LEAP model with the latest GHG inventory available for their country. In case of significant differences among these, the participants had to find out their causes relying on the input variables. In summary, the participants had to prepare a 2-page report on the coincidences and differences between GHG emissions calculated by LEAP and emissions as reported in the national inventories as well as the possible reasons for such differences. If needed, the participants had to prepare an improved data-set based on their research with the indication of data sources in "notes" in LEAP.

Task 2 of the 1st homework was to review the modelling tree for the demand and transformation sectors in the LEAP model for participant countries. The participants had to make suggestions how to improve the tree based on the data identified in the Task 1. This could be, for instance, disaggregation of the residential sector by end-use or by types of buildings; disaggregation of the services sector by branches, by end-uses, or by types of buildings; further disaggregation of transport or industry, etc. The tree had to include the following sectors considering only GHG emissions from energy use: buildings (including residential and services), transport, industry, electricity and heat production and distribution, as well as agriculture and fisheries.

Further, the participants had to choose two of the above mentioned sectors (e.g. transport, industry), for which they would build later detailed scenarios to the future. The participants had to identify what historic data and assumptions about the future for the reference scenario are available for these sectors in their country in addition to Heap's data. Such data include assumptions about the development of social and economic indicators, technology stocks (shares or saturations of technologies), and energy intensities of end-uses/technologies. The participants had to provide a list of data and its sources in a note which also identified data gaps and/or data quality problems. For the chosen two sectors, the participants had to prepare detailed branches in LEAP in the "current account" view, keeping in mind data additionally identified. For the two sectors, the participants had to populate their variables with the historic input data identified until the base year. Where the data was not available, the participants had to find data in literature, obtain information from relevant experts, or make assumptions.

The 2nd homework assignment consisted of three tasks. Similar to the previous assignment, the homework 2 was based on the LEAP models for the participant countries distributed by Charlie Heaps. The first task was to improve the submissions of the previous assignments if it was necessary. Further, the participants had to identify reliable data on current costs of fuels and technologies and include this information into the LEAP model prepared in the 1st homework assignment. These assumptions as well as those made in the 1st homework assignment had to be entered into LEAP to create the reference scenario.

Finally, the participants were expected to create a High Ambition Mitigation Scenario (HAM) for their countries taking into account the EU emission targets. Doing so, they had to prepare the description of their scenario (what sectors and emissions are included, what are the characteristics, assumptions, measures, etc.). These should not be based on official sources but should reflect a very ambitious mitigation scenario which was physically feasible. Then, based on available data, the participants had to create in LEAP the HAM scenario and insert the relevant functions, with time horizon from approximately 2010 (or another convenient base year for which historical data is available) to 2030 and 2050.

The submission had to include the HAM mitigation scenario as a LEAP file as well as the brief report on the results including the discussion of costs and benefits. The participants also had to articulate under which states of the world the proposed mitigation scenario could be possible and realistic as well as under which conditions the scenario would be feasible.

Discussion of the results of homework assignments

The rest of the day was devoted to review and discuss the results of the homework assignments submitted by country groups. The discussion also included brainstorming on how to improve the models and results refining the modelling trees, overcoming data gaps and challenges. Below, the progress of each country team is summarised.

The results of homework assignment – Albania

The Albanian team prepared the modelling tree to calculate the GHG emissions of the country and identified the national data for the base year. The team made the assumptions how population growth, economic growth, final energy intensity per GDP and capita, power plant capacity and other variable will change in the reference case until 2030. Figure 3 presents the modelling results for the reference case. The figure illustrates final energy consumption by energy source and sector according in the business-as-usual.

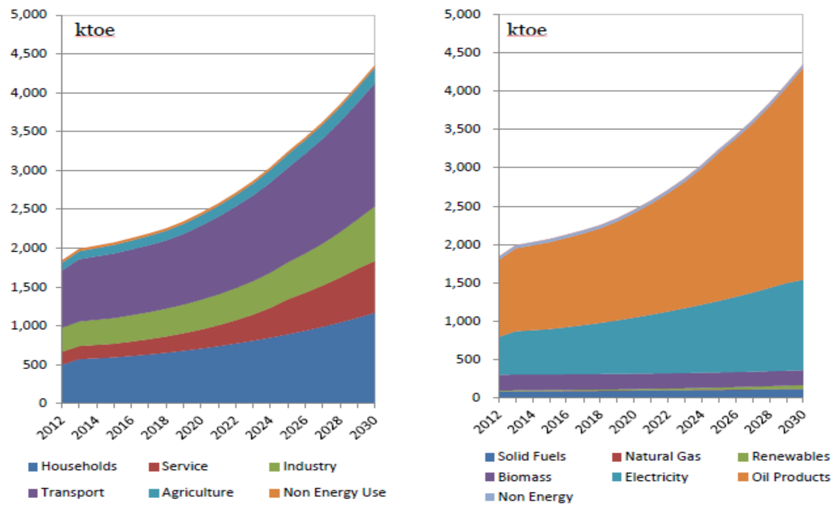

Figure 3: Final energy consumption in the baseline scenario for Albania

Further, the team made assumptions how such variables as energy intensities, power plant capacities, and other may look like in the HAM scenario modifying the baseline case. Table 1 presents the key assumptions made for the HAM scenario.

Table 1: Key assumptions of the HAM scenario of the Albanian team

Indicator	2012	2030	Average Annual Growth Rate (%)	Overall Growth (%)	Change compared to Baseline (%)
Primary energy requirements (ktoe)	2,035	4,033	3.9	97	-17
Final Energy Consumption (ktoe)	1,843	3,489	3.6	89	-20
Power plant capacity (MW)	1,721	3,221	3.6	87	11
Imports (ktoe)	1,297	2,227	3.1	72	-29
Imports of electricity (TWh)	2.5	2.5	1.6	-2	-63
GDP (€ Mill.)	9.5	21.6	4.7	127	0
Population (Mill.)	2.86	3.42	1.0	20	0
Final Energy intensity (toe/€000 GDP)	0.19	0.16	-1	-17	-20
Final Energy intensity (toe/Capita)	0.64	1.02	2.6	58	-20

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The Albanian team mostly focused on the HAM scenario for the residential sector. Figure 4 presents the results of the modelling of mitigation measures on the demand side and Figure 5 illustrates the modelling of mitigation measures on the supply side.

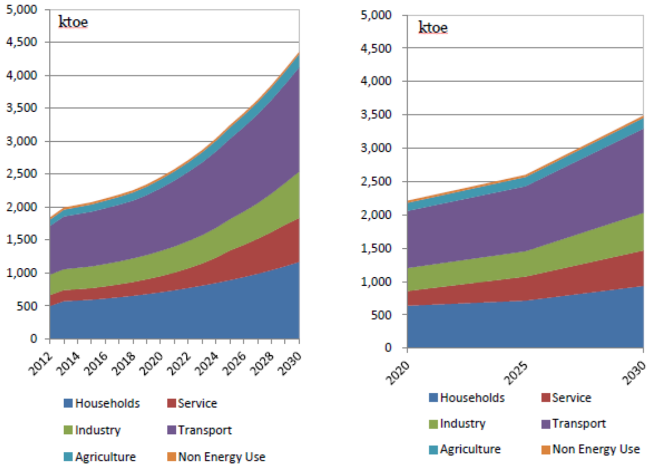


Figure 4: Final energy consumption in the baseline (left) and energy efficiency (right) scenario for Albania

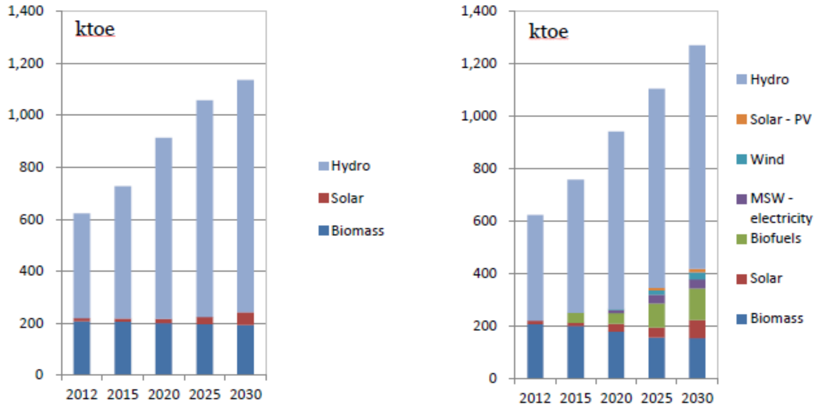
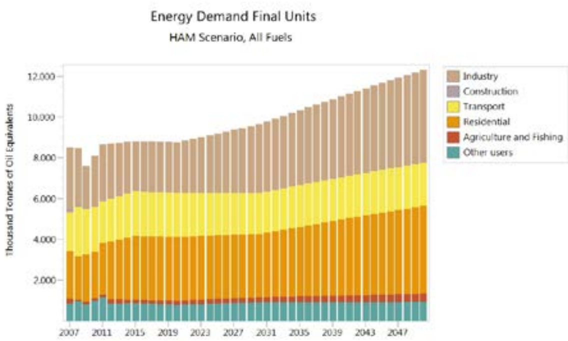


Figure 5: Electricity production in the baseline (left) and HAM scenario (right) for Albania

The results of homework assignment – Serbia

The Serbian team compared the Heaps' datasets with the information from such sources as the Official Gazette of Republic of Serbia, statistical yearbooks, technical reports of Electric Power Industry of Serbia (the state-owned electric utility power company), and the draft of the energy strategy of the Republic of Serbia. The team prepared the BAU and HAM scenarios for the demand side sectors and the HAM scenario for the transformation sector. Figure 6 presents the results of the team estimates for the final energy consumption in the BAU and HAM scenarios.



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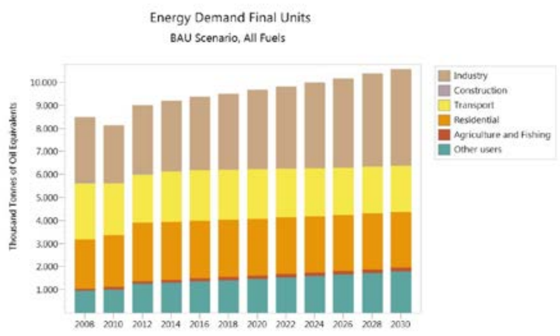

Figure 6: Final energy consumption according to the BAU and HAM scenarios, Serbia

There was a complex set of assumptions applied by the team to prepare the HAM scenario of the transformation sector until 2050. These include the decrease of capacity of in coal power plants from 4500 MWel to 2000 MWel, the increase of capacity of hydro power plants from 2835 to 3100 MWel, the decrease of capacity of old gas power plants to 0 MWel, the increase of capacity of wind from 0 to 600 MWel, the installation of the new gas power plant 600 MWel, and the installation of the nuclear power plant capacities of 2000 MWel.

Figure 7 presents the estimated GHG emissions for the demand and transformation sectors of Serbia in the HAM scenario.

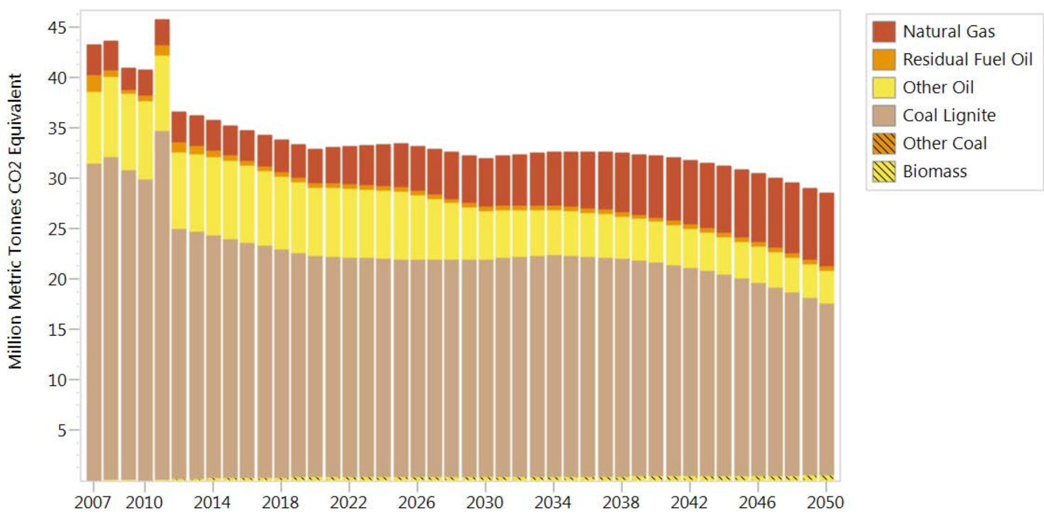

Figure 7: One hundred year GWP, direct emissions according to the HAM scenario of Serbia

The Serbian team also prepared the cost and benefit analysis summarized below:

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Cumulative Costs & Benefits: 2007-2050. Relative to Scenario: BAU. Discounted at 5,0% to year 2009. Units: Million 2009 U.S. Dollar	HAM
Demand	-1.890,2
Industry	-
Construction	-
Transport	-
Residential	-1.890,2
Agriculture and Fishing	-
Other users	-
Transformation	-109,2
Distribution_Losses	-
Own Use	-
Electric Generation	-109,2
Resources	7.379,2
Production	7.379,2
Imports	-
Exports	-
Unmet Requirements	-
Environmental Externalities	-
Non Energy Sector Costs	-
Net Present Value	5.379,8
GHG Savings (Mill Tonnes CO2e)	384,8
Cost of Avoiding GHGs (US Dollar/Tonne CO2e)	14,0

The results of homework assignment – Montenegro

The Montenegrin team prepared the reference and HAM scenarios until 2050 for all sectors paying special attention for the electricity generating and two industrial sectors, iron and steel as well as non-ferrous metals. The historical data was located and inserted by the team into the modelling tree for these sectors. The team also located the information on the costs of fuel and technologies.

To build the business-as-usual scenario, the team applied the following assumptions. The GDP was assumed to grow at the 3.7%/yr. to reach USD 5.2 billion in 2030 and USD 10.6 billion in 2050. The population was assumed to grow at 0.3% and reach 652 thousand inhabitants in 2030 and 692 thousand in 2050. Further, the team made assumptions on fuel shares and efficiency improvements in energy using and producing sectors in the baseline and HAM scenarios. Table 2 presents these assumptions.

Table 2: The assumptions of the reference and HAM scenarios of the Montenegrin team

Sectors	Historical total energy	Fuel share	End year value Reference scenario	End year value HAM
Residential	Growth 1%	Electricity	2030, 41%	2030, 38%, 2050,30%
		Residential fuel oil	2030, 0%	2030, 0%
		Diesel	2030, 0.5%	2030, 0.5%
		Coal lignite	2030, 0%	2030, 0%
		LPG	2030, 0.3%	2030, 0.3%
		Solar photovoltaics	2030, 0.5, 2050, 2%	2030, 2, 2050, 5%
		Solar thermal	2030, 0.5, 2050, 2%	2030, 2, 2050, 10%
		biomass	remainder	remainder
Agricultural and fishing	Growth 5%	electricity	Growth 21%	Growth 21%
Services	Growth 3.5%	diesel	remainder	remainder
		biodiesel	2050, 30%	2050, 50%
services	Growth 3.5%	Electricity	remainder	remainder
		Coal lignite	2030, 0%	2030, 0%
		LPG	2030, 5%	2030, 5%

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		Other oil	2030, 0%	2030, 0%
		biomass	2050, 20%	2050, 20%
		Solar photovoltaics	2030, 2, 2050, 5%	2030, 5, 2050, 10%
		Solar thermal	2030, 2, 2050, 5%	2030, 5, 2050, 10%
Transport - road	Growth (2.5%)	Diesel	Remainder	Remainder
		Motor gasoline	2050, 20%	2050, 15%
		Other oil	2030, 0%	2050, 0%
		Biodiesel	2030, 30%	2050, 30%
		CNG	2030, 30%	2050, 30%
		electricity	2050, 10%	2050, 20%
Transport - rail	Growth (2.5%)	Electricity	2030, 100%	2030, 100%
		Diesel	2030, 0%	2030, 0%

The aluminium and steel industrial branches are very important for Montenegro because the share in total energy consumption is very high. In the past, the aluminium plants consumed more than 40% of total electricity in Montenegro; nowadays they consume much less. By 2020, the team assumed that the electricity consumption of aluminium plants will again grow. This is because of the growing production of aluminium (value added assumed to grow from USD 83.2 to 200 million). It was also assumed that the value added of the iron and steam sector will grow at 3%/yr.

Table 3 presents the assumptions of the reference and HAM scenarios of the Montenegrin team for the transformation sector.

Table 3: The assumptions of the reference and HAM scenarios of the Montenegrin team for the transformation sector

	Reference scenario	HAM scenario
Losses	Interp(2014, 19.5, 2030, 8, 2050, 7)	Interp(2014, 19.5, 2030, 8, 2050, 5)
Electricity generation		
TPP Pljevlja	Step(2018,100,2024,0) MW	Step(2018,100,2024,0) MW
Hydro small	Step(2012, 8.7, 2015, 33.6, 2016, 36.6, 2017, 38.6, 2018, 80.6, 2019, 87.6, 2025,120.9) MW	Step(2012, 8.7, 2015, 33.6, 2016, 36.6, 2017, 38.6, 2018, 80.6, 2019, 87.6, 2025,120.9) MW
Wind	118 MW	189.7 MW
New hydro	406 MW	406 MW
TPP Pljevlja II block	220 MW	-
biomass	-	29.3 MW
solar thermal	-	31.5 MW

The team estimated that in 2011 the GHG emissions of Montenegro were 2513 thousand tCO_2eq. The team calculated that the national emissions in 2030 of the reference scenario will be higher than those in the base year. The efforts of the HAM scenario may help to the 2030 GHG emissions below their level in the base year (Figure 8).

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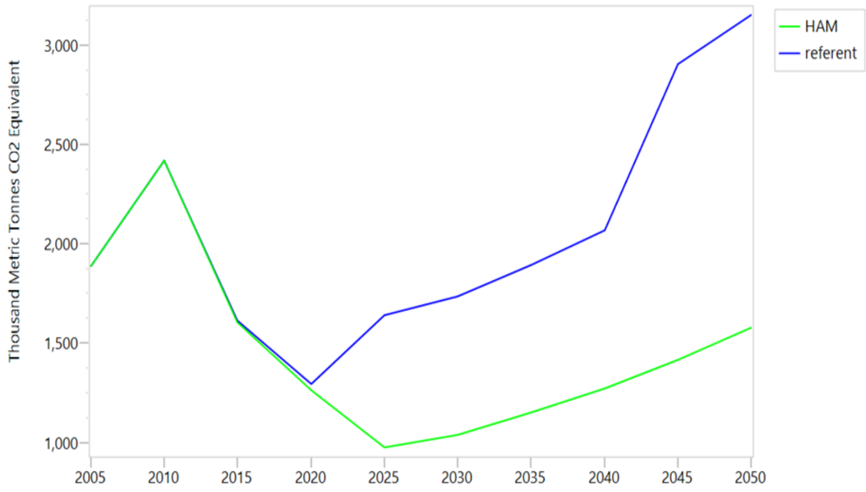

Figure 8: One hundred year GWP, direct emissions in the reference and HAM scenarios of Montenegro

The Montenegrin team also prepared the cost and benefit analysis summarized below:

Table 4: Cost and benefit analysis, Montenegro

Cumulative Costs & Benefits: 2005-2050. Relative to Scenario: referent. Discounted at 5.0% to year 2005. Units: Million 2005 U.S. Dollar	
	HAM
Demand	94.61
Residential	-
Agriculture and Fishing	94.61
Services	-
Industry	-
Transport	-
Transformation	-180.94
Distribution_Losses	-
Own Use	-
Electric Generation	-180.94
Resources	-94.21
Production	-121.37
Imports	27.16
Exports	-
Unmet Requirements	-
Environmental Externalities	-200.02
Non Energy Sector Costs	-
Net Present Value	-380.56
GHG Savings (Mill Tonnes CO2e)	25.58
Cost of Avoiding GHGs (U.S. Dollar/Tonne CO2e)	-14.88

The results of homework assignment – the former Yugoslav Republic of Macedonia

The team prepared the reference and HAM scenario until 2030. The team relied on the following sources of information: country energy balances (2006-2011), the UN World Population Prospects 2015 to understand the population projections, GDP data, and GHG emission factors, including country-specific lignite emission factor.

The team designed the modelling tree for the residential and transformation sectors. The residential sector was into urban and rural sub-sectors. For the transformation sector, additionally CHP and heat plants were modelled. The team assumed the domestic production instead of import for lignite, hydropower, renewable energy and heat.

The team estimated in LEAP that the total GHG emissions in 2011 were 9,504 thousand tCO_2eq. According to the former Yugoslav Republic of Macedonia Inventory, these emissions are 9,559 thousand tCO_2eq. The difference in these estimates is ca 0.5% and it takes place due to the difference in emission factors assumed and some differences in the input data on transport consumption.

The team constructed the baseline scenario applying assumptions on how hydropower capacity and electricity production at lignite power plants will change in the future. The team thought also thought it is a priority to make assumptions on the changes in space heating and cooling demand for the residential sector. The Figure 9 presents the final energy consumption estimated by the team for different energy end-use sectors of Former Yugoslav Republic of Macedonia in the reference scenario.

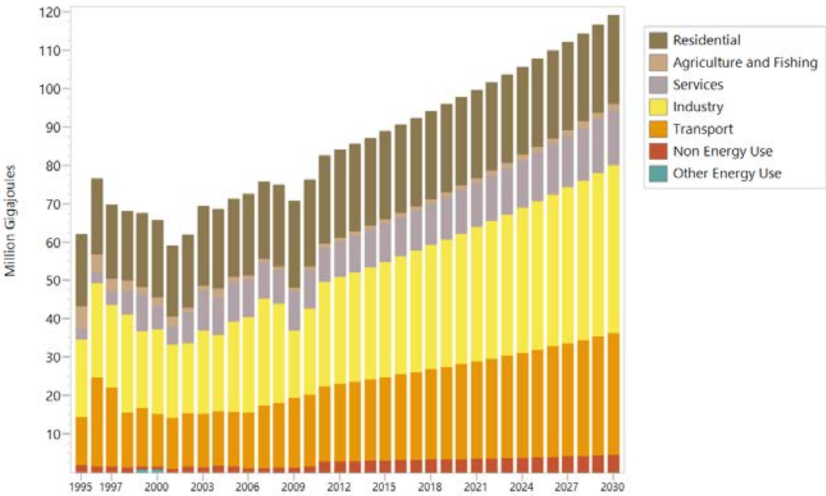

Figure 9: Final energy consumption in the reference scenario, the former Yugoslav Republic of Macedonia

For the HAM scenario, the team applied the following set of assumptions. New electricity generation capacities based on wind, solar PV, solar rooftop, hydro, and natural gas will be installed. The existing lignite power plants will be phased out in 2017 – 2021. Figure 10 presents electricity generation by feedstock fuel in the HAM scenario.

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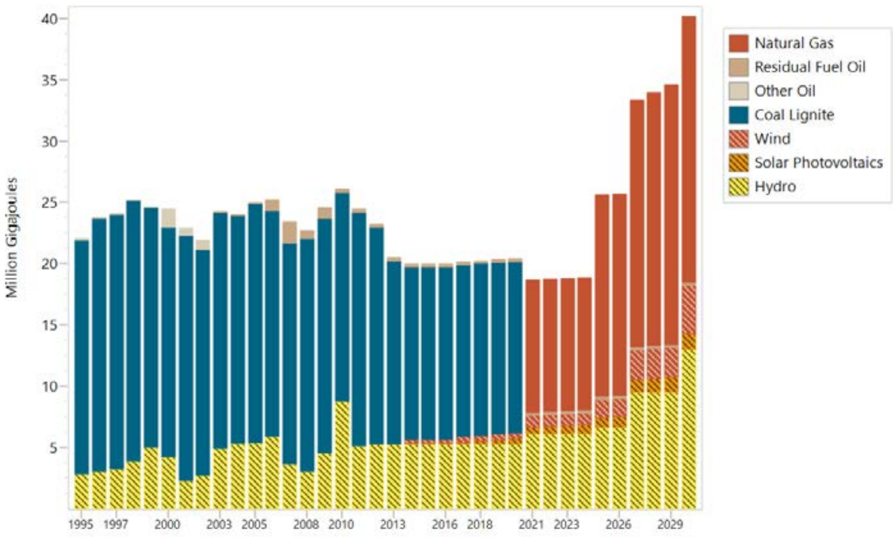

Figure 10: Electricity outputs by feedstock fuel, HAM scenarios of the former Yugoslav Republic of Macedonia

In the residential sector, the share of natural gas in the energy mix will be 10% in 2030, the same shares of LPG and biomass in the energy mix will remain the same over time, and diesel will be replaced by natural gas. The electricity demand will decrease by 1%/yr. in the urban areas and by 0.5% in the rural areas. In the transportation sector the team assumed the increase of electricity use from 1% in 2020 to 10% in 2030. The team further assumed the replacement of coal and diesel by natural gas in the iron and steel industries.

As a result of these assumptions, the low carbon measures assumed in HAM can help reduce GHG in 2020 by 54% as compared to the base year.

The results of homework assignment – Kosovo*

For social and economic data, the Kosovar team relied on the information from the Kosovo* Statistical Agency, the Ministry of Economic Development and from the Ministry of Environment and Spatial Planning. In 2011, 38.3% of country's population lived in urban areas and the rest in rural areas. The total number of households in 2013 was 319,009 and the average household size was 5.68 persons.

The team compared the energy balances provided in LEAP by Charlie Heaps and the energy balances available from the Ministry of Economic Development. This comparison is presented in Table 5.

Table 5: Comparison of Kosovo* energy balances from LEAP and from the Ministry of Economic Development

Energy Balance for Area "Kosovo*_3.1"	2010LEAP	2010	2011LEAP	2011	2012LEAP	2012	2013LEAP	2013
Production	-	1860.77	-	1792.63	-	1746.64	-	1790.140
Imports	2,601.1	574.77	2,332.8	702.28	2,341.1	668.82	2,348.1	637.730
Exports	-		-		-		-	
From Stock Change	-		-		-		-	

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Total Primary Supply	2,601.1		2,332.8		2,341.1		2,348.1	
Electric Generation	-1,278.9		-1,005.2		-1,008.6		-1,010.8	
Own Use	-51.7		-59.3		-59.6		-59.8	
Distribution and losses	-81.0		-74.4		-74.7		-75.0	
Total Transformation	-1,411.5		-1,138.9		-1,142.9		-1,145.5	
Statistical Differences	-		-		-		-	
Residential	461.6	461.67	465.9	490.51	470.2	473.73	474.6	495.520
Agriculture and Fishing	18.5	18.44	18.5	19.95	18.5	19.85	18.5	
Services	112.1	113.39	112.1	119.57	112.1	117.09	112.1	118.790
Industry	272.3	254.89	272.3	315.64	272.3	272.98	272.3	266.630
Iron and Steel	52.5	59.36	52.5	69.03	52.5	85.31	52.5	77.660
Chemical and Petrochemical	1.4	1.83	1.4	1.89	1.4	1.56	1.4	1.460
Non Ferrous Metals	61.7	61.75	61.7	64.47	61.7	37.72	61.7	25.550
Non Metallic Minerals	28.8		28.8		28.8		28.8	
Machinery	2.1		2.1		2.1		2.1	
Food and Tobacco	79.3	78.88	79.3	83.80	79.3	58.21	79.3	55.980
Paper Pulp and Printing	0.2	0.24	0.2	0.26	0.2	0.24	0.2	0.250
Textile and leather	0.1	0.16	0.1	0.17	0.1	0.13	0.1	0.090
Construction	-		-		-		-	
Other Industry	46.3	21.72	46.3	32.62	46.3	32.02	46.3	36.060
Transport	316.7	318.91	316.7	338.58	316.7	342.65	316.7	328.520
Road	315.7	316.52	315.7	325.44	315.7	327.38	315.7	311.110
Rail	1.0	1.15	1.0	1.21	1.0	0.99	1.0	2.420
International Aviation	-		-		-		-	
Non Energy Use	7.4	0.37	7.4	50.41	7.4	39.62	7.4	42.370
Other Energy Use	1.0		1.0		1.0		1.0	
Total Demand	1,189.6		1,193.9		1,198.2		1,202.6	

There are several conclusions, which the Kosovar* Team made, based on the analysis of the data in Table 5. First, the differences between GHG emissions calculated in LEAP and National Inventory are significant. Second, the causes of these differences are likely to result from the application of different accounting methodology and software used.

Table 6 presents the comparison of Kosovo* GHG emissions according to LEAP and GHG inventory submitted to the UNFCCC. The analysis of the table shows small differences between GHG emissions calculated in these two sources. However, Kosovo* did not systematically collect data for many sectors which makes it difficult to estimate the quality of its inventory reports.

Table 6: Comparison of GHG from LEAP and IPCC (total)

	2008	2009	2010	2011	2012	2013
LEAP	7,537.747	8,483.332	8,738.145	7,658.766	7,682.090	7,700.124

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IPCC	7,441.100	8,401.200	8,451.604	8,619.833	8,064.392	8,257.598

The Kosovo* team selected the transportation sector to model it in detail. To construct its business-as-usual scenario, the team applied a complex set of assumptions. It assumed that Kosovo* population and GDP will grow at the rate of 3.0%/yr. in the future until 2030. The assumptions used by the HAM scenario and the results obtained are presented in Table 7. According to the scenario built, the low carbon measures assumed in HAM can help reduce GHG in 2050 by factor 10 as compared to 2016.

Table 7: The results of the modelling the HAM scenario for the transport sector of Kosovo*

Year	2016	2030	2050
ROAD			
Diesel	76.87 %	35 %	20 %
Gasoline	19.81 %	2 %	1.5%
LPG and other gases	3.32	2.8 %	2.5 %
Hybrid	0.00	15 %	35 %
Natural gas	0.00	Reminder 100	Reminder 100
RAIL			
Diesel	100 %	40 %	20 %
electricity	0.00 %	60 %	80 %
ENVIRONMENTAL INDICATOR			
Tones CO2/per capita	5.7 million lit	2.85 million lit	0.14 million lit
GHG total emissions	9568 Gg CO_2eq.	4784 Gg CO_2eq.	956 Gg CO_2eq.

The results of homework assignment – Bosnia and Herzegovina

The team modelled possible pathways of GHG emissions until 2040 as well as the associated financial effects. The scenarios included S1 – a baseline scenario ("business-as-usual"), S2 – a scenario that assumed partial implementation of mitigation actions, and S3 – an advanced scenario that assumed the implementation of a comprehensive set of mitigation actions. These scenarios were modelled through the 1st biannual update report for Bosnia and Herzegovina under the UNFCCC.

The Bosnia and Herzegovina team started with the modelling of the energy sector because it is responsible for more than 70% of total CO_2 emissions in the country. The S1 scenario assumes a moderate increase in the share of electric power generated from renewable energy sources with the majority of power still being generated from fossil fuels. The S2 scenario assumes the construction of power generation plants in accordance with the relevant strategies and other data collected on planned activities. The S3 scenario assumes the intensive use of renewable energy sources and energy efficiency measures as a result of obligations assumed under international agreements. The S1 and S2 scenarios assume that CO_2 emissions from the Bosnia and Herzegovina energy sector will increase in the period 2010–2040, with the increase exceeding 100% in the S2 scenario. Under the S3 scenario, however, emission in 2040 will be similar to those in 2010. In addition, the financial analysis for the S3 scenario indicates financial benefits, which are 16% higher than in the S1 scenario. Figure 11 presents GHG emissions of the energy sector according to the scenarios described.

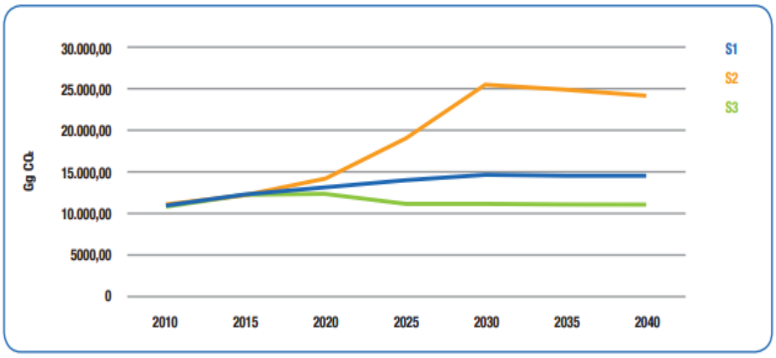

Figure 11: GHG emissions of the energy sector according to the scenarios prepared by the Bosnia and Herzegovina team

Next, the team modelled the scenarios for the transportation sector. Road transport in Bosnia and Herzegovina accounts for 90% of sector annual energy consumption (diesel and petrol). The S1 scenario is based on previously established trends of an increasing number of road motor vehicles at the average annual rate of approximately 5.8%, an average age of vehicles of between 12 and 15 years, no implementation of emission controls, and an average annual rate of increase in the consumption of diesel and petrol fuels of 3.7%. The S2 scenario assumes the introduction of additional technical measures for road motor vehicles supporting improved motor energy efficiency and reductions in fuel consumption; it also assumes the same rate of increase in the number of road motor vehicles as the S1 scenario, but with improvements in the quality of fuels and in the quality of road infrastructure. The S3 scenario is based on the assumption that by 2025 Bosnia and Herzegovina will become an EU member state, implying the compulsory implementation of EU Directives regulating this sector. The S1 scenario envisages an increase in emissions from transport by 123% by 2040 as compared to 2010; the S2 scenario envisages an increase by 72%; and the S3 scenario envisages a reduction in emissions by 37%. This reduction would help avoid external costs totalling to EUR 1.4 billion over 2015 - 2040. Figure 12 presents GHG emissions of the transport sector according to the scenarios described.

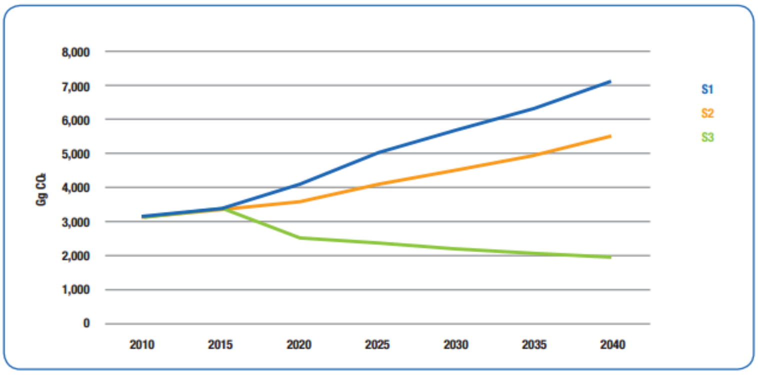

Figure 12: GHG emissions of the transport sector according to the scenarios prepared by the Bosnia and Herzegovina team

The next set of scenarios was developed for the district heating sector. The S1 scenario assumes a higher economic growth rate and a corresponding increase in energy consumption for heating. The S2 scenario assumes a lower economic growth rate, with a lower increase in energy consumption. The S3 scenario envisages a higher economic growth rate, but it also assumes numerous energy efficiency measures, resulting in a significant reduction of energy consumption. Figure 13 presents GHG emissions of the district heating sector according to the scenarios described.

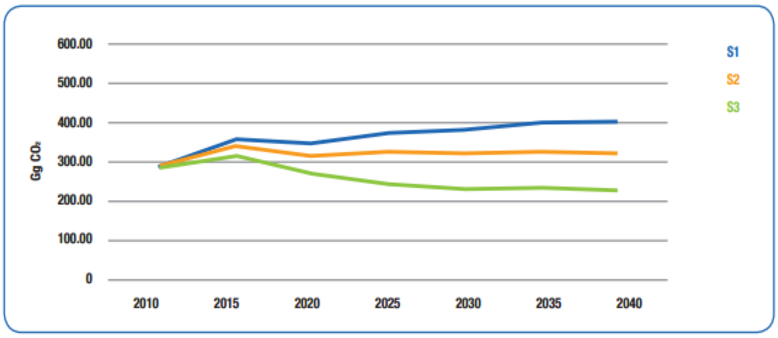

Figure 13: GHG emissions of the district heating sector according to the scenarios prepared by the Bosnia and Herzegovina team

The results of homework assignment – Turkey

The Turkish team created the demand data tree according to the energy balances of Turkey published by Republic of Turkey Ministry of Energy and Natural Resources. The tree consisted of the following sectors: residential and service buildings, agricultural energy use, industrial energy use, transport, and non-energy use. The team identified and entered into the LEAP model the historical data including GDP, value added, population and income from 1990 to 2013. The team modelled the scenarios from 2014 until 2050. There was a problem to identify the technology cost data. The transformation sector is very comprehensively modelled and utilizes hard coal, lignite, asphalt, coke, petroleum coke, briquettes, wood, waste, oil, natural gas, electricity, heat, solar, and air gas.

In the reference (BAU) scenario, the team entered the assumptions based on the majority of energy targets and policies. These include a new nuclear power plant built until 2020 having the capacity of 4800 MW, a decrease in the share of natural gas in the power sector to 30% in 2030, a decrease in electricity losses to 2012 in 2050, an increase in wind and solar power by 2030, as well as the full utilisation of hydropower potential. The share of electricity produced from natural gas is decreased by 30% percent in 2030 as compared to 2015 and it stays then constant until 2050. It was assumed that electricity exports and imports remain constant until 2050. The historical and projected exogenous capacities for the electricity production are shown in Figure 14.

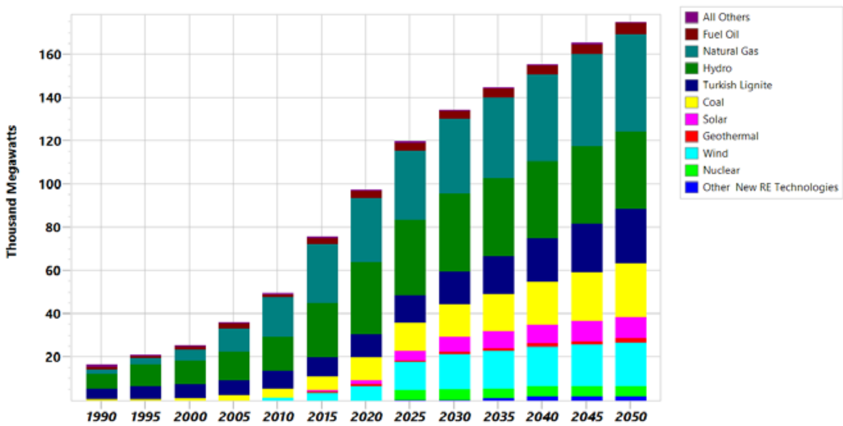

Figure 14: Power generation capacity in the business-as-usual scenario, Turkey

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The GHG emissions in Turkey from electricity production mainly originated from coal, lignite and natural gas. The team built six mitigation scenarios. All these scenarios produce the same amount of electricity but their associated GHG emissions and costs are different. All mitigation scenarios were constructed based on the BAU scenario and covered only the transformation sector. The scenarios included the maximum solar power scenario, the maximum wind power scenario, the process efficiency scenario with high efficiency natural gas, the process efficiency scenario with high efficiency coal, the high nuclear power plant scenario, and the HAM transformation scenario. The HAM transformation scenario was an integration of five other scenarios. To balance capacities and have more accurate costs results, for every capacity added to BAU, the fossil fuels capacities (lignite, natural gas and coal) were decreased equivalently. The differences of impacts between the BAU and HAM scenarios are presented in Figure 15.

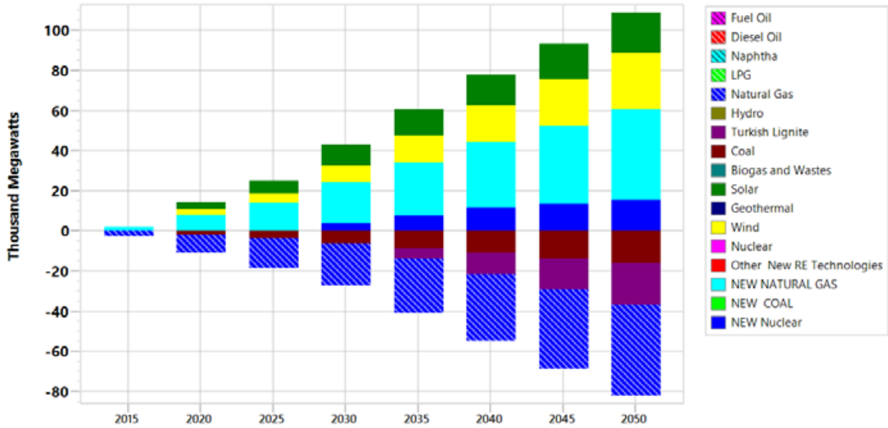

Figure 15: Differences in the power generation capacity between the BAU and HAM scenarios, Turkey

GHG emissions of scenarios and their differences compared to BAU are presented in Figure 16. The figure illustrates that the high nuclear power plant scenario may reduce the largest amount of emissions among five individual scenarios. The HAM integrated transformation scenario may reduce ca. 2/3 of emissions in 2050.

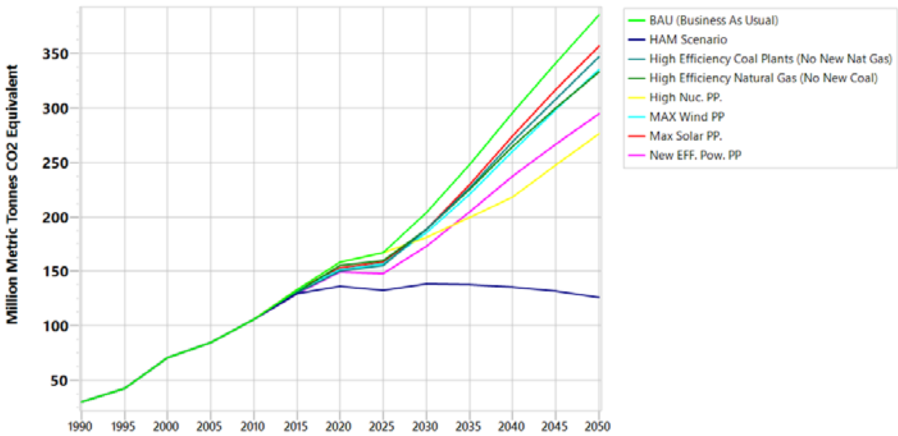

Figure 16: One hundred year GWP, direct emissions, Turkey

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The team also calculated costs and benefits of the scenarios presented in Table 8. According to the table, the high nuclear power plant scenario seems to be the cheapest solution for limiting or decreasing GHG emission, as it could be seen in the "Cost of Avoiding GHG's" line, which had a value of *5,9 $* per ton. The maximum wind power scenario takes the second place with 7.1 $/ton. The third best score share the maximum solar power scenario and the HAM scenarios with 7.6 and 8.8 per ton CO_2eq, respectively.

Table 8: Costs and benefits of the HAM scenario, Turkey

Cumulative Costs & Benefits: 1990-2050. Relative to Scenario: BAU (Business As Usual). Discounted at 5,0% to year 2005. Units: Billion 2005 U.S. Dollar	MAX Wind PP	Max Solar PP	New EFF Pow PP	High Nuc PP	HAM Scenario	High Efficiency Natural Gas (No New Coal)	High Efficiency Coal Plants (No New Nat Gas)
Transformation	6,0	4,2	23,6	9,0	35,0	12,2	7,9
distribution and lossess	-	-	-	-	-	-	-
Coke Production	-	-	-	-	-	-	-
Electric Generation	6,0	4,2	23,6	9,0	35,0	12,2	7,9
Refining	-	-	-	-	-	-	-
Resources	-	-	-4,3	-	-1,7	-4,3	-
Production	-	-	-4,3	-	-1,7	-4,3	-
Imports	-	-	-	-	-	-	-
Exports	-	-	-	-	-	-	-
Unmet Requirements	-	-	-	-	-	-	-
Environmental Externalities	-	-	-	-	-	-	-
Non Energy Sector Costs	-	-	-	-	-	-	-
Net Present Value	6,0	4,2	19,4	9,0	33,4	7,9	7,9
GHG Savings (Mill Tonnes CO2e)	854,0	551,7	1.464,9	1.538,7	3.794,2	768,6	719,6
Cost of Avoiding GHGs (US Dollar/Tonne CO2e)	7,1	7,6	13,2	5,9	8,8	10,3	11,0

Highlights Day 2: INDCs build up and the use of LEAP, the LEAP training on scenario analysis

21 April 2016, Tirana International Hotel, Tirana, Albania

<u>Assessment results of the aggregated impacts of INDCs and relevant climate impacts – Imre Csikos, ECRAN</u>

Mr Csikos started his presentation calling attention to the most recent calculations on the potential impacts of climate change. By 2100, the impacts of the current GHG emission pathways as compared to the situation without climate change may lead to having two billion people with increased water scarcity, having 70-90 million people affected by river flooding annually, having 10-12 million people exposed to heat waves annually, doubling cooling demand, losing by 50% of plant species more than half of their habitat, and having 60% of cropland less suitable for agriculture.

Climate change may also bring some benefits. For instance, some water-stressed regions may enjoy more water, some flood-prone territories could be flooded less frequently, some cropland could see an improvement in suitability for agriculture, and higher CO_2 concentrations could improve the productivity of some crops. But not all of these benefits may actually take place in practice. The degree of severity of both negative and positive impacts varies a lot among world regions.

To avoid the most serious impacts of climate change, the experts agreed on ceiling the global warming to the 2 degrees Celsius. Keeping the global warming effect to this level help avoid the exposure to heatwaves for 85% of people affected, avoid the exposure to river flooding for 80% of people affected, avoid 70% of cooling energy demand increase, avoid 75% plants species losing their habitat area, avoid 35% croplands with reduction in suitability, and avoid the exposure to increased water resource stress for 25% people affected.

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Regardless of the model used to forecast the low carbon future, the fuel mix in end-use sectors shifts to highly decarbonized electricity and other low-carbon fuels.

The delay in starting climate mitigation actions is associated with higher costs. Thus, the immediate actions to keep global warming within the 2 degree Celsius limit would cost around 1.5% of the GDP per year over 2012-2100 (present value cost, % present value GDP). The delay of the actions until 2030 would cost around 2.25% of this GDP.

Meeting a temperature target depends largely on cumulative emissions. Different pathways of annual emissions can lead to the same cumulative emissions. The later and higher the emission peak, the faster emission reductions after this peak should take place.

In October 2015, the UNFCCC issued a synthesis report of INDCs, which summarizes their outcomes for 2030. The report concluded that as at 1st October, 148 Parties submitted their INDCs, covering 87% of global population, 94% of global GDP, and 80% of global GHG emissions. The 2030 median estimate is 57 $GtCO_2e$ (range 53-59 $GtCO_2e$). The targets submitted by INDCs may reduce these emissions only by 2.8 $GtCO_2e$. The other two literature sources calculated similar range of estimates. Namely, the Climate Action Tracker estimates that the INDCs will lead to a 53-55 GtCO2e level of 2030 emissions and the AVOID 2 project calculated that INDCs will lead to a 54 $GtCO_2e$ level of 2030 emissions. The differences and uncertainties result from LULCUF accounting, the estimates of future GDP growth, the estimates of future business-as-usual emissions, and conditionality of estimates.

There have been several estimates in regard to what 2100 temperature changes could the INDCs lead to. The Joint Research Centre of the European Commission estimates that the INDCs could lead to an "around 3 degree Celsius increase", the AVOID 2 project concluded that INDCs could lead to no back-tracking a 3 degree Celsius increase, the IEA World Energy Outlook (special report) concluded on a 2.6 degree Celsius increase, the Climate Action Tracker – on a 2.7 degree Celsius increase, the MIT Energy and Climate Outlook on a 3.9 degree Celsius (assumes no new policy beyond 2030). Methods vary, but rely heavily on assumptions around post-2030 trajectory, following energy intensity improvements, continued phase-out of fossil fuels, and increasing CO_2 pricing in line with initial efforts.

According to the INDC analysis, if no mitigation actions would be taken, this will lead to a 5.3 degree Celsius increase by 2100. Actions without backtracking would results in a 3.0 degree Celsius increase whereas global coordinated actions could lead to a 2.0 degree Celsius increase. With sustained effort up to and beyond 2030, the Paris pledges will limit the severity of key impacts on people and society.

In order to meet the 2.0 degree Celsius target, we should significantly reduce GHG emissions by 2030. The earlier actions, the lower are the costs and the slower are rates of decarbonisation. The actions started by 2020 will require 1.7% global GDP annually to stay within the 2 degree Celsius threshold, whereas the actions delayed to 2030 will result in the annual costs of 2.2% global GDP. Earlier actions mean less aggressive technology deployment. Namely, much more renewable energy capacity and CCS should be installed in the case of delayed actions. Delaying actions for 10 years i.e. until 2030 means three times as much negative emissions in the 21st century. Bio-energy with CCS (BECCS) is the key to stay within the 2 degree Celsius threshold but several uncertainties remain. If bio-energy uses existing forest land, it could result in net positive emissions. Net removal of 476 GtCO2 over the 21st century is possible.

Energy efficiency can help keep costs manageable. Furthermore, with behavioural change costs are 20% cheaper than without it.

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Lessons learnt from INDC development: Albania and Montenegro – Agnes Kelemen, ECRAN

Ms Kelemen started her presentation discussing what a "good" model is. Ideally, the good model should explicitly the include modelling of individual technologies. It should include microeconomic modelling of behaviour using cost-optimization or simulation, taking account of barriers for GHG emission reduction. It should also consider macroeconomic feedbacks including the representation of economic interactions between different markets.

Second, Ms. Kelemen discussed how a "good" scenario looks like. Ideally, the baseline scenario should represent current undertakings i.e. existing policies and the mitigation scenario should be additional policies as compared to the current undertakings. Ideally, the autonomous energy efficiency improvement should be included into the baseline scenario. The level of mitigation scenario ambition should be in line with the 2 degree Celsius target. The commitment should be fair and reflect national responsibilities and respective capabilities.

It is time- and resource-intensive to build a comprehensive "good" model and a "good" set of scenarios. Ideally, the models should be developed over the course of 1-2 years and it should be updated and improved regularly. Significant financial resources and expertise are required to produce a high quality model. To maximize the use of models for policy-makers, the modellers need to have contact points within the national government to tailor the model and its outputs to the policy-maker need.

Figure 17 presents the results of modelling direct CO2 emissions for energy end-using sectors of Albania in 2010 by different models. The analysis of the figure illustrates that the results are highly dependent on the input data and assumptions used by these models. Therefore, the model and its results could be only as good as the assumptions and data.

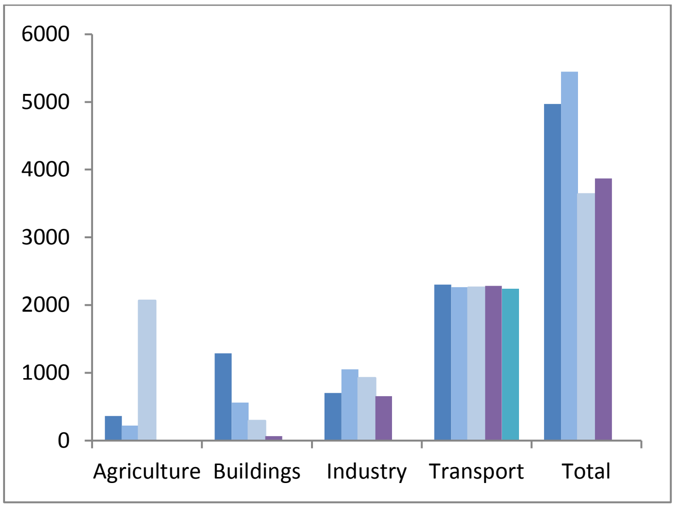

Figure 17: Direct CO2 emissions in 2010 according to different models

Unfortunately, the modellers of GHG scenarios often phase the problem of data imperfections and gaps. Especially, it is a problem for certain gases, especially PFCs, HFCs and SF6, and certain sectors, especially agriculture and land use change. However, the modellers need to develop models even if data not good or not available. This is why, it is important to focus on improving statistics as part of long-term model development exercise.

Another issue is an impact of politics and lobbying on modelling results. Models are developed to inform policy making and are therefore interesting to politicians and the sectors targeted by the policy. Industry will function according to market signals not the government's plans or informal agreements. Therefore, it is best if models inform politicians rather than the other way around.

The models should carefully treat the future. Setting long-term decarbonisation goals helps to avoid short-sighted policies or lock-in to carbon-intensive technologies. The modellers should avoid tricks such as inflating baselines. It is also the best, if the models consider autonomous improvement in energy efficiency, improvement in renewable energy technologies, reduction in the price of these technologies, more interconnections in electricity grid, EU membership, and other influencing aspects.

The lessons, which therefore the team learnt preparing an INDC for Albania and Montenegro, include the following. The team did not find really good existing models for these countries and therefore there is need to develop new models. The time and financial resources should not be underestimated. The result uncertainty due to such data issues as gaps and reliability should be taken into account. Using the models, we should always consider who stands behind them as well as we shall try to avoid the being influenced by lobbying. Preparing and using models, we need to keep the future in mind (2050 EU target, evolution of future technologies and costs, etc.).

LEAP training: scenario analysis reflecting INDC targets, Charlie Heaps

The rest of the module was devoted to in-class exercise in country groups. The groups received the data set for a non-existing country called ECRANISTAN, which is located somewhere in the Western Balkans and plans to join the EU in the nearest future. The groups had to design and model the HAM scenario for ECRANISTAN in LEAP, which reflects very ambitious targets beyond those suggested by INDCs. The groups could target the mitigation of emissions in any/all energy using and producing sectors.

Below, the results of modelling ECRANISTAN scenarios for selected country groups are summarized. All groups successfully completed the exercise and created scenarios, which reduce GHG emissions reductions at least by half as compared to the business-as-usual scenario of ECRANISTAN in 2050. Each group had to present their results during 15 minutes.

ECRANISTAN scenarios prepared by the Serbian team

The Serbian team aimed to help ECRANISTAN become an EU Member State complying with the EU directives related to energy and climate. For this, the team aimed to reduce the direct and indirect GHG emissions by at least 50% in 2050 as compared to the business-as-usual scenario.

In the residential sector, the team considered energy efficiency and fuel switch in many energy services. Thus, for lighting the team assumed phasing out incandescent lights by 2020 and increasing the share of LED lights to 80% in 2050. For space heating, the team assumed a reduction of liquefied petroleum gas (LPG) use, a reduction of direct electricity heaters, and an increase of the heat pumps. The team also assumed the efficiency improvement of wood and natural gas stoves. Furthermore, the team assumed thermal efficiency retrofit of buildings to reduce their energy demand. For water heating, the team assumed fuel switch from LPG and electric direct heaters to natural gas and solar thermal water heaters. For cooking, the team assumed the technology switch from electricity conduction and LPG stoves to electricity induction and natural gas stoves. The efficiency of air conditioning, refrigeration and other uses was assumed to improve.

In the agricultural sector, the team assumed the introduction of renewable energy sources and the changes in shares of other energy sources. Thus, the team assumed 0% share of oil and coal on one hand and the higher than before share of electricity, natural gas, biofuels, solar, and geothermal on the second hand in 2050. In the services sector, the team assumed also the changes in fuel shares (coal, oil, natural gas, electricity, and solar).

In the chemical and petrochemical industrial branches, the team assumed the improvement of energy efficiency, which should lead to a decrease of final energy intensity. The team also assumed fuel switch from coal and oil to natural gas and electricity. In the non-ferrous metal industrial branch, the team planed a decrease of final energy intensity due to efficiency improvement. In the food & tobacco branch, the team assumed fuel switch from coal and oil to natural gas and electricity.

In the transport sector, the team assumed an increase in the share of rail transport for passengers and freight. For the road transport, the team planned more hybrid, electric, and compressed natural gas (CNG) cars over time as well as the introduction of biofuels. The cars are supposed to partially switch to electricity, biodiesel, and CNG from petroleum products. Similar, the rail transport is supposed to switch from petroleum products to electricity and biofuels.

In the transformation sector, the team assumed the reduction of electricity losses as well as the introduction of new coal technologies. The results of the team modelling are presented in Figure 18.

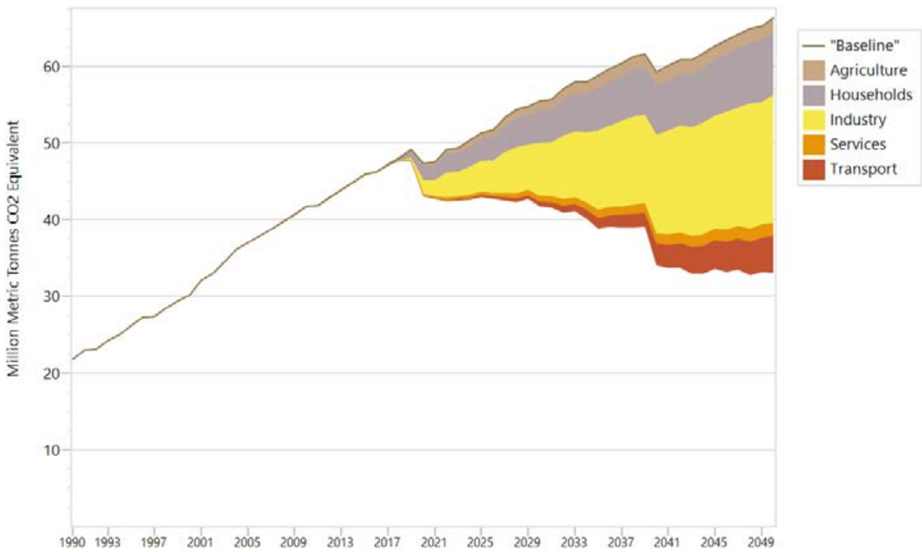

Figure 18: One Hundred Year GWP, direct and indirect emissions, HAM Scenario Differences vs. Baseline

ECRANISTAN scenarios prepared by the Bosnia and Hercegovina team

The team planned the reduction of GHG emissions for ECRANISTAN during the period of 2017-2050. In order to realize these emission reductions, the team designed a comprehensive energy efficiency strategy and a fuel switch strategy. These strategies rested on higher energy efficiency in the

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household sector, fuel switch in transport and industry sectors, new technologies in the housing sector, lower prices of new renewable energy based vehicles and machinery, measures promoting public, railway and air transport, and investing in renewable electricity production (hydro, solar and wind). Table 9, Table 10, Table 11, and Table 12 present these assumptions in detail.

Table 9: Assumptions for the residential sector in the HAM scenario, 2017-2050

	Fuel switch	Efficiency
Lighting	-	Incandescent lightning decreased from 68% (2017) to 10% (2050); Fluorescent lightning from 30 to 45% Led 2- 45%
Cooking	-Natural gas 30- 20 %, LPG 30-20%	Electricity induction 0% -60 % , Electricity conduction 50 -0%
Space heating	Electricity direct 20%-30% Heat pumps 0% - 40% Natural gas 30%-5% LPG 30 -5 % Wood pellet 5% (no change) Biomass 15% (no change)	
Air conditioning	-	Existing 100% -20% Ideal 0 -80%
Water heating	Solar 10% - 50% Natural gas 30-5% LPG 30-5% Electricity 30-40 %	
Refrigeration	-	Existing 100% -20% Ideal 0 -80%
Other	-	Existing 100% -35% Ideal 0 -65%

Table 10: Assumptions for agriculture in the HAM scenario, 2017-2050

	Fuel switch	Efficiency
All	Coal28% - 5% Oil 39% -10% Biofuels 0-60% Electricity 33-25%	-
	Services	
All	Coal 11%-0% Oil 50-20% Natural gas 7-25% Electricity 32 -55%	
	Industries	
Petrochemical	Coal 36%-5%	-
Non-ferrous metals	Coal 30-5%	-
Machinery	Coal 32-5% Natural gas 5-15%	-
Food & Tobacco	Coal 57-7%	-
Pulp & Paper	Coal 52-10%	-
Other	Oil 40-25%	-

Table 11: Assumptions for the transport sector in the HAM scenario, 2017-2050

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	Fuel switch	Efficiency
Road	Passengers: Hybrids 2-30%, Electric 0-15% Freight: Oil 100% -40% Biodiesel 0-60%	
Rail	Oil 90%-0%, Electricity 10-100%	Passengers 35-50%, Freight 30-60%
Air	-	Passengers 6-15%
Water	Oil 100-60% Biofuels 0-40	
Pipeline	Electricity 0-30%	

Table 12: Assumptions for the electricity generation and distribution sector, 2017-2050

Electricity losses	**2017 18.7% - 2% 2050**
Electricity generation – processes – importance factor:	
Solar	2017: 0.5 – 2050.: 4
Wind	2017: 0.5 – 2050.: 5
Hydro	2017: 0.5 – 2050.: 10
New coal	2017: 0.5 – 2050.: 4
New natural gas	2017: 8 – 2050.: 4
Oil	2017: 3– 2050.: 1

Figure 19 presents the impact of the HAM scenario on the GHG emissions as compared to the baseline scenario for all sectors. The figure shows that the strategies planned by the team could mitigate more than 50% of GHG by 2050.

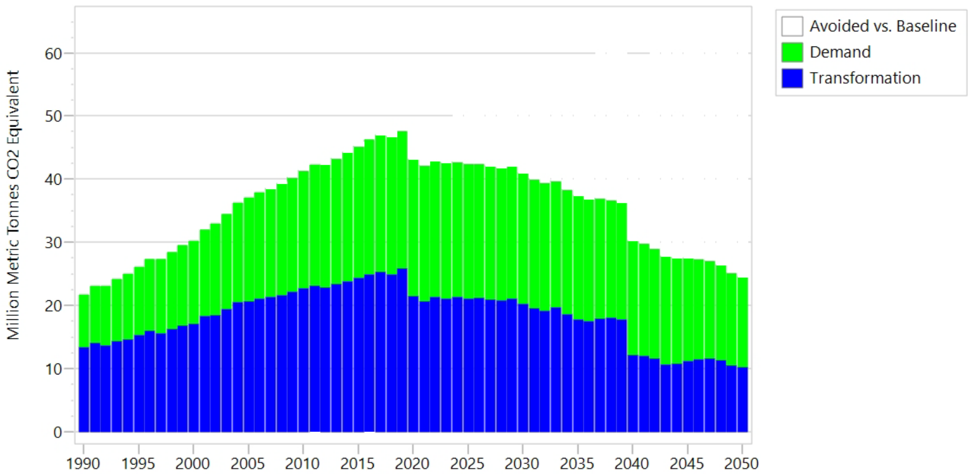

Figure 19: One hundred year GWP, direction emissions, avoided emissions (white) vs baseline

<u>ECRANISTAN scenarios prepared by the Kosovo* team</u>

The Kosovo* team prepared the HAM scenarios focusing on the reduction of GHG emissions in the most emitting end-uses and sector segments. Thus, the team especially focused on energy efficiency and fuel switch in the residential space heating, petrochemical industry, non-ferrous industry, and road transport. Figure 20 presents the avoided emissions and the remaining emissions broken down into the emissions of the energy demand sectors and the transformation sector in the HAM scenario.

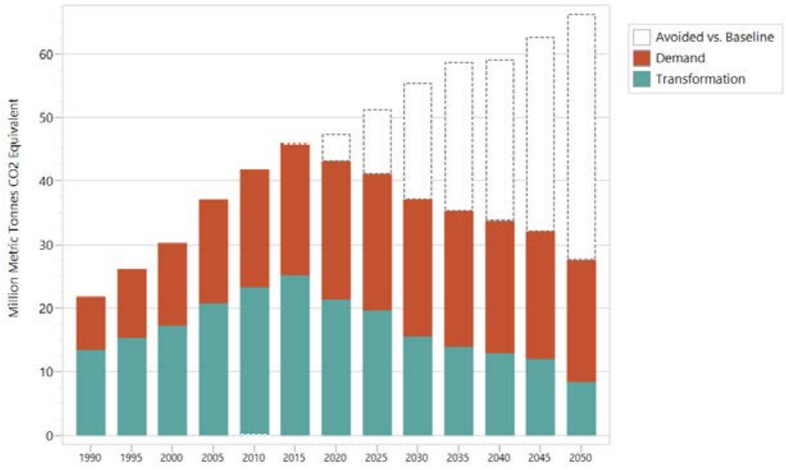

Figure 20: One Hundred Year GWP Direct At Point of Emissions HAM Scenario Wedge vs. Baseline

Highlights Day 3: Experiences with the application of LEAP in scenario work in the last years

22 April, 2016, Tirana International Hotel, Tirana, Albania,

LEAP training: scenario analysis reflecting INDC targets, Charlie Heaps

In the morning of Day 3, the country groups continued to present the results of the in-class modelling exercise.

ECRANISTAN scenarios prepared by the Montenegrin team

The Montenegrin team modelled the HAM scenarios for all energy using sectors for ECRANISTAN including the household, services, agriculture, and industrial. The team applied energy efficiency measures, fuel switch measures, and modal shift for transport. These measured allowed to reduce emissions by more than 50% by 2050 as compared to the baseline scenario. Figure 21 presents the avoided emissions and the remaining emissions broken down by end-uses or branches in the HAM scenario.

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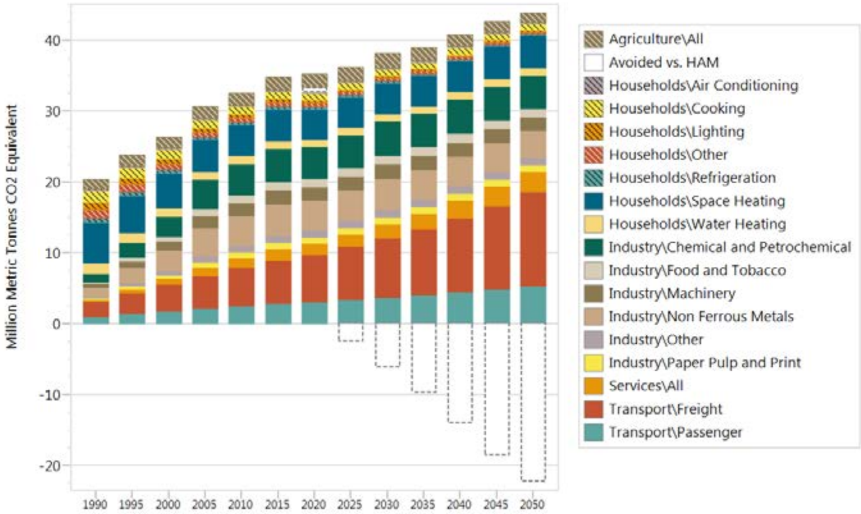

Figure 21: One Hundred Year GWP, direct and indirection emissions, avoided emissions in the HAM scenario vs the baseline scenario

Table 13 presents the results of the cost and benefit analysis prepared by the Montenegrin team for the HAM scenario.

Table 13: Cumulative costs and benefits of the HAM scenario vs the baseline scenario, 1990-2050

	HAM
Demand	5,286.8
Households	-5.2
Agriculture	-
Services	-
Industry	2,066.9
Transport	3,225.1
Transformation	-1,638.6
Transmission and Distribution	-
Electric Generation	-1,638.6
Refining	-
Resources	-8,084.0
Production	163.0
Imports	-8,247.0
Exports	-
Unmet Requirements	-
Environmental Externalities	-
Non Energy Sector Costs	-
Net Present Value	-4,435.8
GHG Savings (Mill Tonnes CO2e)	306.4
Cost of Avoiding GHGs (U.S. Dollar/Tonne CO2e)	-14.5

ECRANISTAN scenarios prepared by the Albanian team

The Albanian team focused on the HAM scenario for the transformation sector of ECRANISTAN. In particular, the team focused on the detailed planning of the scheduled phasing out high carbon capacity and the introduction of renewable energy capacity. Figure 22 presents the emission trends calculated for ECRANISTAN in different scenarios.

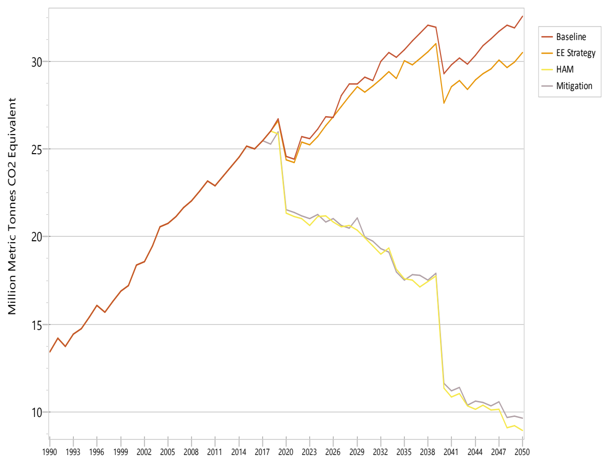

Figure 22: One Hundred Year GWP, direct emissions of ECRANISTAN

The remaining of the training was devoted to the discussion of experience of using LEAP and other modelling tools to prepare mitigation scenarios for some countries of the Western Balkans.

Electricity modelling of SLED – Laszlo Szabo, Corvinus University

Dr Szabo presented the results of the project titled "Support for Low-Emission Development in South Eastern Europe (SLED)" for the electricity sector. The work of the research team aimed to help policy-makers in Albania, the former Yugoslav Republic of Macedonia, Montenegro and Serbia to set realistic but ambitious decarbonisation pathways for their electricity sectors up to 2030. In the case of Montenegro and Albania, project results were also used in the assessment process for their INDCs.

The assessment was carried out using the European Electricity Market Model (EEMM) developed by the Regional Centre for Energy Policy Research (REKK) and the network model of the Electricity Coordinating Center (EKC). The EEMM is a detailed, bottom-up economic simulation model covering the whole European Network of Transmission System Operators for Electricity (ENTSO-E) region, while the EKC network model covers the medium- and high-voltage network of the South East European (SEE) region. The detailed description of the methodology and the results is available at http://sled.rec.org/electricity.html.

The model has the following key features. The electricity trade was modelled within the whole EU and the Energy Community Treaty countries. Hydropower generation is modelled under average rainfall conditions, but in the sensitivity assessment the impacts of dry years are also simulated. The team used benchmark costs on investment. The support for renewable energy is calculated based on global investment cost trends. The project prepared a regional assessment based on harmonized policies as well as assessments for the countries in focus. They also include Bosnia and Herzegovina.

Figure 23 shows the main results of the model, namely the competitive market equilibrium prices by countries as well as electricity flows and congestions on cross-border capacities in 2025. As the figure shows, overall 36 countries are handled in the model. Morocco, Tunisia, Turkey, Moldova, Russia and Belarus are considered as exogenous markets. In these markets the net export positions are equal with the factual one in 2013 i.e. they are assumed a baseload flow. The model is calculating the

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marginal cost of around 5000 power plant blocks and sets up the merit order country by country. Taking into consideration the merit order and exports/import, the model calculates equilibrium prices. Power flow is ensured by 85 interconnectors between countries.

Figure 23: Modelled baseload prices in 2025 (€/MWh), and the yearly trade flows

The project constructed four regional scenarios: the reference scenario, the scenario with the currently planned policies and the ambitious scenarios. The scenarios use different assumptions including carbon value, energy/excise tax, environmental standards, deployment of renewable energy technologies, deployment of conventional generation technologies, and electricity demand integrating assumptions on end-use energy efficiency improvement. The scenarios and the assumptions were agreed with the relevant ministries, transmission system operator, regulator, and electricity experts. Table 14 provides an example how the scenarios for Montenegro were defined.

Table 14: SLED scenario definition, Example of Montenegro

	Scenario assumptions	Reference GHG scenario	Currently Planned Policies GHG scenario (CPP)	Ambitious GHG policy scenario (AMB)
Taxation	Introduction of EU ETS	ETS to be introduced in 2025	CO_2 cost in 2020 is 40% of the ETS price; from 2025 ETS is introduced	ETS to be introduced in 2020
	Introduction year of minimum excise duty	Year of introduction: 2020	Year of introduction: 2020	Year of introduction: 2018

Electricity supply	Environmental standards enforcement (LCP Directive)	Due to requirements of the LCP Directive, Pljevlja I closes in 2023.	Due to the requirements of the LCP Directive, Pljevlja I closes in 2023.	Due to the requirements of the LCP Directive, Pljevlja I closes in 2023.
	RES-E deployment	NREAPs: 826 MW hydro; 151 MW wind; 10 MW PV; and 29 MW biomass by 2020. By 2030: 826MW hydro; 190 MW wind; 32 PV; and 39 MW biomass.	NREAPs: 826 MW hydro; 151 MW wind; 10 MW PV; and 29 MW biomass by 2020. By 2030: 826MW hydro; 190 MW wind; 32 PV; and 39 MW biomass.	NREAPs: 826 MW hydro; 151 MW wind; 19 MW PV; and 29 MW biomass by 2020. By 2030: 1,267 MW hydro; 229 MW wind; 32 PV; and 64 MW biomass.
	Conventional capacity developments	Pljevlja II comes online in 2023 (254 MW) and Pljevlja I closes in 2023. Maoce TPP will not be built. For the LCP Directive: Pljeva I will operate until 2023 (20,000 hours between 2018 and 2023).	Pljevlja II comes online in 2023 (254 MW) and Pljevlja I closes in 2023. Maoce TPP will not be built. For the LCP Directive: Pljeva I will operate until 2023 (20,000 hours between 2018 and 2023).	Pljevlja II comes online in 2023 (254 MW) and Pljevlja I closes in 2023. Maoce TPP will not be built. For the LCP Directive: Pljeva I will operate until 2023 (20,000 hours between 2018 and 2023). 10% biomass utilisation rate is assumed for Plejva II.
Electricity demand	Electricity demand: KAP aluminium smelter operation	According to the May 2014 Strategy (KAP operates with two lines at 100% capacity from 2019). Means 100% total presently installed capacity (A and B line).	50% of the total installed capacity, according to the agreement at the July 2015 stakeholder meeting. Only one line operating at 100%.	50% of the total installed capacity, according to the agreement at the July 2015 stakeholder meeting. Only one line operating at 100%.

The following main conclusions can be drawn from the scenario modelling presented in Figure 24. Self-sufficiency in generation in 2015 turns into a 20-30% percent export level in 2020 due to coal and hydro capacity expansion (the relative share depending on the scenario), after which this export share gradually decreases up to 2030. Other renewable energy technologies remain at moderate levels throughout the whole period. Natural gas–based generation units are utilized at a very low level, despite the new capacities built in Albania, the former Yugoslav Republic of Macedonia, Serbia and Bosnia. Carbon leakage is present in the region after 2020, irrespective of the scenario or the year.

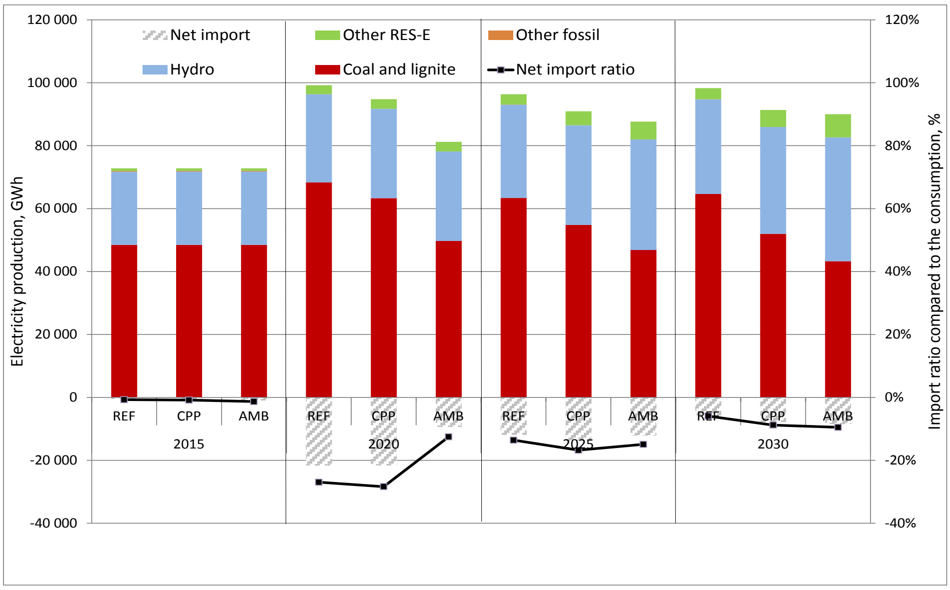

Figure 24: Regional generation mix (BA, AL, ME, MK, RS) and net import

The loss of hydro generation in years when there are unfavourable hydrological conditions is mainly substituted by imports in the first period (if it occurs up to 2020), then by coal- and lignite-based generation from 2025 onwards in most scenarios (see Figure 25). In dry years up until 2020, hydro production is substituted mainly by imports, with a limited contribution from gas, while from 2020 onwards the new coal capacities gradually increase (in Serbia and Bosnia and Herzegovina) and take a complementary role alongside imports.

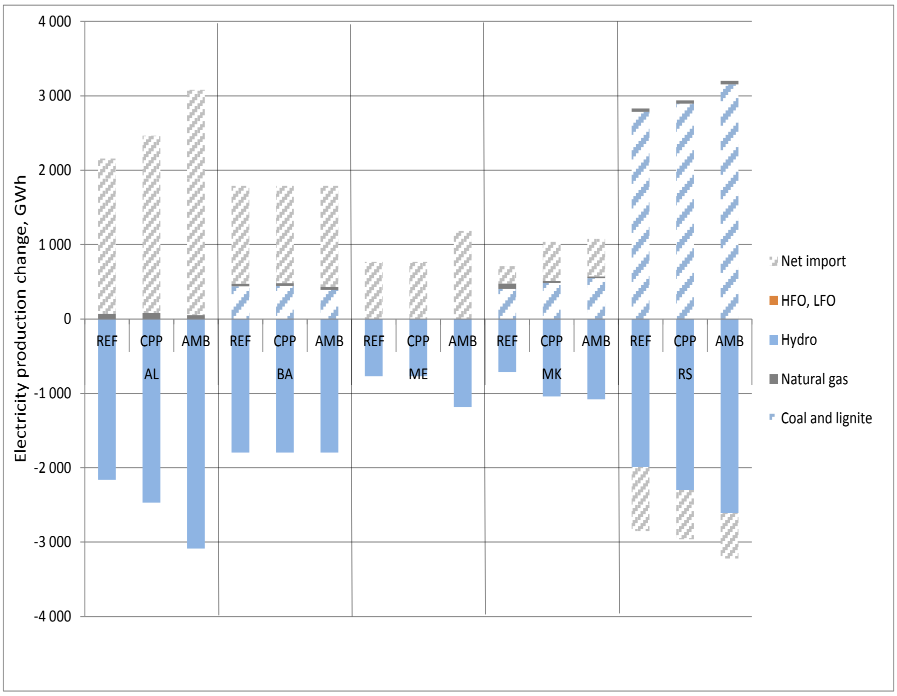

Figure 25: Generation mix change in the case of low hydro availability (2030)

A higher assumed European CO_2 price results in lower CO_2 emissions, as it is presented in Figure 26. According to all SLED scenarios, in 2030 regional producers pay the European carbon price. Coal-based production decreases gradually and is substituted by imports. This decrease in production becomes more significant at a carbon price of EUR 40/t. Gas-based production is not competitive in the region: its utilization becomes profitable at high carbon price levels.

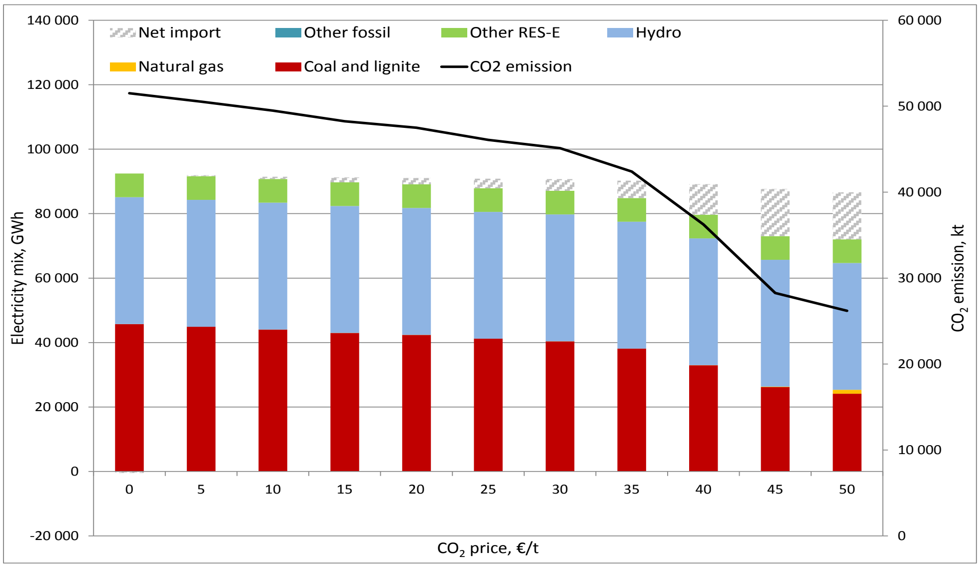

Figure 26: Regional generation mix with different CO2 prices in the AMB scenario (2030)

The overall conclusion that can be drawn from these figures is the sensitive situation of the fossil-based generation capacities in the region. The most important drivers for their utilization (both gas and coal) are: capacity expansion in coal- and gas-based, generation, capacity expansion in hydro generation, infrastructure development in the gas networks, and carbon pricing in the region and in the EU.

The national energy strategies show that an important decision has to be made in almost all countries in the region: Should they substitute the currently ageing coal- and lignite-fired generation by new lignite/coal plants, or also plan gas-based combined-cycle gas turbine (CCGT) power plants? Gas-based power plants have lower investment costs but are subject to high risks related to production quantities due to uncertainties about the availability of competitive gas prices in the region. If these gas units do not operate economically, they will constitute risky investments in the region. The dilemma is further complicated by other factors: What will be the long-term prevailing carbon price in the region? And how will demand change in the future? At higher carbon price levels (e.g. from EUR 35 to EUR 40) gas could gain a significant role in the region, which would reduce carbon emissions, and countries would avoid lock-in expensive and carbon-intensive coal- and lignite-based generation.

Modelling policy packages for the residential sector in SLED - Aleksandra Novikova, IKEM

Ms Novikova discussed with the participants her experience of using the LEAP platform for the scenario building of the residential buildings sector of Albania, Serbia, and Montenegro in the SLED project. She started her presentation asking the participants about the possible classification of the residential buildings in their countries. The participants concluded that the residential stock and therefore the modelling tree could be organized in clusters, which describe the building age, type (size), and climate zone. This is the structure, which was applied to the modelling in SLED. Further, the modelling tree contained the branching according to thermal energy uses (space heating, space cooling, and water heating), the level of performance, and energy sources.

Then Ms Novikova asked the participants on the main possible policies, which can be applied to the residential buildings sector to reduce GHG emissions. After the discussion, she described that the SLED

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had two scenarios, moderate and ambitious. The SLED moderate scenario implied that by 2050 the performance of all new and existing buildings would correspond to the building codes recently introduced by countries required by the European Building Performance Directive. The SLED ambitious scenario implied that by 2050 the performance of the largest part of new and existing buildings would be close to zero energy and carbon. The scenarios assumed the adoption of building codes and the introduction of low-interest loans and grants for building efficiency retrofit. The financial support was modelled only for the eligible share of retrofit costs.

To include the calculation of the number of retrofitted buildings by building category and the detailed financial analysis of policy tools, the number of user-defined variables was added to the model. Furthermore, many additional outcome indicators were added as user-defined. Figure 27 illustrates the modelling tree and the user-defined variables and indicators for the SLED residential model for Albania prepared in LEAP.

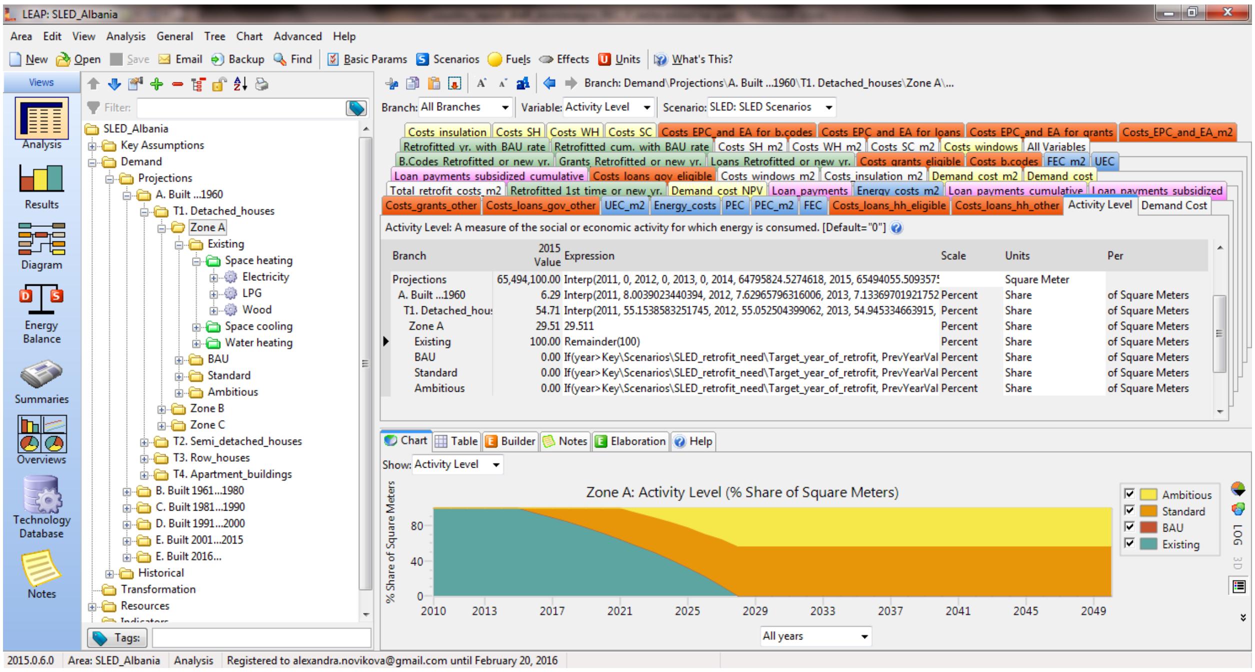

Figure 27: The illustration of the Albanian model in LEAP

The model also was prepared in a way to allows changing easily few key assumptions within given intervals and thus obtaining results, when sensitivity analysis is needed. Such assumptions were pre-modelled as discount rate, business-as-usual retrofit rate, the target year when the whole stock is retrofitted, the year of building code adoption, the shares of loans and grants, the share of eligible costs in the package of financial incentives, and others. Figure 28 presents the screen of conducting the sensitivity analysis in the Albanian model.

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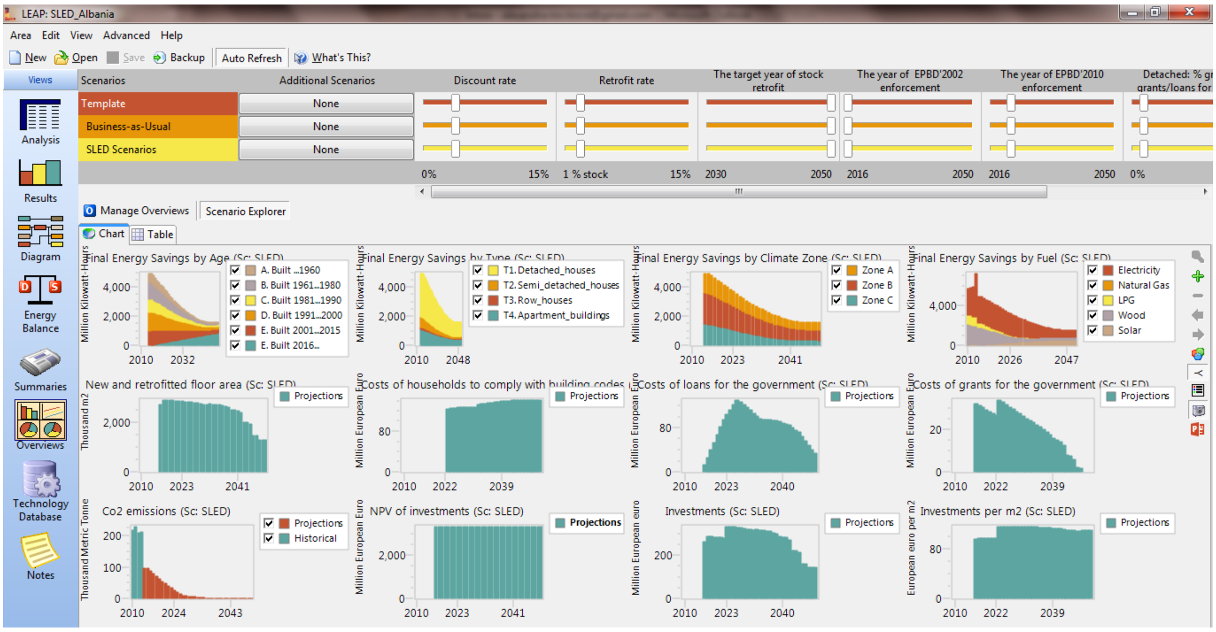


Figure 28: The illustration of the sensitivity analysis in the Albanian SLED model

In conclusion of the training, Mr. Csikos awarded the participants and trainers with certificates. The participants completed all four modules received a certificate about the completion of the whole training. The participants completed not the whole series of modules received a certificate about the partial completion of the training. Figure 29 presents the participants and trainers.

Figure 29: Participants and trainers of the modules

V. Evaluation

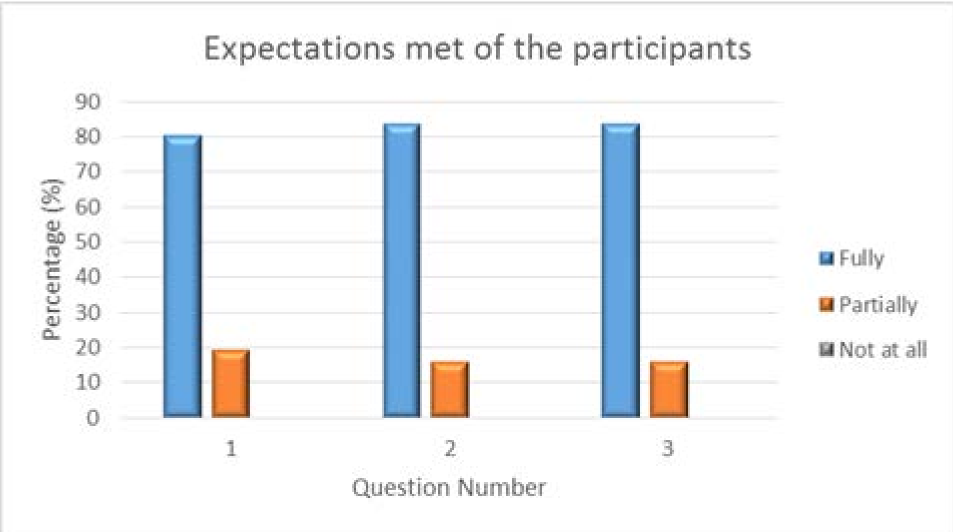
Reference is made to Annex IV for the detailed evaluation.

In the evaluation of the workshop **over a four fifths majority** of participants indicated that their **expectations were fully met** in the areas of increased understanding of the requirements to establish national systems for GHG estimations, the identified priorities for short and long-term GHG inventory improvements, the elaboration of a country specific plan for improving the national system for GHG estimations.

100% of the evaluation scores regarding the quality aspects of the workshop such as achieved objectives, overall quality, practical work, presentations, facilitators, obtained the marks 'excellent') to 'good'. The aspect on logistical arrangements had a significantly lower score than the other aspects. Almost 95% of all participants indicated that they found the workshop 'time well spent'.

My Expectations

1. Helped to implement specific policies and measures to converge with the EU climate change policy and selected EU legislation.
2. Helped to understand the connection between modelling and the implementation of INDCs and high ambition decarbonisation scenarios.
3. Provided a proper wrap up of all previous modules and helps us to take initial steps in filling the LEAP structure with country relevant data, building up the basic model.



Aspect of Workshop

1. The workshop achieved the objectives set
2. The quality of the workshop was of a high standard
3. The content of the workshop was well suited to my level of understanding and experience
4. The practical work was relevant and informative
5. The workshop was interactive
6. Facilitators were well prepared and knowledgeable on the subject matter
7. The duration of this workshop was neither too long nor too short
8. The logistical arrangements (venue, refreshments, equipment) were satisfactory
9. Attending this workshop was time well spent

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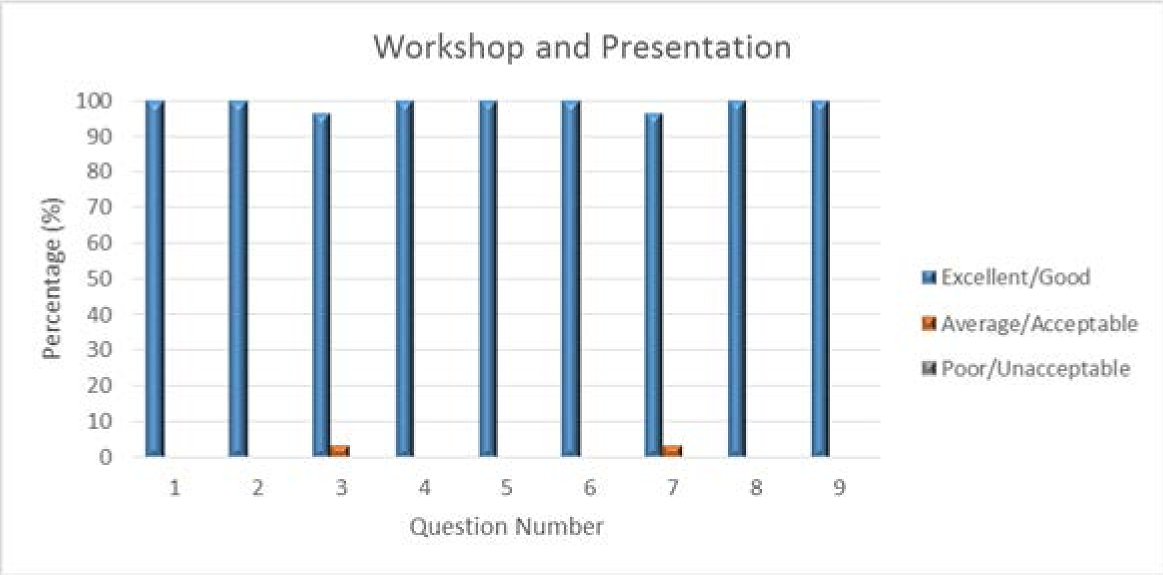

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ANNEX I – Agenda

Day 1: Wednesday 20 April 2016

Topic: Beneficiary Results from Module 3 homework and recap of previous Modules Chair and Co-Chairs: Imre Csikós and Jozsef Feiler				
Start	**Finish**	**Topic**	**Speaker**	**Sub topic/Content**
08:30	**09:00**	**Registration**		
9.00	9.15	Introduction	Imre Csikós	
9.15	9.45	Recap of Modules 1-3	Charlie Heaps, ECRAN	• Summary of which policy and modeling issues were covered in the different modules of the training program.
9.45	11.00	Policy update: COP21 outcomes	Jozsef Feiler, ECRAN	• Short description of COP21 outcomes and relevant procedures.
11.00	**11.15**	***Coffee Break***		
11.15	12.00	EU policy agenda towards the long-term climate goal.	Agnes Kelemen, ECRAN	• Presentation of EU action agenda (policies, legislation, climate finance, etc.)
12.00	13.00	Homework from the third module (1)	Presentations from beneficiaries and ECRAN/TAIEX team (15 min. each beneficiary)	• Beneficiary results on HAM (High Ambition Mitigation) scenarios • Challenges / bottle necks • Discussion on the policy options and financing needs
13.00	**14.00**	***Lunch Break***		
14.00	15.00	Homework from the third module(2)	Presentations from beneficiaries and ECRAN/TAIEX team (15 min. each beneficiary)	• Beneficiary results on HAM (High Ambition Mitigation) scenarios • Challenges / bottle necks • Discussion on the policy options and financing needs

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15.00	15.30	Recap of LEAP training from Modules 1-3 and LEAP updates	Charlie Heaps, with support of TAIEX/ECRAN trainers	• Summary of which modelling exercises and parts were covered in previous modules • Presentation of LEAP updates
15.30	**15.45**	***Coffee Break***		
15.45	17.00	LEAP training: cost-benefit analysis and other	Charlie Heaps, with support of TAIEX/ECRAN trainers	• Summary of cost-benefit analysis in LEAP and other concepts based on feedback from homework exercise. s.

Day 2: Thursday 21 April 2016

Topic: INDCs development and use of LEAP, and LEAP training on scenario analysis

Chair and Co-Chairs: Imre Csikós and Jozsef Feiler

Start	Finish	Topic	Speaker	Sub topic/Content
08:30	**09:00**	**Registration**		
9.00	10.00	Lessons learnt from INDC development: Albania & Montenegro	Agnes Kelemen, ECRAN	• How the INDCs for Albania and Montenegro were developed. • Data availability.
10.00	11.00	Assessment of the aggregated impacts of INDCs and relevant climate impacts	Imre Csikos, ECRAN	• Presentation of the UNFCCC synthesis report
11.00	***11.15***	***Coffee Break***		
11.15	12.00	LEAP training: scenario analysis reflecting INDC targets (1)	Charlie Heaps, with support of TAIEX/ECRAN trainers	• Building the scenarios with the relevant policy options.

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12.00	13.00	LEAP training: scenario analysis reflecting INDC targets (2)	Charlie Heaps, with support of TAIEX/ECRAN trainers	• Running of relevant scenarios. • Fixing of possible errors.
13.00	***14.00***	***Lunch Break***		
14.00	15.30	Comparison of HAM and INDC-based scenarios	Charlie Heaps, with support of TAIEX/ECRAN trainers	• Comparison of the mitigation scenarios already developed: HAM, INDC-based. • Commenting on the results.
15.30	***15.45***	***Coffee Break***		
15.45	16.30	Comparison of HAM and INDC-based scenarios continuation	Charlie Heaps, with support of TAIEX/ECRAN trainers	• continuation

Day 3: Friday 22 April 2016

Topic: Experiences with the application of LEAP in scenario analyses work in the last years

Chair and Co-Chairs: Imre Csikós and Jozsef Feiler

Start	**Finish**	**Topic**	**Speaker**	**Sub topic/Content**
08:30	**09:00**	**Registration**		
9.00	10.00	Lessons learnt from LEDS development in LEAP	Charlie Heaps	• Presentation of different LEAP tree structures and scenario analysis according to data availability and type of analysis. • Challenges using LEAP in scenario modelling during INDC development

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10.00	11.00	Modelling policy packages using LEAP in SLED	Alexandra Novikova, IKEM	• Examples on modelling with LEAP on residential building blocks of Albania, Montenegro and Serbia
11.00	***11.15***	***Coffee Break***		
11.15	12.00	Electricity modelling of SLED	Lászlo Szabó, Corvinus University	• Focus on arising issues in the region: Carbon taxation, network connections, RES uptake
12.00	13.00	LEAP training	Charlie Heaps	• Special Topic and • Wrap-up of remaining issues
13.00	***14.00***	***Lunch Break***		
14.00	15.30	Round table discussion on technical, human resources, financial and institutional weaknesses in the region	Charlie Heaps	• Stocktaking of progress and identification of needs/gaps. • Discussion with the teams of beneficiaries on further capacity building needs in their beneficiary. • Recommendations for relevant actions.
15.30	***15.45***	***Coffee Break***		
15.45	16.30	Conclusions		• Comments and next steps

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ANNEX II – Participants

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ANNEX III – Workshop materials (under separate cover)

Additional Workshop materials including presentations and exercises, can be downloaded from:

http://www.ecranetwork.org/Files/Workshop_Presentations_Modelling_Module_4_April_2016_Tirana.zip

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ANNEX V – Evaluation

Statistical information

1.1	Workshop Session	ECRAN modelling: Multi-beneficiary workshop on modelling: Module 4 20-22 April 2016, Tirana, Albania
1.2	Facilitators name	As per agenda
1.3	Name and Surname of Participants (evaluators) optional	As per participants' list

Your Expectations

Please indicate to what extent specific expectations were met, or not met:

My Expectations	My expectations were met		
	Fully	Partially	Not at all
1. The workshop will help me to implement specific policies and measures to converge with the EU climate change policy and selected EU legislation.	IIIII IIIII IIIII IIIII IIIII (81%)	IIIII I (19%)	
2. The workshop helped me to understand the connection between modelling and the implementation of INDCs and high ambition decarbonisation scenarios.	IIIII IIIII IIIII IIIII IIIII I (84%)	IIIII (16%)	
3. The training provided a proper wrap up of all previous modules and helps us to take initial steps in filling the LEAP structure with country relevant data, building up the basic model.	IIIII IIIII IIIII IIIII IIIII I (84%)	IIIII (16%)	

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Workshop and Presentation

Please rate the following statements in respect of this training module:

Aspect of Workshop	Excellent	Good	Average	Acceptable	Poor	Unacceptable
1. The workshop achieved the objectives set	IIIII IIIII IIIII IIIII I (70%)	IIIII IIII (30%)				
2. The quality of the workshop was of a high standard	IIIII IIIII IIIII IIIII IIII (80%)	IIIII I (20%)				
3. The content of the workshop was well suited to my level of understanding and experience	IIIII IIIII IIIII II (57%)	IIIII IIII II (40%)	I (3%)			
4. The practical work was relevant and informative	IIIII IIIII IIIII IIIII III (77%)	IIIII II (23%)				
5. The workshop was interactive	IIIII IIIII IIIII IIIII III (77%)	IIIII II (23%)				
6. Facilitators were well prepared and knowledgeable on the subject matter	IIIII IIIII IIIII IIIII IIIII II (93%)	II (7%)				
7. The duration of this workshop was neither too long nor too short	IIIII IIIII IIIII IIIII I (70%)	IIIII III (27%)	I (3%)			
8. The logistical arrangements (venue, refreshments, equipment) were satisfactory	IIIII IIIII IIIII IIIII IIII (83%)	IIIII (17%)				
9. Attending this workshop was time well spent	IIIII IIIII IIIII IIIII IIIII III (93%)	II (7%)				

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Comments and suggestions

I have the following comment and/or suggestions in addition to questions already answered:

<u>Workshop Sessions:</u>

- Excellent;
- Water was not enough the saloon;
- All the participants were certificated and this was not provided. I have followed the training programme since 2014in the 4-modules. I do not approve this certification.

<u>Facilitators:</u>

- Very good;
- Very experienced and ready to respond all questions;
- No comment;
- Charlie Heaps is the best.

<u>Workshop level and content:</u>

- Excellent;
- High level and very informative;
- Very good;
- Excellent;
- Very good.

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