Transition to bioenergy systems in transition economies: Case of Ukraine

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1 Introduction and background

Economies in transition (EiTs) (e. g. Ukraine (UA), Belarus, Moldova etc.) are characterised with significant dependence on energy imports, require revitalisation of their agricultural sectors and improvements in the state of environment (Gavrilita & Druta 2009; IEA 2006; Voytenko et al. 2009). The development of the countries' bioenergy potentials could help resolve these problems. However, EiTs face technical, political, financial, and capacity-based constraints in their transition to bioenergy (Srebotnjak & Hardi 2011; Voytenko et al. 2009). This field is significantly unresearched. In particular, there is an urgent need for the knowledge development that could support the formulation of national strategies and policies to overcome the mentioned barriers.

In UA biomass can supply 1 EJ per year (18% in the country's energy balance), the major part of which is formed by agricultural residues and energy crops (Geletukha & Dolinsky 2009; Geletukha et al. 2008). Currently the biofuels sector in UA is not institutionalised although a number of initiatives have emerged (Voytenko 2011). Biomass supplies only 0.5% in UA's energy balance (Dolinski & Geletukha 2010).

This paper aims to identify facilitating and constraining factors for the transition to bioenergy in UA and suggests strategies for policy makers and other bioenergy actors to stimulate such transition.

2 Theory and methods

2.1 Conceptual framework

Earlier developed 'agro-biomass framework for organisation and action' (ABF) (Voytenko 2011; Voytenko & Peck 2011) based on technology innovation system (TIS) approach (Bergek et al. 2008; Carlsson & Stankiewicz 1991; Hillman et al. 2008; Jacobsson & Bergek 2004; Jacobsson & Johnson 2000) is applied. It includes four categories of analysis: actors and networks, natural resources, technical and non-technical components (Fig. 1).

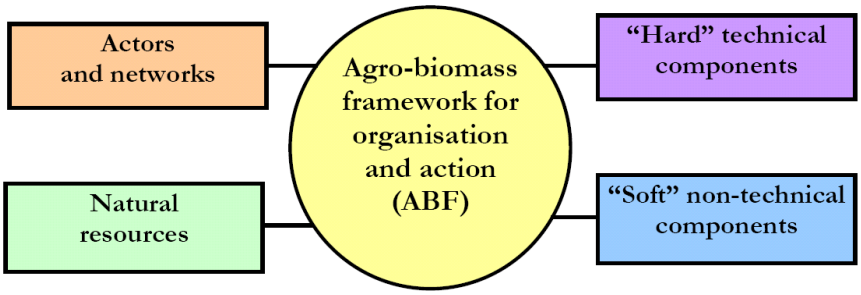

Figure 1. Components of an agro-biomass framework for organisation and action

A modern approach that applies TIS is considered to be dynamic as the analysis of a system is performed through the evaluation of its functions, which influence each other and create feedback loops (Bergek et al. 2008; Hekkert et al. 2007; Hillman et al. 2008). The enhancement of any/all of those stimulates TIS development. TIS functions by Hillman et al. (2008) are adopted here (Table 1). Identification of facilitating and constraining factors for bioenergy in UA and recommendations on the promotion of bioenergy development pathways in the country are guided by Table 1.

Table 1. TIS functions and their indicators

System function	***Indicators of function development***
F 1: Entrepreneurial activities	Projects with a commercial aim, demonstration, portfolio expansions
F 2: Knowledge development	Studies, lab trials, pilots, research programmes
F 3: Knowledge diffusion	Conferences, workshops, alliances between actors
F 4: Guidance of the search	Expectations, promises, policy targets, standards, research outcomes
F 5: Market formation	Market regulations, tax exemptions, events constituting niche markets
F 6: Resource mobilization	Subsidy programmes
F 7: Support from advocacy coalitions	Lobbies, advice

Source: Hillman et al. 2008

2.2 Methods

Data collection involved desktop and field research. Desktop research covered review of literature on bioenergy use and potentials in UA, related policies, theories, documents from bioenergy events etc. Field studies involved 14 in-depth interviews with key actors within agro-biomass production chain in UA and site visits to two grain producing farms with straw-fired installations, straw storages, baling equipment, premises with heating needs etc.

Data analysis involved nine initiatives using straw for energy and underpinned the proposal of three ABF types in UA. ABFs were developed for each case and compared in a cross-case analysis. Identification of facilitating and constraining factors for bioenergy in UA was guided by TIS functions (Table 1). Recommendations for the UA's bioenergy sector were formulated based on this analysis.

3 Results and discussion

3.1 Facilitating and constraining factors for bioenergy in Ukraine

Facilitating and constraining factors for bioenergy sector development in UA are presented in Table 2. The links to theory are highlighted via the analysis of the each factor's contribution to a TIS function (Table 1). The enhancement of the function is marked with '+', and its hindering – with '-'.

Table 2. Facilitating and constraining factors to establishment of bioenergy sector in Ukraine

	Facilitating factors	*Constraining factors*
Actors and networks	• National bioenergy leader SEC Biomass (**+F1**, **+F2**, **+F7**); • Bioenergy networks via "Biomass for Energy" conference (**+F3**); • National biomass equipment producers (**+F3**); • Local actors with energy needs (**+F4**); • UA & foreign actors with business interests (**+F1**); • Knowledgeable & enthusiastic prime movers (**+F2**, **+F4**).	• Market incumbents with opposing interests & lobbies for conventional fuels (**-F7**); • Local authorities with low level of cooperation & interest (**-F7**); • Limited funding institutions & potential sponsors (**-F6**); • Limited actors with sufficient funding capacities (**-F1**); • No strong Ukrainian Bioenergy Association (**-F7**); • No strong farmer associations (**-F7**); • No associations of straw suppliers (**-F7**).
Natural resources	• Sufficient straw resources (**+F4**); • Significant grain crop production (**+F4**); • Large potentials of lands for 2nd generation feedstocks (**+F4**).	• Soil impacts from excessive & uncontrolled straw removal & unsustainable agricultural practices (**-F4**).
"Hard" technical components	• Existing agricultural machinery (**+F4**); • Existing infrastructure (e. g. DH networks) (**+F4**); • National production lines for biomass-fired equipment (**+F1**, **+F2**); • Conversion facilities on fossil fuels (**+F2**).	• No baling tradition in straw handling (**-F6**); • No water distribution networks in rural areas (**-F4**); • No "cheap" domestic biomass boilers (**-F1**, **-F2**); • No national production of biomass-fired boilers above 2 MW & straw-fired boilers above 1 MW (**-F1**, **-F2**); • No national production of biomass CHPs (**-F1**, **-F2**).
"Soft" non-technical components	• Support schemes for renewables (**+F4**); • Low cost & competitiveness of agro-biofuels (**+F5**, **+F6**); • Fast payback of Ukrainian straw boilers (**+F6**); • Tradition of straw-to-energy in villages (**+F2**); • Locally acquired co-benefits (**+F6**); • Equipment sharing between actors (**+F6**); • 'Good practices' on straw-to-energy (**+F1**); • Successful foreign cooperation (**+F1**); • First straw supply contracts (**+F1**, **+F5**).	• Imperfections in bioenergy support schemes (**-F4**); • No fossil fuel or differentiated emission taxes (**-F5**); • Lack of transparent government influence in local/regional decision-making (**-F7**); • Lack of access to funds & low paying capacity by key actors (**-F1**, **-F6**); • Prejudice against 'old' traditions of straw-firing for energy (**-F7**); • Lack of awareness, knowledge & expertise on bioenergy among key actors (**-F2**).

3.2 Recommendations for transition to bioenergy in Ukraine

Recommendations focus on target groups to this study and include UA policy makers and nongovernmental actors, academia and researchers in UA, EiTs and other countries.

Ukrainian policy makers (i.e. governmental leaders, local and sub-regional authorities)

1. Support the implementation of the first demonstration 5-10 MW straw-fired district heating (DH) plant with financial and technical resources and thus positively contribute to the expansion of entrepreneurial activities (F1) and knowledge development (F2) in the bioenergy sector.
2. Seek for potential sites to implement demonstration and pilot bioenergy projects to

increase awareness, knowledge (F2) and understanding (F4) of various actors, and improve attractiveness of bioenergy to national and foreign investors.

3. Create cost preferences for (e.g. remove cross-subsidised tariffs for natural gas) and promote renewable energy/bioenergy and thus stimulate market formation (F5) and resource mobilisation (F6) in bioenergy sector in UA.
4. Introduce a carbon tax for fossil fuels (or similar policy intervention) to encourage more streamlined bioenergy market formation (**F5**), mobilisation of resources (**F6**) and thus enhance socio-political legitimacy of bioenergy at the institutional level.
5. Introduce a state subsidy on the purchase of biomass-fired equipment to increase its affordability for potential owners and operators and thus stimulate resource mobilisation (**F6**).
6. Develop and stimulate the implementation of regional state programmes on the promotion of renewable energy and bioenergy use to create efficient incentive based schemes for local decision makers and improve guidance of the search by them (**F4**).

Non-governmental actors (NGAs)

1. NGAs with *business interests* in UA's bioenergy and *bioenergy consultants* should seek for potential energy objects to be converted to biomass. To stimulate entrepreneurial activities (**F1**) NGAs should develop concrete business ideas on transformation of such objects to bioenergy.
2. *Farmers* and *rural development actors* should strengthen local farmer associations and seek to form local straw supplier associations. The later could then unite their efforts in a National straw supply association, which could act as a counterbalance against fossil fuel and nuclear lobbies (**F7**), stimulate knowledge diffusion (**F3**) and increase the legitimacy of bioenergy.
3. To stimulate entrepreneurial activities (**F1**) and knowledge development (**F2**) national *manufacturers* of firing equipment should seek to produce grain dryers on biomass with up to 2 MW capacity, straw-fired boilers above 1 MW and co-generation units on biomass of 10 MW.
4. *SEC Biomass* should promote its Biomass for Energy conference among rural development actors and find ways to continue its educational bioenergy seminars. This is expected to improve the knowledge and understanding of bioenergy options by key actors (contribute to knowledge diffusion (F3) and thus enhance cognitive legitimacy of bioenergy.
5. *Bioenergy and environmental NGOs* should establish a meaningful National Bioenergy Association with a unit responsible for fund raising and advising on funding sources for bioenergy implementers. This is to overcome financial and cognitive

barriers to bioenergy in UA, and establish prerequisites for a more efficient goal achievement via collective action.

6. All potential *bioenergy leaders* should search for foreign project partnership. Foreign support through technology transfer is required as it helps building up experience, stimulates knowledge development (F2) and diffusion (F3) and creates opportunities for external funding of bioenergy projects thus activating entrepreneurial activities in the sector (F1).

Academia and researchers

1. Systematise all potential funding sources and financial schemes for biomass installations in UA to reduce economic barriers, which are often linked to the low purchasing power of actors. This is to stimulate resource mobilisation (F6) and market formation (F5) around bioenergy systems.
2. Conduct country study on sustainably acceptable crop residue removal levels from soils in different parts of UA and thus guide the search (F4) of bioenergy practitioners.
3. Assess current market potential for grain dryers in UA, and the use of crop residues in such to improve knowledge (F2) on expansion prospects for biomass-fired grain dryers in the country.
4. Estimate the market potential for straw-fired co-generation units above 10 MW to obtain a better understanding (F4) of large scale agro-biomass use for energy in UA.
5. Identify potential suppliers of economically viable biomass-fired equipment outside UA to reduce technological barriers, stimulate resource mobilisation (F6) and entrepreneurial activities (F1).
6. Seek for potential sites to implement demonstration and pilot agro-bioenergy projects to increase awareness and knowledge of various actors (F2 and F3), and improve attractiveness of bioenergy to national and foreign investors.

4 Conclusions and further implications

The major *constraining factors* for bioenergy in UA include flaws in legislation; imperfections of incentive-based systems for renewable energy/bioenergy; presence of market incumbents lobbying for conventional fuels; lack of collective action between bioenergy actors; lack of national technology production lines; low access to funds, knowledge and technology by local and sub-regional actors.

The major *facilitating factors* include significant bioenergy potentials; presence of a national bioenergy leader with a potential for networking, knowledge development and diffusion; existence of national biomass equipment producers; low costs and competitiveness of agro-biofuels; fast payback of biomass boilers; interest of foreign actors in biomass-to-energy

activities in UA.

A number of targeted recommendations to key actors are suggested for the enhancement of each function of a bioenergy TIS in UA. This work establishes prerequisites for a legitimate agro-industrialbioenergy sector in UA and thus is unique of its kind for Ukrainian and EiT context. It emphasises the engagement of various stakeholders to facilitate the transition to bioenergy with the help of a new framework by the author. The latter can also be applied in a variety of settings for the analysis of bioenergy initiatives and the degree of bioenergy development.

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