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Diffusion of Mitigation Technologies in Kazakhstan

Analysis of Barriers for Small Hydro Promotion

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***Abstract*— Kazakhstan is expected to be the biggest renewable energy player in Central Asia with ambitious target increase from 3persent by 2020 to 50 percent in energy balance by 2050. EXPO-2017 in Astana will bring the best international practices and resource-saving technologies to demonstrate international tendency of renewables development, as well as the success of introducing the Green Economy Concept in Kazakhstan.**

Despite good legislative base in place and conditions created by state the real diffusion of mitigation technologies including small hydropower develops at a slow pace. The conducted analysis of barriers preventing small hydropower technology diffusion and investigated policy mechanisms allows selecting effective measures that promote the development of small hydropower, increase the competitiveness of technology, and accelerate development with lower climate change impacts in Kazakhstan.

Keywords—small hydropower, mitigation, technology diffusion, climate change

I. INTRODUCTION

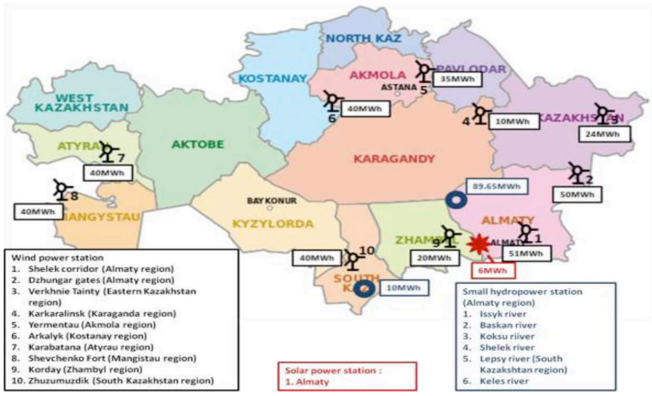
Kazakhstan is one of most energy intensive economy from CIS (14.63 t CO2/capita, 0.46 toe/thousand 2010 USD in 2013) [1]. The energy sector is the largest GHG emitting sector accounting for 85% of all emissions, mostly because of coal makes about 80% of fuel in electricity power generation.

Kazakhstan approved the Concept of transition to a Green Economy (2013) focusing on the following areas: energy efficiency, power, agriculture, water resources, air pollution, waste management; became a member of IRENA (2014) and the Renewable Energy Policy Network for the 21st century (REN21).

EXPO-2017 in Astana will bring the best international practices and resource-saving technologies to demonstrate international tendency of renewables development, as well as the success of introducing the Green Economy Concept in Kazakhstan.

Being rich in fossil energy resources, such as oil, gas and coal [2] Kazakhstan is expected to be the biggest renewable energy player in Central Asia. Kazakhstan is taking further steps towards development of its alternative energy potential and is keeping modernizing the carbon-reliant economy from innovative development perspective [3].

Fig. 1. Plan of location of objects on renewable energy sources in Kazakhstan



The share of renewable energy in total final energy consumption was less than 2% and share in power generation was less than 1% in 2012. Kazakhstan is a net exporter of energy [2], the lack of generation capacity in the south, forces to import electricity from neighbouring countries.

Kazakhstan has great protentional resources of renewable energy sources (RES) including of hydropower - about 170 TWh per year, wind energy – 1800 TWh per year, solar-2,5 TWh per year; wastes use- 35 billion kWh per year. Small hydropower plants (HPP) with capacity less than 35 MW have a great value. The research showed that it is technically possible to implement - 62 billion kWh, of which about 8.0 billion kWh of capacity of small hydropower plants (HPPs). The best prospects in the development of small HPPs exist in the Southern zone of the country (Almaty region with mountainous rivers capacity of 100-120 MW), also Eastern and South-eastern zones (Fig. 1).

II. Targets for technology diffusion and policy context

The favorable conditions created for attracting investments into the construction of power plants based on renewable energy sources in Kazakhstan include the Law "On supporting the use of renewable energy" (2009), the introduction of FITs (Table 1) in amendment to the law (2013) which are expected to perform a kind of guarantee for the investors return on investment and the "Concept of Transition to Green Economy of the Republic of Kazakhstan" (2013), setting the ambitious targets for RES development as the following: from 3% share of RES in energy balance by 2020(2.5 TWh) [4], to 30% by 2030 and to 50% by 2050 accordingly. Kazakhstan plans to spend an average USD 3.2 billion a year along with investors to achieve its green goals set in the Kazakhstan 2050 Strategy and to cut carbon emissions significantly.

The hydroelectric plant development is part of the government effort to increase significantly its overall renewable power generation before 2020 as the Country Rivers enjoy significant hydropower capacity

The target for small hydropower set in the "Action Plan for alternative and RES development in Kazakhstan for 2013-2020" (2013-2014) is to construct 41small HPPs with total capacity 539 MW which will be 17.65% of total RES capacity (3054.55 MW) to be built by 2020. The capital costs required are about 1040 million USD (cost of 1 MW small HPP- 1.929 million USD). Cost of GHG reduction will be 0.013 USD per kg CO_2.

The diffusion of small HPP technology in Kazakhstan includes reconstruction and renovation of previously constructed small HPPs, adding small HPPs to water management projects with already existing water retaining structures with the aim of utilizing waste releases, and construction of new small HPPs for power supply in the remote districts.

TABLE I. ELIGIBLE RES TECHNOLOGIES AND FIXED RATE OF FEED-IN-TARIFFS IN LOCAL CURRENCY(KZT) AND USD

Eligible Technologies	**Fixed Feed-in-tariff**	
	KZT/MWh	***US$/MWh* (July 2015)**
Wind	22,680	121.94
Solar PV	34,610	186.08
Small hydropower	16,710	89.84
Biogas	32,230	173.28

(Source: Resolution of the Government of Kazakhstan #645 "On approval of fixed tariffs for RES" dated 12, Jul,y 2014)

Application of small hydro-power technology lines with the country's social, economic and environmental development priorities. Climate Change Mitigation benefits: Green House Gas (GHG) emissions reduction expected in amount of 30 Mt CO_2 by 2020. Regarding the country's social development priorities, application of the above-mentioned technology will create new employment opportunities (5300-6000 jobs by 2020) and will also have a positive influence on public opinion, which would realize the necessity to protect the environment and reduce consumption of the traditional energy resources. Regarding the country's economic development priorities, the technology will reduce energy production costs. Regarding the country's environmental development priorities, the application of an environmentally sound technology that has zero emission will help create a better environment.

Despite the interest to promote small hydropower plants, having national plan and policy Kazakhstan has not performed as expected, the real diffusion of mitigation technologies including small hydropower develops at a slow pace. In this regards revision and analysis of barriers for small hydro power technology promotion are relevant.

III. Analysis of barriers for small hydropower promotion

A. *Description of methodology used*

The initial long list of barriers compiled based on Questionnaire and interview based on own experience, existing studies and policy documents was discussed, screened and grouped by stakeholders via workshop using brainstorm, Logical Problem Analysis tool, Market mapping, root cause analysis and arranging the key barriers for further identification of measures to overcome them. Barriers (and similarly measures) have been identified in ten categories (Economic and financial; Market failure/imperfection; Policy, legal and regulatory; Network failures; Institutional and organizational capacity; Human skills; Social, cultural and behavioral; Information and awareness; Technical and Other barriers), analyzed using national and international practice, applied a participatory approach of working group consisting of representatives from the ministries (Ministry of Energy, Ministry of National Economy, Ministry of Investments and Development), research and educational institutions, NGOs, business, international organizations, associations and independent consultants. The working group has discussed the political environment and functioning regulations influencing technology transfer taking into consideration economic, market and other data. Using Logical Problem Analysis (**LPA**) the working group could bring together the key elements of problems, apply logical analysis of interrelated elements, and identify linkages between problem elements and external factors. The cause/effect relations were organized in Problem tree, having the main problem put as starter problem, causes at the bottom of the tree and their effects in the upper part of the diagram.

B. Analysis of barrier and results obtained

Economic and financial barriers

High capital costs. The small hydropower technology is mostly imported to Kazakhstan as the local production is very small, this lead to high investment capital costs. There are very few local manufacturers for small HPPs, the equipment is mostly imported from Russia, China and Europe. In case of organization of local production of equipment for mini HPPs (diversion type) the cost will go down from USD 350 -700 USD per kW to 100 – 250 USD per kW, at a cost of 0.05 - 0.4 US cents per 1 kWh of electricity.

Inadequate access to acceptable financial resource. The private sector does not have adequate access to low- interest and long-term loans and credits to acceptable financial resources at local and international market, so the private sector is unable to provide sufficient investment for introduction of the small hydropower technology

High transaction costs. The lack of experience of local consultants and the weak capacity of R & D institutions are the reasons why the costs of the feasibility study are high in Kazakhstan

Inappropriate financial incentives. There is lack of financing instruments. Though there is state support of SME by allocation of funds from the republican budget to the Entrepreneurship Development Fund "DAMU" but the volume of concessional lending is not enough, for small hydropower projects. There is lack of risk insurance for investors in the financing of innovative RES projects. The existing FIT for small hydropower also could not compete with consumer tariffs (6.5–8.6 KZT/ kWh, without VAT) for electricity generated by coal based Power Plants. The market for small hydropower technology is not economically viable for technology producers/importers, as electricity consumers are accustomed to the use of cheap energy.

Non-finanial barriers. The list of prioritised non-financial barriers is named below.

- Weak Policy, legal and regulatory barriers include inadequate tariff regulation; inefficient permission procedures; absence of long -term program or clear strategy on small HPP development
- Technical barriers include u*ncertainty regarding the ability of networks to carry additional load*
- Institutional and organizational capacity barriers include weak capacity of R&D institutions
- Information and awareness *barriers include* lack of market information, on modern equipment, lack of electronic atlas developed on small HPPs.

Finally, measures and enabling framework to overcome barriers of prioritized technology have been identified due to grouped barriers as financial and non-financial following the same steps, presented in Table 3. Example of LPA for non-financial barriers for small hydro power technology is presented in Fig. 2.

The assessment of financial measures by economic, social, environmental aspects is presented in Table 2, using Cost Benefit Analysis for further presenting to policy-makers.

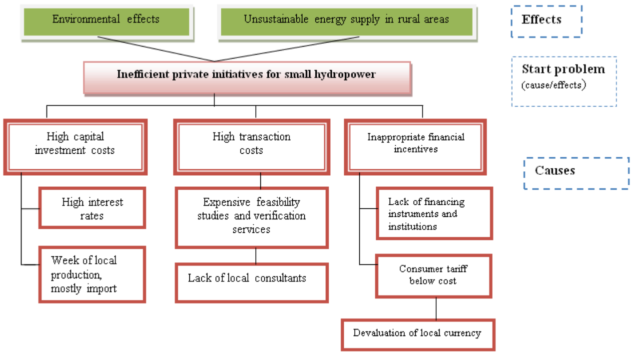
Based on results of assessment it is recommended to use investment subsidies along with standard PPA through LLP Billing Renewable Center. FITs are recommended to enhance using auction system introduction as mechanisms for stimulating introduction of small hydropower technology

TABLE II. ASSESSMENT OF FINANICIAL MEASURES FOR SMALL HYDROPOWER TECHNOLGY IN KAZAKHSTAN

Measures	**Benefits**				**costs**		**Benefits considering W**
	economic	***social***	***GHG reduction***	***environmental***	***capital***	***O&M***	
Weighted coefficient, W	0.1	0.1	0.3	0.2	0.2	0.1	1
Financial measures							
Loan guarantees (in case of no subsidy)	100	20	0	0	90	90	40
Standard Power Purchase Agreements (PPA)	100	80	30	0	80	100	53
Production incentives	70	100	0	100	80	60	60
Investment subsidies	100	80	0	100	90	60	61

(Source: "Barrier Analysis and Enabling Framework for Mitigation Technologies", July, 2016, Republic of Kazakhstan: http://www.tech-action.org/)

Fig. 2. LPA for non-financial barriers of small hydro-power technology



(Source: "Barrier Analysis and Enabling Framework for Mitigation Technologies", July, 2016, Republic of Kazakhstan: http://www.tech-action.org/)

TABLE III. BARRIERS AND MEASURES FOR SMALL HYDROPOWER IN KAZAKHSTAN

Categories	**Measures**
Economic and financial	Expanding use of financial instruments and financial resources
Legal and regulatory	Improve legal and regulatory framework
Institutional and organizational capacity	Expand Capacity Building Initiatives and Collaboration
Information and awareness	Implement Information Gathering and Sharing
Technical	Implement projects on small hydropower to achieve RES targets

IV. KEY FINDINGS

It has been observed that strategic directions for renewable energy development reflect national characteristics. Barrier analysis and possible enabling measures for small hydro power technology were identified for Kazakhstan using LPA analysis [5].

The authorities in Kazakhstan showed great interest in the development of small hydro projects to compensate the deficit in electricity demand for south rural areas in the amount of 7 TWh.

It was estimated that promotion of small and medium-sized power plants will help to reduce CO_2 emissions produced by thermal power plants to 3.2 million tons per year in 2020 and 8.6 million tons per year in 2030.

Policy support and financial support strategies must be designed to support home market development. Continued R&D investment and cooperation with international firms for technology transfer is important.

Adoption of long-term RES targets and the new regulatory framework by the Government has been welcomed as an important step toward developing the Kazakh renewable energy sector and increased investors' interest in RES projects. Since the adoption of the framework in 2009-2013, over 300 MW of RES-based capacity has been approved and/or put in operation and additional projects for over 450 MW have been submitted for approval by the Government. If all planned investments materialize, the 2020 3% RES target will be met.

The successful development of renewable energy, technologies to reduce initial investment costs, will not only make "green" electricity competitive on the market, but also to direct its energy to remote rural areas, as well as to provide for the use by individuals, and will make a significant contribution to reducing the country's emissions of greenhouse gases.

The results of this research and analysis will provide policy makers in Kazakhstan with the direction needed to develop Action Plan and strategy for small Hydropower technology diffusion into Kazakhstan market, and secondly, could be used in preparation of the NC report and implementing NDC.

REFERENCES

[1] IEA, International Energy Agency, 2013. Data from Statistics Report: https://www.iea.org/statistics/statisticssearch/report/?country=Kazakhstan&product=Indicators&year=2013

[2] REN21 (2015), UNECE Renewable Energy Status Report 2015, REN21 Secretariat, Paris, pp.19.

[3] S. Inyutin, G. Zhaparova, L. Inyutina, "Transition to green economy a new vector of Kazakhstan's innovative development", PROMIHEAS-4: 6th International Scientific Conference on Energy and Climate, vol.1, pp.38, 2013

[4] Inyutin, L. Inyutina, Y. Kalashnikov "Obstacles for the promotion of RES in Kazakhstan", PROMITHEAS-4: 6-th International Scientific Conference on Energy and Climate Change, October, 2013: http://www.promitheasnet.kepa.uoa.gr/index.php/activities/conferences/9-6th-international-scientific-conference-on-energy-and-climate-change-9-11-october-2013

[5] Boldt, J., I. Nygaard, U. E. Hansen, S. Traerup (2012). Overcoming Barriers to the Transfer and Diffusion of Climate Technologies. UNEP Risoe Centre, Roskilde, Denmark, 2012