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TECHNO-ECONOMIC ANALYSIS: ENVIRONMENTAL DUE DILIGENCE OF RENEWABLE ENERGY TECHNOLOGIES

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Abstract: *When performing analysis (techno-economic) of renewable energy sources, the need for some kind of indicators for comparison appears.*

Although most renewable energy technologies are environmentally sound in theory, all of them can have negative impacts on the environment if poorly planned.

Development of procedures for Environmental Due Diligence of Renewable Energy Technologies and Renewable Energy-like indicators are underlined in this paper, as the instruments of comparisons and analysis.

Key Words: ***Environment, Renewable Energy, Indicators, Sustainable Development, Climate Change***

1. INTRODUCTION

The term *renewable energy* covers a number of sources and technologies at different stages of development. Renewable energy technologies such as windpower and solar photovoltaic devices have achieved major cost reductions over the last decades, which are expected to continue in the medium term as large global companies enter new energy markets for wind, solar and biomass technologies.

Renewable energy technologies are not environmental friendly *a priori*.

The environmental laws provide the background for determining the main issues that should be considered during the environmental appraisal process. There is a growing realization in energy and environmental policy and research circles.

2. DEVELOPMENT OF RE-LIKE INDICATORS

It is important to have Renewable Energy (or RE-like) indicators .

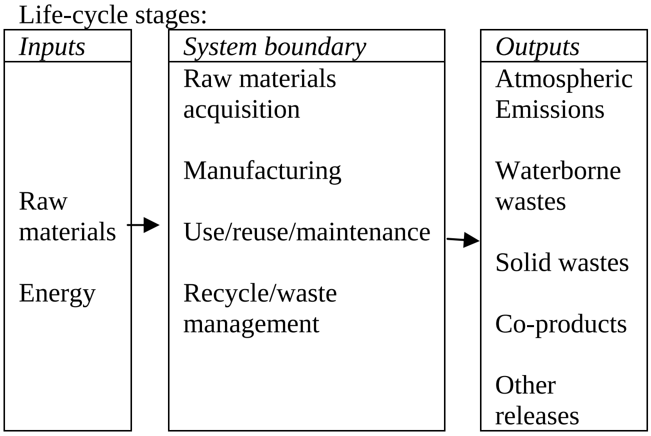
Renewable energy is a significant subset of sustainable development: it offers an opportunity to engage business and provide a practical tool in the agenda of sustainable development [1] .

The core energy intensity indicator is proposed to measure all the direct and indirect fuels used to produce the product(s) or deliver the service(s) per unit of production or service delivery [6] :

$$\text{Core Energy intensity} = \frac{\text{Energy consumed within the project boundary from all sources}}{\text{Unit of production or service delivery}}$$

Energy or fuels used are taking in account: electricity, oil, gas, coke, coal, wind, nuclear, other (solar, biomass, geothermal).

Life-cycle stages:



Life-cycle energy intensity indicator refers to the consecutive and inter-linked stages of product system, from raw material acquisition or generation of natural resources to final disposal.

Excess energy intensity indicator measures the excess energy generated within a product or service entity that is not used within the facility but used by or sold to others. This indicator applies to companies that produce energy as a co-product. Used together with the core energy intensity indicator can indicate a net energy benefit for a company.

Transportation energy intensity indicator of materials or personnel addresses the energy needed to transport materials and/or energy (personnel) between life-cycle steps per unit of service. *For materials*: it should be noted that travel within the project boundary is already included in the core indicator - for industries such as energy or forestry, if assuming the project boundary is the corporate level, the transport of materials to and from the project boundary may represent a significant portion of total energy use. *For personnel*: it should be noted that this includes the travel of personnel to and from the project boundary on a daily basis and business travel.

*Complementary waste or water intensity indicator*s are additional important indicators.

Reduction of the amount of waste send to final disposal is easy to measure by the amount of reused waste as the percentage of total waste.

$$\text{Waste utilization (\%)} = \frac{\text{Waste utilized}}{\text{Total waste output}} \times 100$$

The water discharge intensity indicator is defined as:

$$\text{Water discharge intensity} = \frac{\text{Water discharged}}{\text{Unit of production or service delivery}}$$

3. DEVELOPMENT OF EDD RETS PROCEDURES FOR ENVIRONMENTAL REVIEW

Although *Environmental Due Diligence* and *Due Diligence Review* are well defined, procedures for *Environmental Due Diligence of Renewable Energy Technologies* (EDD RETs) are poorly defined. By this paper we are proposing more systematic approach based on The UNEP Guidelines on Environmental Due Diligence of Renewable Energy [5] .

The general intention of a due diligence review is to ensure that a projected investment does not carry financial, legal, or environmental liabilities beyond those that are clearly defined in an investment proposal. The environmental component of the due diligence procedure is referred to as environmental due diligence (EDD). EDD is the collection and assessment of data relative to environmental conditions or impacts prior to a transaction to identify and quantify environment-related financial, legal, and reputation risks. EDD has become a way for financial institutions to incorporate environmental and social considerations in their investment review process.

Although most renewable energy technologies are environmentally sound in theory, all of them can have negative impacts on the environment if poorly planned and EDD RETs is highly recommended.

The first stage of the procedure is establishing the relevant regulatory framework for the project, including national regulations, international standards, and good practice guidelines. Environmental regulations, standards and guidelines provide practical information concerning emission limits, permitting requirements, pollution abatement and control techniques and equipment, best management and operational practices, etc., against which the investment proposal should be benchmarked.

Two timeframes must be considered for this process:

- first, that of existing laws and regulations that currently affect the project, and
- second, that of anticipated laws and regulations (e.g. in process of development, discussion, or approval) that may change the conditions under which the project must operate.

The second stage is the core of the entire process. It comprises four main steps:

a) assessing the environmental risk;
b) determining mitigation measures;
c) estimating the cost of risk management; and
d) reporting the results.

It is important to note that since these tools are intended for general use, they may not reflect all the possible environmental and/or social issues related to a particular investment. The analyst should incorporate additional issues as needed. To facilitate the first two steps of this stage a number of new EDD tools are proposed. These tools are intended to complement, not replace, any EDD tools currently used for environmental review procedures.

The third stage is the monitoring and environmental evaluation of the project. This procedure serves two main purposes:

a) to ensure that the project sponsor complies with the applicable environmental standards and various environmental components of operations included in legal agreements;

b) to keep track of ongoing environmental impacts associated with project operations and of the effectiveness of any mitigation measures.

If the project has been approved, the final stage is the monitoring stage. For this purpose, specific provisions should be included in the legal documentation, for example, the requirement of annual environmental reports, independent environmental audits at specific intervals, site visits, etc. Significant changes in the project (like projected expansions, changes in technology), changes in the type of finance (e.g. from loan to equity), and/or foreclosures should always be preceded by a re-assessment of environmental risk.

Case study: Serbia

The analysis is piloting for Serbia as the case study. The following renewable energy sources are of interest: - biomass and biogas, - hydro-potential, - geothermal potential, - solar energy, - wind energy, as well as waste-to-energy.

As the illustration some indicators are presented bellow:

	Biomass	*Geothermal*	*Hydro*	*Solar*	*Wind*
Bulgaria	Very Good	Good	Very Good	Fair/Good	Very Good
Croatia	*	*	*	*	Good
Czech Republic	Good	Fair	Fair	Poor	Good
Estonia	Fair	Poor	*	Poor	Very Good
Hungary	Very Good	Good/Very Good	Poor	Poor	Fair
Latvia	Good	Fair	*	Fair	Good
Lithuania	Good	Good	*	Poor	Fair
Poland	Very Good	Fair/Good	Good	Poor	Good
Romania	Good	Good	Very Good	Good	Very Good
Serbia and Montenegro	*	*	*	*	Poor
Slovak Republic	Good	Poor	Good	Good	Poor
Slovenia	*	*	*	*	Poor
Regional Average**	3.2	2.3	2.8	1.7	2.6

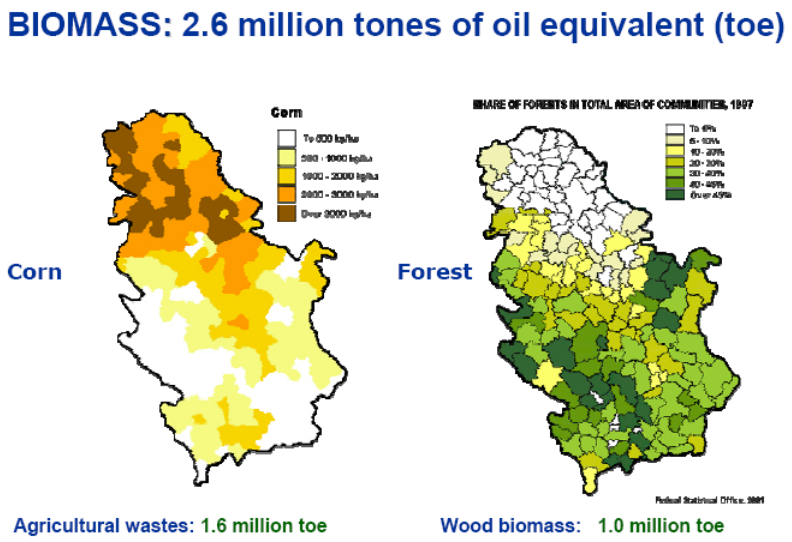
* No rating available.
** Average indicators are derived from assigning a point system to the qualitative assessments for each country: poor = 1; fair = 2; good = 3; very good = 4.
Source: Preliminary information prepared for European Bank for Reconstruction and Development by Black and Veatch International based on private consultancy reports.

As noted, the results for Serbia were not available when this assessment was done. However, results in [7], as well as other documents at national level, confirms significant renewable energy sources potential in Serbia, together with : -favorable conditions for renewable energy sources deployment; - ambient for low risk investments in small hydropower plants; - technical and financial support from international community needed, and -promotion of good practice renewable energy sources projects. Note: EDD RETs have to accompany each project, in addition to EIA requirements.

As the third priority of Serbian National Energy Policy wider use of renewable energy sources, measures and instruments, with new legislative and institutional framework and new renewable energy sources regulation is foreseen [1], [4] .

Renewable energy sources potential in Serbia are as follows:

Biomass (2.58 million toe)
Small hydro (1 600 GWhor 0,4 million toe)
Geothermal (0,18 million toe)
Solar energy (ne)
Wind energy (ne)



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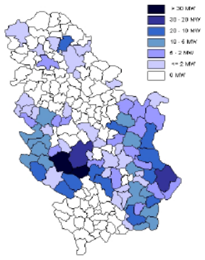
SMALL HYDRO ENERGY

❑ **Potential**
- 900 locations for building up new SHPP (up to 10 MW) with total capacity of 500 MW
- >5 MW: 9 locations
- 2-5MW: 30 locations (average 3 MW)
- <1 MW :most SHPP

❑ **Actual state of existing SHPP**
- 60 SHPP (50 % out of operation)
- 1 MW in average

❑ **Legislation**
- technical and financal aspects

❑ **Prospective projects**
- revitalisation of old and out of operation SHPPs (30)
- building new ones at existing water accumulation



Total MW from Small Hydro Power Plants

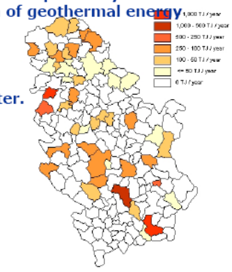
GEOTHERMAL ENERGY

❑ **Actual state**
- Only in some spas and agricultural companies geothermal energy of water wells are in use.
- At many locations there is an old equipment presently out of operation that were used for utilisation of geothermal energy

❑ **Potential** 0,18 million toe

> 100 registered geothermal wells of hot water. Temperature: usually between 30 to 80 °C. Max. 110 °C.

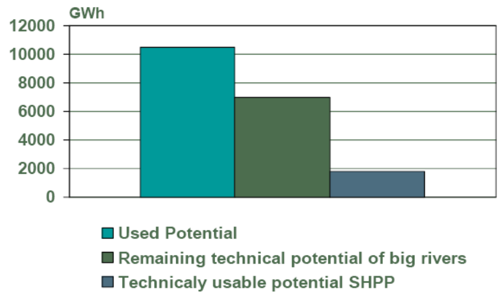
❑ **Prospective projects**
- replacement of old and non-operational installations (direct use, heat pumps)
- building up new installations



Total TJ / year from Geothermal Energy Sources

New renewable energy sources are planned in National Policy for Energy Sector Development until 2015, in the structure of final energy. It is need for further assessment of national potentials (with waste-to-energy potentials [2] , [3]), determination of national indicative targets, defining stimulating mechanisms, defining rules for network systems and defining internal market rules.

STRUCTURE OF HYDRO POTENTIAL



Economic and financial opportunities and constraints will be important, along with issues of energy security, increased access to modern forms of energy, cost of imported fuels, and a number of more specific national priorities.

Reducing GHG emissions by introducing more renewable energy, for example, will also have positive impacts on the security of energy supply, while potentially compounding the need for investment capital.

Renewable energy can potentially play an important role in stabilizing greenhouse gas emissions and mitigating climate change. To secure broad public and policy support to promote renewable energy development, it is essential to include broader economic, environmental, and social benefits in any analysis (i.e. to develop and implement national strategy for sustainable development).

To accelerate both the development of better renewable energy technology and markets in the next decades, policy action is required at both national and international levels. Targets and timetables at the global level to reduce emissions such as those established under the Kyoto Protocol or develop technologies can be important instruments to ensure and accelerate national action and to guide private investment decisions in the increasingly globalised economy. With the current and predicted cost competitiveness of many renewable energy technologies, however, it is not necessary to wait for strengthened global agreements before taking action at the national level.

4. REFERENCES

[1] A.Mihajlov, “Sustainable Development and Environment in 95+ steps”, *SCC / Environmental Ambassadors* (**www.ambassadors-env.org**),Beograd (2006)

[2] S. Miletic, M.Ilic, A.Mihajlov, “Using Alternative Fuel in Cement Plants”, *Proc. REWAS 2004, [pp. 2515 - 2522], Madrid, Spain (2004)*

[3] D.Ubavin, G.Vujic, A.Mihajlov, Dj.Basic, “Gas to energy opportunity on landfill in city of Novi Sad – Serbia and Montenegro”, *World Congress and Exhibition "ISWA 2005", November 6.-10. 2005. Buenos Aires, Argentina Ref No 194, Proceedings p.82*

[4] A.Mihajlov, “Towards Sustainable use of Natural Resources: Product Development from Sustainable Consumption and Production Perspective”, *Proc WASCON 2006 Conference – Waste Materials in Construction, Belgrade (2006)*

[5] EBRD Policy papers

[6] Eco-efficiency indicators, National Round Table on the Environment and Economy, Canada (2001)

[7] Report on Project TD 7029 for Serbian Ministry for Science and Environmental Protection (2006)