Long-term Renewable Targets and Energy Efficiency Savings in the B&H Energy Sector

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Abstract — **This paper presents aspects of the regional Synenergy Strategic Planning Project final results for Bosnia & Herzegovina. The main focus of the analysis undertaken is renewable targets (biomass, hydro and wind) and energy efficiency. The energy system was modeled in a widely used, bottom-up, linear programming energy systems analysis modeling framework (MARKAL/TIMES). Four scenarios were examined: Reference, Renewable Targets, Energy Efficiency Scenarios, and a Combined scenario consisting of Renewable Targets with Energy Efficiency improvement measures; highlighting the costs and benefits of each.**

Keywords-renewable targets; energy efficiency; savings; energy sector; Markal/Times

I. Introduction

We are witnessing an enormous increase in the world's global energy demand, which is generally met by non-renewable energy sources. That enormous share, of more than 75%, leads towards eventual depletion of carbon resources, with simultaneous emission of harmful greenhouse gases.

Limited resources on the one hand, and increased demand for energy on the other, together with the need to reduce CO_2 emissions, will influence the need for alternatives and more efficient use of all forms of energy. As with its neighbours, B&H is facing the problem of rising energy demand and limited energy reserves (conventional fuels such as low caloric brown coal and lignite). Therefore, it's necessary to increase the share of renewable energy sources.

Hydro energy is most important renewable energy resource in B&H. Given the importance and availability of hydro energy, it is necessary to make additional efforts to tap the remaining potential, as only 45% of the total estimated hydro potential is being used at the moment [1]. Another important and significant domestic renewable resource is biomass, including wood and crop residues, along with wind power.

II. Scenarios and Modeling Issues

A MARKAL/TIMES model for B&H (MARKAL-B&H) has been developed under the US Agency for International Development (USAID) and Hellenic Aid-funded SYNENERGY Strategic Planning (SSP) project, and its predecessor, the USAID sponsored Regional Energy Demand Planning (REDP) project. These four year undertakings have led to the development of MARKAL/TIMES models in eleven countries in the Southeast Europe, Black Sea, and Caucasus regions. [2] The project's goal is to develop national energy modelling capacity in each of the participating countries, leading to a common technical "language" in support of the Energy Community regional energy strategy dialog. [3]

As part of SYNENERGY the B&H team has been collecting energy data, and modelling the national energy system, starting in 2006, and running eight 3-year periods out to 2030. Four scenarios were examined:

- Reference scenario – represents the business-as-usual situation;
- Renewable Targets – requiring an increased share of energy to come from renewables (e.g., hydro, wind and biomass);
- Energy efficiency– promoting the uptake of more efficient end-use devices (e.g., furnaces, air-condition), and
- Energy efficiency combined with renewable targets - examines how efficiency improvements can assist with achieving the renewables target more cost-effectively.

III. Reference Scenario

To assess the impact of different strategies or policies on the evolution of the B&H energy system, the Planning Team developed a robust Reference Scenario. This scenario represents a business-as-usual outlook against which policy choices and incentive programs can be compared.

The main data source for the model in general, as well as for this scenario, was the EIHP (Energy Institute Hrvoje Požar) Study of the B&H Energy Sector [1], produced a year earlier for the B&H government, as well as ISOBIH (Independent System Operator for Bosnia and Herzegovina) Production development indicative plan. [4]

The current Reference Scenario takes account of such specific characteristics of the national energy system as existing technology stock, domestic resource availability and import options, and near term policies in place.

Under the Reference Scenario energy consumption is projected to grow significantly, by 84% in terms of final energy by 2030, driven by projected economic growth averaging over

5% per annum. Energy intensity, an indicator of energy use per unit of economic output, goes down, pointing to a more efficient energy system in the future, while energy use per capita increases, as higher incomes lead to increasing consumption levels. These key indicators shaping the Reference Scenario are shown in Table 1.

TABLE I. PROJECTED ENERGY CONSUMPTION AND KEY ENERGY INDICATORS FOR THE REFERENCE SCENARIO

	Primary Energy (Ktoe)	Final Energy (Ktoe)	GDP (€ Mill.)	Population (000s)	Energy use per capita (toe/Capita)
2006	4,816	2979	8,619	3,557	1.35
2030	10,411	5489	37,157	4,405	2.36
Aver. Annual Growth	3.1%	2.4%	5.8%	0.9%	4.5%
Total Growth	116%	84%	331%	24%	73%

The most significant change to the type of energy being used in B&H between 2006 and 2030 is electricity consumption, which more than triples over the period, increasing its share of final energy from 28% in 2006 to more than 50% in 2030. The uses of coal and oil products gradually reduce (in relative terms), as does biomass consumption constrained by resource limits.

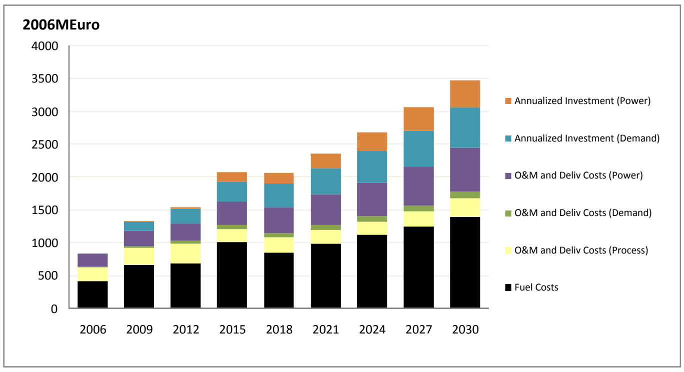

Fig.1. Energy system expenditure by cost type

The growth in the energy system will require significant levels of new investment. However, energy investments are generally expected to absorb a smaller percentage of GDP in 2030 due to the reduced energy intensity per unit of economic output. Investment expenditures are incurred as demand rises, existing power plants and devices reach the ends of their operational lifetimes and new ones are built and bought. Fig. 1 shows the evolution of these expenditures as well as expenditures incurred on fuel purchases and maintenance costs over the study horizon.

As noted earlier, the electricity generation system plays a growing role, with generation tripling by 2030. Currently, electricity generation is shared between hydro (46%) and coal (brown coal and lignite: 54%). In 2006, B&H was a net exporter of electricity, representing around 11% of total generation. Future investments in generation are allocated primarily to coal, with some investment in hydro and in gas. In 2030, around three-quarters of domestic electricity generation is from coal.

The investment required to expand the system is shown in Fig. 2. Cumulative investments of €4.7 billion will be required to fund the 4.9 GW of new capacity. Most of this investment is in new coal capacity, with €1.35 billion required in 2015 to deliver 1500 MW. Any problems with raising the necessary capital or project delays may require more expensive technology options or greater reliance on imports and should be investigated further using MARKAL-B&H.

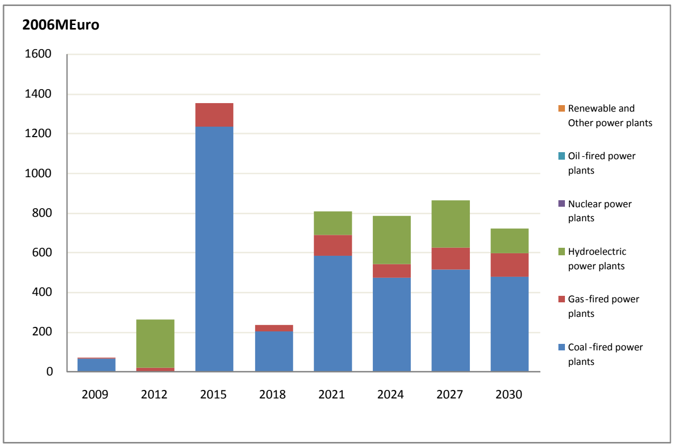

Fig.2. Investment levels (by period) in electricity generation capacity by plant type

Final energy consumption increases by 84% under the Reference Scenario, illustrating the impact of economic growth on the requirements for energy (see Fig. 3). The main change in the type of energy used is electricity consumption. Electricity is used extensively across all key end use sectors – Residential, Commercial and Industry, reducing the requirements for the direct use of other carriers. Due to the availability of cost-effective hydro and coal generation, gas is only used for peak generation.

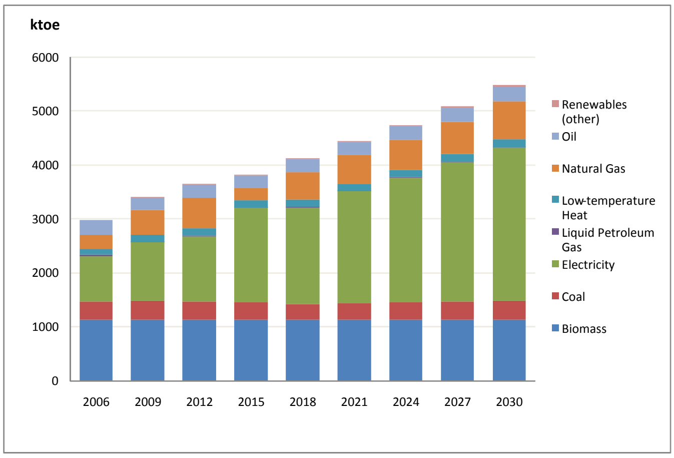

Fig.3. Final energy consumption by fuel type

IV. ASSESSMENT OF FUTURE ENERGY EFFICIENCY AND RENEWABLE ENERGY PATHWAYS

Promoting energy efficiency and renewable energy could lead to significant changes in the evolution and longer term characteristics of the energy system in B&H, as well as the levels and timing of investments. The Planning Team has undertaken policy analyses to assess the additional investment requirements of such policy goals, identify the types of technologies that need to play a key role, and the associated benefits. The analysis examined three alternative pathways for the B&H energy system in response to these programs and policies.

1. Supply Side (RE Target): Introduction of a target of 33% renewable energy (as a share of Gross Final Energy Consumption (GFEC)) in 2020, and subsequent years. This target is set based on the approach used for setting the EC targets under the Renewable Directive. In 2006, B&H had a share of 21.5% renewable energy.

2. Demand Side (Energy Savings Potential): Increase the energy efficiency of the economy by promoting greater market penetration of improved technology (up to 50% of new purchases), simulating a policy agenda setting appliance and building standards, limiting the use of inefficient devices (e.g. prohibiting incandescent bulbs) and incentivizing improved devices.

3. Combined Policy (RE+EE): Combining the analyses to explore the synergies of these policy goals.

A. Renewable Energy (RE) Targets

The key metrics for the RE target analysis are presented in Table 2. The increase in the share of renewable energy is achieved at a relatively low additional cost of 0.72% higher than the costs observed under the Reference case. In actual expenditure terms, this is an additional €169 million (discounted value) over the 25 years planning horizon. This indicates that B&H is relatively well placed to meet a high RE target in 2020.

The additional renewable energy in 2021 (of 150 ktoes) relative to the Reference is provided mainly by more hydro capacity (730MW) and new wind (600MW). By 2030, the additional renewable energy is around 500 ktoes, with 39% from hydro, 53% wind power and 8% solar end-uses (e.g. solar water heating).

TABLE II. KEY RESULTS METRICS (RENEWABLE TARGET ANALYSIS)

Metric	Units	Reference	RE Target	
			Difference	% Difference
Discounted Costs	2006M€	23,492	169	0.72%
CO2 Emissions	Kt	539,502	-52,046	-9.6%
Primary Energy	Ktoe	201,694	-8261	-4.1%
Final Energy	Ktoe	115,421	-696	-0.60%
Imports	Ktoe	32,104	-1358	-4.2%
Fuel Expenditure	2006M€	8,366	-528	-6.3%
New PP Capacity	GW	5.48	0.78	14%
New PP Capacity Investment	2006M€	5,102	2,061	40%

Over the whole study horizon the generation capacity of the system increases by 14% (780MW), while investment costs for generation rise by 40% relative to the Reference Scenario due to the need for more expensive renewable electricity sources.

The remainder of the renewables shows up in end use energy services, notably with solar water heaters. Given the technology options and data assumptions used in the modeling, this mix of technologies is considered the most cost-effective of those examined. In order to meet the 2020 target the modeling shows that investments in RE will need to start in earnest within 3 years. Without incentives to promote investment in RE, these targets will be difficult to attain.

B. Energy Efficiency Promotion and Combined Energy Efficiency - Renewables Target

The energy efficiency case was undertaken to explore the impact of promoting greater penetration of energy efficient technologies in the various end use sectors. Under the Reference Scenario the assumption is that mainly conventional technologies are chosen owing to higher upfront costs of improved efficiency technologies, coupled with lack of consumer knowledge and policy effort. This reflects a business-as-usual situation, where no additional policies have been introduced to overcome the many barriers to realising energy efficiency potential.

Achieving the RE target was also analysed in conjunction with the promotion of energy efficiency. The key result metrics for both analyses are shown in Table 3.

A key observation from this analysis is that energy efficiency cuts costs overall. The discounted system costs when achieving an increased uptake of improved efficiency devices are 3.2% lower than the costs under the Reference Scenario. This is due to the reduction on fuel expenditure over the life of advanced technology devices, which exceeds the higher investment costs of these technologies. In addition, since demand for electricity is lower, less investment on the generation side is required.

TABLE III. KEY RESULTS METRICS (ENERGY EFFICIENCY AND COMBINED ANALYSIS)

Metric	Units	Reference	Energy Efficiency	Energy Efficiency + RE Target
			% Difference	% Difference
Discounted Costs	2006M€	23,492	-3.2	-2.7%
CO2 Emissions	Kt	539,502	-7.6	-13.6%
Primary Energy	Ktoe	201,694	-5.7	-7.9%
Final Energy	Ktoe	115,421	-4.8	-5.1%
Imports	Ktoe	32,104	-5.2	-11.2%
Fuel Expenditure	2006M€	8,366	-6.6	-12.3%
Power Plant New Capacity	GW	5.48	-18.5	-0.46%
Power Plant New Capacity Investment	2006M€	5,102	-17.3	18.1%

Fig. 4 illustrates the nature of the expenditures and total savings, demonstrating the increased savings over time as the share of efficient appliances increases.

Combining EE with the RE target shows that the renewable target can be met at lower costs than seen when the target is imposed directly on the Reference case. Efficiency-induced reductions in fuel consumption lead to a lower level of renewables being needed. This effect is illustrated in Figure 4, where the additional annualized investment costs in the RE+EE case are lower than those under the RE target case.

Due to the lower fuel consumption, associated co-benefits of energy efficiency policy include lower import dependency and lower CO_2 emissions. Both are important in achieving a more sustainable system and enhancing energy security.

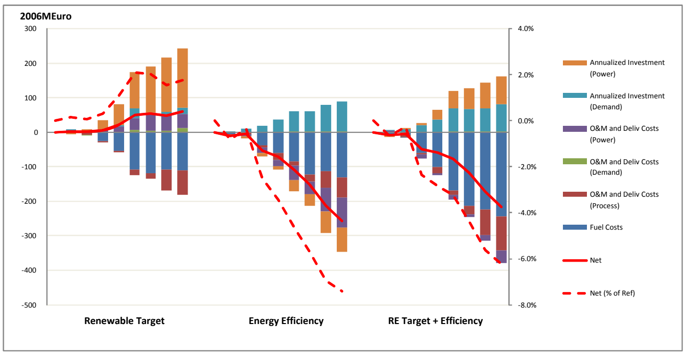

Fig.4. Costs and Savings from Renewable and Efficiency Policies

Opportunities for energy efficiency are economy wide, as illustrated in Fig. 5. This figure shows the reduction in final energy consumption by sector. The main reductions occur in the consumption of electricity and oil, with more efficient appliances used for lighting, cooling and heating in the Residential and Commercial sectors, and in the iron and steel and non-metallic mineral industries.

The reduction in electricity demand has a significant impact on both capacity and energy generation. These reductions centre primarily on coal power plants, reduced coal and electricity imports in 2030 (see Fig. 6).

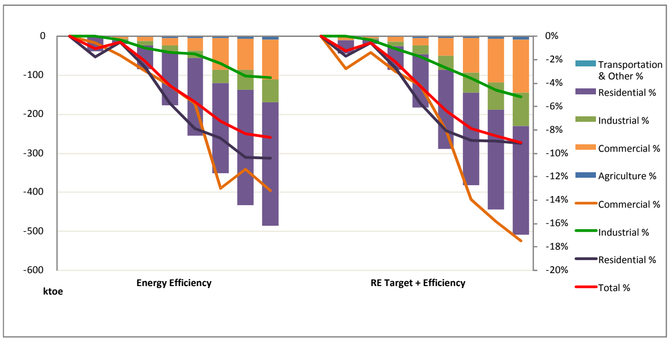

Fig.5. Change in Final Energy Consumption by sector

Under the combined RE Target and Efficiency Scenario, hydro generation levels remain higher than observed in the Reference Scenario due to the the RE target. However, the more expensive renewable are not needed in this case since the lower overall energy consumption reduces the total amount of renewable energy required.

The economic benefits observed in the analysis suggest that measures to promote improved efficiency, such as appliance standards, make real economic sense. The savings achieved through the promotion of energy efficiency devices are high enough that even the RE target can be achieved at lower cost than seen in the Reference Scenario. However, implementation costs to overcome the many barriers associated with realizing efficiency savings - consumer inertia due to uncertainty over new technologies, associated transaction costs, and supply chain constraints – are only partially accounted for and have the potential to increase the time and reduce the savings of adopting efficient technologies, though still clearly a net benefit.

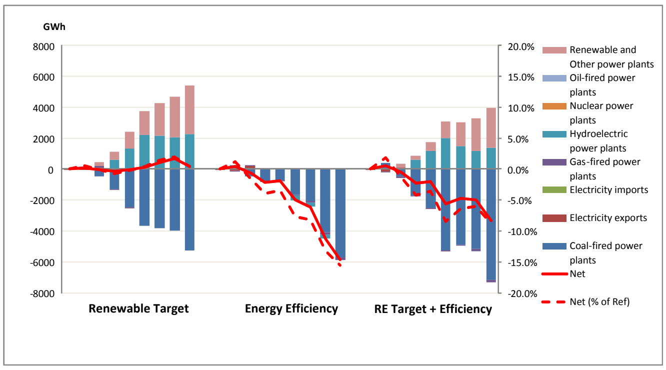

Fig.6. Difference in electricity generation relative to Reference case

V. Policy Insights from Model Analysis

A key issue in our country's energy planning community is that B&H doesn't have an energy strategy on the state level. Such a strategy should be developed and agreed upon as soon as possible, pointing out and regulating today's hot topics (hydro, wind, biomass, energy efficiency, green-house emissions, etc…) to foster an environment conducive to attracting the necessary investment.

Nevertheless, the modelling analysis provides some important insights for the policy community in B&H:

- Renewable targets are achievable at modest additional cost, and can be delivered at even lower cost if energy efficiency measures are implemented in parallel;
- Meeting the EU 2020 renewable energy targets requires B&H to achieve significant investment levels in renewable generation soon;
- The most cost-effective technologies to achieve a higher contribution from renewables are hydro and wind generation, however, wind requires incentives to reach levels necessary to meet the EU 2020 targets;
- A higher renewable generation target results in higher costs, however with important co-benefits of enhancing energy security and lowering carbon emissions;
- Mandatory appliance standards, in particular for wood stoves and heat pumps, the elimination of incandescent light bulbs, all represent measures that deserve government action to promote wider uptake of energy efficient devices.
- Economic benefits could be significant due to energy savings potential. However, the fact that these options are not currently taken up indicates significant barriers. Such barriers could reduce the apparent economic benefits due to increased transaction and policy costs associated with implementation. For example, government subsidies for specific technologies may be needed to overcome the barriers associated with higher up-front purchasing costs, or active information dissemination of information on lifecycle appliance costs.

Model results should be used as a starting point to identify the most beneficial policies and economically attractive technologies. This could help focus policy on the most promising opportunities.

VI. Future Priorities

The MARKAL-B&H model is an important analytic tool for undertaking future policy analysis, particularly as it provides a framework for assessing a number of policy goals simultaneously. The results presented illustrate how the model can serve as an assessment framework to assist with the formulation of integrated strategies and synergistic policies that will guide a sustainable evolution of the B&H energy system into the future.

For example, as B&H and other countries in the region consider low carbon opportunities, cost-effective strategies need to be identified. With the model, specific carbon targets, costs, critical technologies, and associated implications can be assessed. Even without carbon reduction targets or incentives, in the analyses reported on here total cumulative CO_2 decreases by 10.9% in the RE Target case, 8.1% under the EE case, and 15.1% under the combined case.

Some preliminary assessment of a low carbon development strategy has already been undertaken, exploring the impacts of different carbon taxes on the energy system. In particular, our analysis highlight the growing decarbonisation of the electricity generation system, typically the most cost-effective sector for carbon mitigation, with earlier additional investment in hydro power and other renewables, such as wind generation. It also suggests increased use of electricity imports (with implications for other country targets). Further analysis of a low carbon strategy remains a key objective for the Planning Team to examine in 2011.

Other policy relevant analyses being discussed include:

- analysis of various scenarios of coal, natural gas and electricity prices in the region;
- testing of the impacts of different schemes for promoting energy efficiency and renewable energy utilization (e.g. promotion of the solar thermal systems through consumer based subsidies or producer incentives), and
- further examination of requirements and pathways to meet EC targets, including related to low emission strategies.

VII. Conclusion

The discounted system costs changes of the three alternate scenarios in comparison to the Reference one are shown at Fig. 7. The total 30-year implementation cost of RE targets is higher, by less than one per cent, compared to the business-as-usual costs. In other words, over a longer period of time, investing in quite expensive renewable energy plants and technology doesn't automatically mean throwing money away. The advantages of such measures would be numerous; improved energy security, reduction of greenhouse emissions and elimination of several environmental issues, and of course reaching the 20-20-20 European goal.

For the Energy Efficiency scenario, a negative cost implies savings (about 3% relative to the Reference case). Considerable fuel cost savings opportunities are possible through the use of more efficient technologies (both on supply and demand sides).

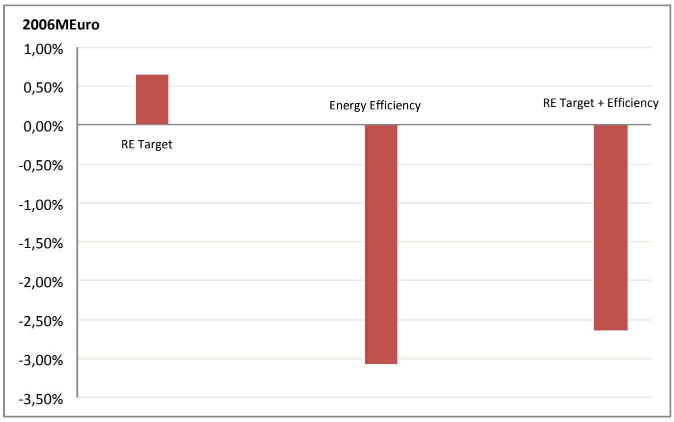

Fig.7. Change in total discounted system costs

Furthermore, the combined results indicate the best price ratio, showing that even under renewable targets savings are achievable with the increased use of efficient end-use devices.

To sum up, the importance of the whole project and this paper lies in the demonstration of the national expertise and the unambiguous results arising from these analyses. Those facts are intended for the policy makers in Bosnia and Herzegovina with an undoubted concept - the country's energy challenges can be met if the process of strategic planning starts now.

Acknowledgment

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